Chapter 4
LANDSCAPES

From north to south, the region in the Land Systems Map extends from the Panamanian isthmus to southern Brazil; from east to west it reaches from the Atlantic Ocean to the Andean foothills. It covers a large part of the watersheds of the Orinoco, Amazon, and Paraná-South America's three major river systems. Its physiography is molded from geological formations spanning nearly 1000 million years; from the Precambrian shields of central Brazil and the Guyanas rich in granites, micas, and gneiss to the alluvial deposits of many rivers that occurred in the recent epoch. Between these extremes there is a rich diversity of landscape formation on sedimentary, metamorphic, and volcanic deposits with a gamut of ages and materials. These include shales from the Devonian to Tertiary periods; mudstones and sandstones of the recently uplifted Andean foothills and their more recent andesitic volcanic ash mantling in the equatorial region; mudstones and sandstones of the Orinoco, Amazon, and the western Paraná basins dating from the Tertiary and Quaternary eras; and an extensive Cretacean tufa (volcanic) capping over parts of the Precambrian-shield region of southern Brazil (Mozart Parada and Maia de Andrade, 1977).

This chapter describes the topography and vegetation classes used as the bases for delineating land facets in the Land Systems Map.

Geology

The Brazilian shield, visible as the plateaus of central Brazil and the higher lands of eastern Bolivia, and its more northern equivalent, the Guyana shield, seen mainly in southern Venezuela, date to the Precambrian era. They support the oldest land surfaces in South America. Nevertheless, in some places, outcrops of hard granitic rock give these regions a more broken topography than that often associated with old surfaces. The landscapes of the two shields are separated by the much younger Tertiary, Quaternary, and Recent sediments of the Amazon basin. Continental drift theory suggests that these shields were once a part of the African continent.

The Brazilian shield extends at a relatively shallow depth from the northern plains of eastern Bolivia (at a depth of about 600 m at Trinidad) to the sub-Andean piedmonts. According to Schlatter and Nederlof (1966), Bolivia can be divided into a tectonically higher northern half and a deeper southern half, separated by a tectonic belt or "fault line" extending from Arica, Chile, on the Pacific coast, to the 41 elbow" of the Andes in the environs of the village of Buena Vista about 80 km to the north of the city of Santa Cruz, and continuing eastward across the continent. This phenomenon, considered in relation to the tremendous centrifugal forces caused by the spinning of the world around its axis over the eons, might provide a possible explanation for the directional change in the lie of the Andes. North of Buena Vista, the Andes swing from a northwest to southwest direction, resulting in a considerable effect on climate.

Schlatter and Nederlof consider that the Andean uplift started in mid-Tertiarian times. Movements were spirogenic, and two major Neogene depositional basins were formed: the Altiplano Trough, sandwiched between the Andes, and the Eastern Foredeep. Both received sediments mainly from the Andes.

At the end of the Pliocene or possibly the start of the Pleistocene era, the main Andean uplift created the high Andean Cordilleras. These are the result of largely vertical uplift with block faulting (a Germanotype style) and asymmetric folds. They are in a stage of active erosion.

Erosion is particularly noticeable in the sub-Andean foothills, which in many places show evidence of very recent uplifting. Erosion, particularly in parts of Peru and Bolivia, is taking place in spite of the forest cover; it is dramatic where soft sandstones and conglomerates are found in the foothill region.

Hydrology

The Orinoco, Amazon, and Paraná river systems drain most of the region; they provide waterways for transport and fishing and are an immense resource for power generation. The Amazon river system is navigable for large, seagoing ships as far inland as Manaus, and for quite large vessels as far inland as Porto Velho, the capital of Rond6nia State in western Brazil, and to Iquitos and beyond in Peru'. Small riverboats penetrate much further.

