Zonal Patterns of Agricultural Land Use in the State of Paraíba, Northeast Brazil

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Although Northeast Brazil has been recognized as being constituted by three distinct zones, the coastal sugar cane zone (*zona da mata*), the semiarid inland cattle country (*sertão*), and the transitional zone between them (*agreste*), their demarcation and the criteria for classification have not always been clear. The present study attempts to visualize the zonal pattern of land use and to propose a quantitative regionalization of the cultural landscape in the state of Paraíba, Northeast Brazil. Along a 270 kilometer belt from the Atlantic coast to Patos, the land use of one square kilometer plots was intensively surveyed at five-kilometer intervals near the coast and ten-kilometer intervals inland. Our analyses suggest that the agricultural land use pattern in the state of Paraíba is composed of eight distinct regions. Three regions are identified near the coast, the urbanized region, the sugar cane cultivation region, and the root crop producing region. The *agreste*, characterized by cattle raising and maize cultivation, is made up of the depression zone-parkland pasture region, the orographic rain-savanna pasture region, and the dense *caatinga* region. The *sertão*, where extensive grazing in sparse *caatinga* is the dominant form of livelihood, consists of the Borborema Plateau and the Patos Basin. These regional divisions, identified by our field survey, were verified by analyses of statistical data on livestock and cultivated crops by *município* as well as by observations of roadside sales of agricultural commodities by peasants.

I. Introduction

In Northeast Brazil the declining precipitation from the seaboard to the inland brings about striking contrasts between the humid tropical coast and the semiarid backcountry. Such differences in natural environment are manifest in agricultural activities and land use. Being students of cultural landscapes and human uses of the earth, geographers have studied Northeast Brazil and suggested that it consists of three regions: the coastal region (*zona da mata*), the semiarid backcountry (*sertão*), and the transitional zone between them (*agreste*).

Although these regional divisions have been commonly accepted, they have lacked clear definitions. Demarcation of their boundaries and the criteria for classification have not always been clear. JAMES (1953) outlined the general features of land use in the Northeast

based on his field survey and statistical analysis. ANDRADE (1980, p. 9), a foremost scholar of the region, has defined the *zona da mata* as the traditional sugar cane region with high temperatures and humidity, the *sertão* as a hot and arid cattle country with frequent drought, and the *agreste* as having small holdings and mixed farming. According to WEBB (1974, pp. 10-12), the *zona da mata* receives precipitation of more than 1,200 millimeters so that tall evergreen and semi-deciduous arbores flourish, while the