It is unfortunate for Bolivia that rapids (rocks belonging to the Brazilian shield formation) make the principal Amazonian tributaries, the lower Beni and Madeira rivers, impassable to river craft. To overcome this problem, a railway was built during the height of the rubber boom to link the cities of Guajard Mirim and Porto Velho; this was abandoned in 1966 but is now being rebuilt because road transport has not proven economic in this part of our energy-short world. A hydroelectric power station was recently constructed near Paranaiba on the Paraná river, and immense power reserves exist at Iguaçu, the site of the world's largest power complex under construction on the lower Paraná river (see Photo Plate

53). The erosion in southern Brazil, and the need for urgent control measures, is indicated by the color of the water in the photograph (see Photo Plate 54).

Major hydrological disasters could well take place in the coming years over parts of the watersheds of the Orinoco and, especially, the Amazon rivers, unless the present tendency to encourage colonization in unstable foothill regions is discontinued. The so-called *carretera marginal de la selva* (marginal jungle road), presently projected to follow along the Andean foothills, should be relocated well into the plains to help avoid the deforestation of erodable lands by colonists.

Physiographic Regions

Map 4 (see Map Plates) summarizes the major macrophysiographic regions identified on the Land Systems Map, the differences among which may be appreciated from the photographs in the Plates.

Amazon Basin

This is the lowland region of Amazonia between the subAndean foothills and the Brazilian and Guyanian shields. (See Photo Plates 1-15.) It is drained by many tributaries of the Amazon river. The land surfaces are predominantly plains or peneplains exhibiting various patterns of dissection and recent terrace formations. A large part of the region, especially in the northwest, is poorly drained; some areas, particularly in the vicinity of large rivers, are susceptible to annual flooding. Most of the region is still covered with native vegetation, although considerable destruction of forest has taken place in recent years.

Brazilian Shield

This refers to the elevated and exposed Precambrian shield region of Central Brazil and is characterized by old, stable plateau surfaces. (See Photo Plates 16-30.) A large part is still covered in native vegetation, mainly savannas locally called "Cerrados." However, considerable development has taken place during the last 20 years with the establishment of Brazil's administrative capital, Brasilia, located virtually in the epicenter of this unit. The formation extends into eastern Bolivia.

Elbow of the Andes

This unit has been delineated to emphasize the fault line across the South American continent extending eastward from the "elbow" of the Andes near Buena Vista nestling in the sub-Andean foothills of Bolivia. Apart from physiographic implications, the region has climatic characteristics transitional from the tropics to the subtropics.

Andean Foothills

This region defines the sub-Andean foothill region. (See Photo Plates 31-34.) It is particularly important as many of the foothills are susceptible to erosion. The indiscriminant clearing of native vegetation from the foothills is already aggravating flooding problems in the Amazon Basin and Mojos Pampas region of Bolivia.

Guyana Shield

This refers to the elevated and rugged Precambrian shield region north of the Amazon river. It is still mainly covered by native vegetation-forest and savannas.

Mojos Pampas

This is an extensive area of wetland savannas in the eastern plains of Bolivia, allegedly formed from the infill of a geologically postulated ancient lake between the Andes and the Brazilian shield. (See Photo Plates 35-38.) Apart from being a major cattle-producing area (Photo Plate 37), it is both geologically and archeologically unique. The presence of hundreds of "square" lakes (Photo Plate 35) has baffled geologists for years; current theory postulates that they are an effect of faulting in the underlying Brazilian shield. The presence of "raised beds" (Photo Plate 38) in many sites (Denevan, 1964) has presented an enigma to archeologists. The senior author believes that pre-Columbian peoples cultivated their food crops on these raised beds simply to raise them above the high, wet-season water tables of the region. It is interesting to speculate that their major grain crop was probably Job's tears *(Coix lacryma* Jobi), as this crop is still cultivated by some of the indigenous peoples in the region.

Orinoco Basin

This is the lowland drainage basin of the Orinoco river and its tributaries. (See Photo Plates 39-45.) It is largely covered by savannas on both poorly and well-drained lands, but includes some forests, particularly those abutting the western edge of the Guyana shield and in the northeast.

Pantanal

This is an area in western Brazil mainly along its border with Bolivia. As the name suggests, it is a lower, poorly drained savanna region. Nevertheless, landscape differences and grades of seasonal inundation exist.

Paraná Basin

This region includes a large part of the watershed for the Paraná river found in southern Brazil. (See Photo Plates 51-55.) It is largely made up of savanna and some deciduous forest covering dissected plain surfaces. There are extensive areas of sandy soils in the western portion of these plains.

Physiographic Units

Within the physiographic regions, physiographic units were identified to separate distinctive landscapes, using locally recognizable names. As the land systems were delineated, they were assigned numbers identifying them with these physiographic units. These are listed by country in the glossary to Part I of the *Computer Summary* (Volume 3). Figure 4-1 illustrates their use to make a physiographic map of Central-West Brazil. They present a picture of the major landscape differences within any one country or region. However, for agricultural production considerations, the land systems per se must be considered.

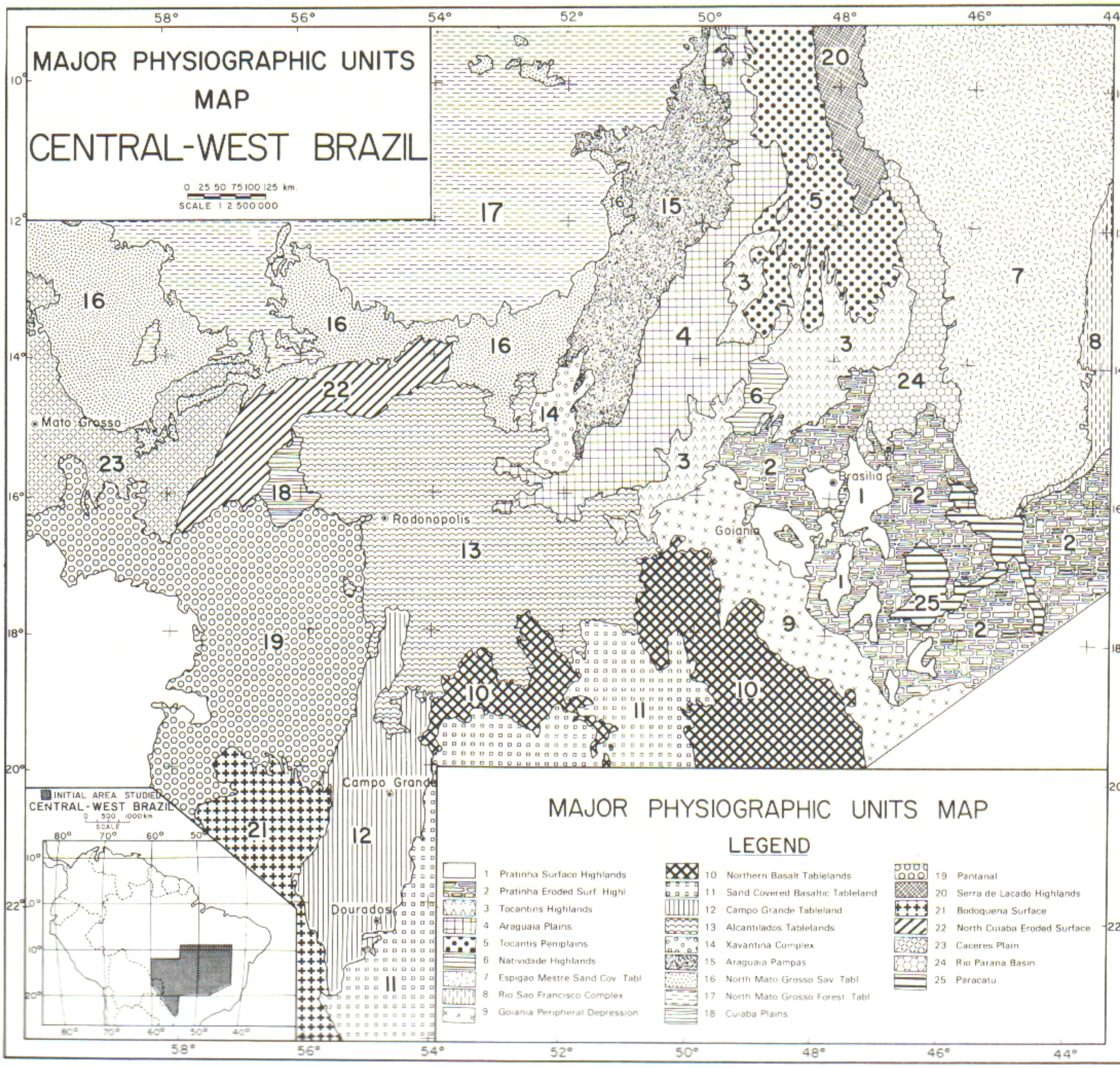

Fig. 4-1 Physiographic units map of Central-West Brazil.

Land Systems, Land Facets and Mapping Scales

The description and coding of the landscape features have been described in Chapter 2. The subdivision of the land systems into land facets emphasizes that landscape is not constant, but continually varying. As practical farming has to cope with a variation in land surfaces and soils, the description of the land facets within a land system is clearly important.

It should be remembered that there may be lesser variations in topography, vegetation, and soils within a land facet; however, some level of generalization must be accepted in making an inventory of land resources. This is inherent in all but the most detailed large-scale maps, such as individual farm maps. Therefore, the generalization made in classifying the soils of the land facets according to their predominant soils is no more serious than those currently accepted in soil mapping. In fact, the emphasis given to describing land systems in terms of facets adds to the usefulness and precision of this study.

For very small-scale maps, further generalizations are quite acceptable. As the mapping scale becomes smaller, the degree of detail is diminished. It is quite permissible, therefore, to depict the topography, vegetation, and soils of the major land facets as those predominating over a region. This is useful to provide an overview of major features-to rephrase an old saying, "to see the forests and not the trees." The computerization of the study facilitated the production of such overview maps.

It also facilitated quantification of properties. Because quantification is made on the basis of the land facets, however, the figures reflect a greater degree of precision than the mapping units based on the land-system subdivisions.

Topography

Map 5 is a computer-based map summarizing the topography of the region.

Poorly Drained Lands

Approximately 21% (170 million ha) of the region is poorly drained; 82% of these poorly drained lands (I 39 million ha) is covered with forests and the remainder by native savannas.

The vast extent of poorly drained forest lands along the Andean foothills and northwest Amazonia imposes a natural barrier to agriculture. Nevertheless, the seasonally flooded Lands or *varzeas* (see Photo Plate 6) of major river systems often have naturally fertile soils, and it is likely that increasingly important areas will be brought into more intensive production of crops, including wetland (paddy) rice and juice, in the not too distant future.

The poorly drained savanna lands have been used successfully since colonial times for extensive cattle production. Significant areas are found in the Brazilian Pantanal (see Photo Plates 46-50); the Bolivian Pampas de Mojos (Photo Plates 35-38); the Casanare plains of northeast Colombia (Photo Plate 45), which extend into southwest Venezuela as the Apure plains; the island of Maraj6 at the mouth of the Amazon river (Photo Plate 2); the Humaitá plains north of Porto Velho in Rondbnia in Brazills southwest Amazonia; parts of the Amapá savannas near the mouth of the Amazon river on its northern side (Photo Plate 1); parts of the Boa Vista savannas in northern Brazil; and the contiguous Rupununi savannas of Guyana.

Well-Drained Lands

About 79% (649 million ha) of the region is reasonably well drained. The major part of this area, 508 million ha, is covered by forest, and the remaining 141 million ha is covered by savannas. Approximately 77% of the well-drained lands (497 million ha) has slopes less than 8%, and 23% (152 million ha) has slopes greater than 8%. The relatively flat lands are often closely dissected by small streams. In fact, over 86% of the entire area has perennial streams at less than 10 km intervals and 39% less than 5 km apart (see Photo Plate 43).

Topography and Climatic Subregions

Table 4-1 provides a summary of the topography within the broad climatic subregions described in Chapter 3. It is based on computer printouts.

There is a significantly higher proportion of poorly drained lands in subregion A, the tropical rain forests. Even so, 70% of these areas are well drained; of these, 128 million ha have slopes less than 8%. With the notable exception of some areas in the sub-Andean foothills, such as the Florencia region of Colombia (see Photo Plate 34) and the Yurimaguas region in the low Selva of Peru (see Photo Plate 9), most of these lands are still covered by native tropical rain forest vegetation. Variations in physiography are common and picturesque along the narrow- sub-Andean foothills (see Photo Plates 31.

Table 4-1. Topography of the climatic subregions of the central lowlands of tropical South America.

Climatic subregion code	Subregion name	Area (million ha) in each topography class: Flat, poorly drained	Well-drained: <8% slope	Well-drained: 8-30% slope	Well-drained: >30% slope	Total area (million ha)	Total area (%)
a	Tropical rain forest	65	128	20	4	217	27
b	Semi-evergreen seasonal forest	50	189	64	5	308	38
c	Isohyperthermic savanna	31	76	13	9	129	16
d	Isothermic savanna	0	33	6	4	43	5
e	(Semi-)deciduous forest	23	62	10	8	103	12
f	Subtropical vegetation[a]	1	9	1	0	11	1
o	Other[b]	0	0	2	6	8	1
	Total area (million ha)	170	497	116	36	819	
	Percentage of total area	21%	61%	14%	4%		

a. Other vegetation on predominantly poorly drained or seasonally flooded lands.
b. Nonclassified, or submontane or subtropical forest.

33, 34). Between the Andean foothills and the Precambrian shield much of the landscape is uniform and gently undulating, although it is often interspersed with extensive areas of poorly drained lands.

By far the largest area of well-drained lands is found in subregion B, the tropical semi-evergreen seasonal forests (see Photo Plates 3, 5, 14). In central, eastern, and southern Amazonia, these forests are largely intact, although sizeable areas, especially in Rondônia state of Brazil's southern Amazonia, have been cut down in recent years (see Photo Plate 12).

About 73% (189 million ha) of the well-drained lands of subregion B are relatively flat, with slopes less than 8%. The landscape tends to be less variable than in other subregions. Nevertheless, there are major physiographic differences; a large part is closely dissected by the many tributaries of the Amazon River.

Subregion C is largely defined by the well-drained isohyperthermic savanna lands. Some extensive areas of flat lands are found, such as the *altillanura* plains along the south bank of the Meta river (3-4 X *I*O' ha) in Colombia's eastern plains (see Photo Plates 41-43), but large tracts of these lands are strongly dissected.

Subregion D is comprised of the isothermic savannas, mainly confined to the higher (greater than 900 m) plateau lands of Central Brazil, and the cooler southern limits of Brazil's "Cerrados," which contain extensive tracts of flat lands dissected by small valleys (see Photo Plates 16, 17, 18, 21, 23, 26, 27).

Subregion E covers a wide range of topographies.

Vegetation

The Land Systems Map and Figure 3-6 (Chapter 3) summarize the distribution of the natural, physiognomic vegetation classes over the region. The use of physiognomic terms does not imply any preconceived ecological or climatic conditions. the description of the savanna and forest classes used throughout the study strictly follow those quantitatively defined terms used by Eiten (1968, 1972) for tropical welldrained savannas and Caatinga and by Eyre (1968) for tropical forests. Only the classification "seasonally inundated pampas" has not been defined in a physiognomic sense; these *pampas* refer to any lowland tropical savanna or grassland with soils that suffer from prolonged periods of waterlogging.

Savannas

According to Bernal Diaz (1975), "savanna" is a Carib Indian word signifying "treeless plain." In modern usage, its meaning has been extended. Eiten notes that "The range in structural forms in cerrado is completely continuous in the sense that stands can be found in any region which may be ranged in a series from arboreal, through all grades of scrub and structural savanna, to (usually) pure grassland of the cerrado type." This continuity was recognized by many early travelers and particularly emphasized by Smith (1885). The classifications used by Eiten for savannas, or Cerrados, are summarized as follows.

Campo limpo. Grassland with tall visible woody plants essentially absent (see Photo Plate 20), and whose flora is made up of practically the same species as the ground layer *of Campo cerrado.* (Note that the use of *Campo limpo* here is for a variation of the Cerrado flora.) Sometimes, when a Cerrado grassland has a few, very scattered, low but conspicuous shrubs or acaulescent palms, it is distinguished as *Campo sujo.*

Campo cerrado. Includes several forms with total woody plant cover rather open or sparse (see Photo Plate 2 1), that is, less than 30-40% cover, such as:

a. Quite open scrub
b. Low arboreal, quite open woodland
c. True physiognomic savanna, i.e., scattered medium-tall or low trees, or shrubs, or usually both trees and shrubs intermixed, over a continuous or slightly open layer of grasses, herbs, dwarf shrubs, and semishrubs.

Cerrado (strict sense). Includes several forms with the total woody plant cover closed down to about 30-40% (see Photo Plate 22), such as:

a. Closed or semi-open low arboreal forms (canopy generally less than about 7 m tall).
b. Closed or semi-open scrub forms (canopy generally less than about 3 m tall), the elements of which may be definitely shrubby, arboriform, or the two mixed.
c. Closed or semi-open scrub mixed with scattered trees of various heights. The trees may be emergents and form a single upper layer or, usually, rise to varying heights along with varying heights of scrub elements so that the upper surface of the vegetation is "hilly."

Cerradio. Medium-tall arboreal form with a closed or semi-open canopy (see Photo Plate 23) (but not less than 30-40% tree crown cover).

Forests

The following descriptions briefly identify the tropical forest classifications (see Plates), as used by Eyre.

Tropical rain forest. Most trees are evergreen in habit, casting their leaves and growing new ones continuously and simultaneously (see Photo Plates 8-10). Some may shed all their leaves for a short period at irregular intervals. Large trees may develop plank buttresses, although these are more common in areas with impeded drainage. The trunks of certain trees, especially "lower story" trees, such as cacao, may bear flowers and fruit. This phenomenon is termed "cauliflory," and the bark of such trees is usually very thin. Palms may be present, but not in the great numbers found in poorly drained areas.

A tropical rain forest is usually well over 30 m in height. Statistical appraisal would indicate that it has a three-tiered structure. Under the often-open upper canopy may be found a layer of smaller trees, and, in turn, below this, a lower "story." Trees in the different layers are frequently specifically adapted to particular niches within the microclimatic and structural complex of the forest, and are not necessarily simply immature forest giants. Thus, trees in the lower forest layers largely consist of species adapted to reduced light conditions.

Usually a large number of tree species exists in any one area. These commonly belong to the Rosaceae, Compositae and Leguminosae families. Lianes and epiphytes are common.

The shrub lay ' er is poorly developed (often just a few ferns and seedlings), and, for this reason, it is usually quite easy to walk through a tropical rain forest.

Tropical semi-evergreen seasonal forest. These forests generally have a two-layered structure, may reach heights of 25 in or considerably more when growing on inherently fertile soils, and possibly 20 to 30% of the upper canopy trees lose their leaves in the dry season. Apparently, many of the evergreen species of the upper layer are facultatively deciduous. In other words, they have the ability to lose their leaves in an extreme dry season. A high proportion of the lower story trees are evergreen.

This type of forest differs from the tropical rain forest in other respects. Fewer trees are buttressed. In the early winter season, many species produce flowers, especially the lower layer trees that tend to be small-leaved.

Tropical semi-deciduous seasonal forest. This forest (see Photo Plate 19) has two strata. The upper at about 15 in is predominantly deciduous. Evergreen trees are common in the lower layer at 4 to 10 in.

Tree species differ considerably from those found in semievergreen seasonal forests. They have more gnarled trunks (as opposed to the straight trunks of the semi-evergreen seasonal forests); they branch quite near the ground and have umbrellashaped canopies, or canopies with distinct horizontal strata, as compared with the compact, conical, or rounded crowns of the wetter forest. Bottle trees, Acacia species, and giant cacti are usually present. The bottle tree flowers about late April to May with the late rains, fruits, then sheds its leaves. Some palms that appear to withstand drought may also be present. A high proportion of the trees are microphyllous. The forest tends to be poor in lianes.

Herbaceous plants, especially grasses, are scantily represented on the forest floor, although spiny plants, particularly Bromeliaceae species, may be very common.

These forest classes correspond to those growing on welldrained soils. The various sub-seres (modification), ecotone characteristic (gradations between two groups), and features worthy of special note of any one type of vegetation are not reflected in the vegetation coding. When very different subseres due to natural phenomena were found, e.g. hvdroseres (vegetation adapted to wet soil conditions), they were classified with the "Other" vegetation classes. When ecotones were found, they were assigned to the closest vegetation class.

Caatinga. Caatinga has been described by Eiten as the thornscrub of northeastern Brazil (see Photo Plate 29). It is not a structural form of Cerrado, but a different coordinate, large-scale vegetation type with different flora; nevertheless, some Caatingas contain a proportion of Cerrados species. Closed scrub is the commonest form of Caatinga, but this vegetation type also occurs in many other structures, all natural in some regions: forest, arboreal woodland, closed shrub (mostly of definite shrubs 2 - 5 in tall), closed scrub with emergent low trees, open shrub (mostly of definite shrubs 1.5 in tall), shrub savanna (scattered low trees or shrubs over a closed shortgrass layer, the *Serido* form), and others. Many of the shrubs and trees are spiny. Cacti are almost always present, such as tree cacti of the Cereus tribe, low clumps of globular and cylindrical species, and Opuntia. Terrestrial species of bromeliads are very abundant in most Caatingas.

Submontane forests. Submontane forests are found at altitudes between about 1000 and 2000 in. The classifications of Eyre were used and noted on the original coding sheets. These may be summarized in the following way.

Sub-montane evergreen forest. This forest has a twotiered structure with an open canopy of trees reaching to heights of 15 to 20 in. Ferns are common in the shrub layer. Most of the tree species are either evergreen or only shed their leaves for short periods at irregular intervals.

Sub-montane semi-evergreen forest. This forest is similar in structure to the sub-montane evergreen forest in that it has a double stratum of trees and an open canopy, but is generally lower (I 3 to 16 in). A noticeable proportion of trees shed their leaves during the June to August period. Leaf shed in some species is preceded by flowering about April, followed by fruiting.

Sub-montane deciduous seasonal forest. This forest usually has a single layer of trees and tends to be open. Heights vary from about 8 to 12 in. Thorny scrub and cacti are common in the shrub laver. Almost the entire forest sheds its leaves for 3 to 5 months of the year.

Table 4-2. Areal extent (%) of the savannas* of tropical South America, subdivided on the basis of relative arboreal biomass contents, with major soil chemical constraints.

Low P		Low K		Al toxic (70% Al sat)		Low Ca		Low Mg	
C	85.6	CD	94.3	CD	93.5	C	82.3	CL+CS	77.6
CC	82.9	C	90.8	C	57.8	CC	74.0	CC	51.5
CD	81.1	CC	88.5	CC	54.4	CL+CS	61.6	C	21.1
CL+CS	58.0	CL+CS	68.1	CL+CS	40.0	CD	49.0	CD	15.5

a. Brazilian terms commonly used (see Eiten, 1972): CL+CS = campo limpo + campo sujo (grassland with occasional shrubs), CC = campo cerrado (open savanna), C = cerrado (intermediate savanna), CD = cerradão (closed savanna).

Sub-montame microphillious forest. This is a low.4 to 7m high, often open forest or scrub. Cacti are common. The density of the vegetation appears to increase with increasing availability of moisture. The forest is relatively leafless for 6 to 8 months of each year.

Vegetation and Soils

Lopes and Cox (1972) reported a soil fertility sequence following the relative arboreal biomass contents of a limited area of the well-drained savannas. However, as shown in Table 4-2, such a sequence was not confirmed by this study, with the exception of Mg, the significance of which may require further investigation, although it is possibly just a coincidence.

Induced Vegetation

Table 4-3 summarizes the areas of human-induced vegetation throughout the region. It must be noted that these figures were based on imagery taken over the period 1973 to 1976, and as such are very approximate. They do not take into account areas that have been cut over or partially altered; only those areas with obvious signs of vegetation changes. They should be used, if at all, with qualification.

Table 4-3. Areas (ha) of human-induced vegetation throughout the central lowlands of tropical South America (from satellite imagery taken during period 1973-76).

Climatic subregion code	Subregion name	Area planted to pastures	Area planted to crops
a	Tropical rain forest	11,697,490	6,959,370
b	Semi-evergreen seasonal forest	20,904,120	11,999,580
c	Isohyperthermic savanna	13,259,220	6,006,850
d	Isothermic savanna	8,738,000	3,571,620
e	(Semi-)deciduous seasonal forest	5,622,700	2,647,440
f	Subtropical vegetation[a]	2,751,320	737,870
o	Other[b]	1,460,510	804,740
	TOTAL	64,433,360	32,727,470

a. Other vegetation on predominantly poorly drained or seasonally flooded lands.
b. Nonclassified, or submontane or subtropical forest.

Conclusion

There is no doubt that the 613 million ha of well-drained lands in the region with slopes of less than 30%, from a climate and landscape point of view, represent one of the world's major reserves for crop, pasture, and agroforestry production under rainfed conditions. It follows, therefore, that their soil conditions should be carefully examined.

Map Plates

1. Agroecological Zones of Tropical Pastures Program
2. Natural Vegetation Classes
3. Climatic Subregions
4. Physiographic Regions
5. Topographic Classes
6. Soil Orders/Soil Taxonomy
7. Suborder Soil Classes/Soil Taxonomy
8. Great Group Soil Classes/Soil Taxonomy
9. Generalized Soil Map/FAO-UNESCO Legend
10. Soil Unit Map/FAO-UNESCO Legend
11. Soil Fertility/FCC System
12. Soil Textural Classes/FCC System
13. Soil Moisture-Holding Capacity
14. pH Levels in Topsoil (0-20 cm)
15. Al Saturation Levels in Topsoil (0-20 cm)
16. Al Saturation Levels in Subsoil (21-50 cm)
17. Potash Levels in Topsoil (0-20 cm)
18. Ca Levels in Topsoil (0-20 cm)
19. Ca Levels in Subsoil (21-50 cm)
20. P Levels in Topsoil (0-20 cm)
21. Levels in Subsoil (21-50 cm)
22. P Fixation in Topsoil (0-20 cm)
23. Suborder Soil with Possible Variable Charge
24. Great Group Soils with Possible Net Positive
    Charge in Subsoil Horizon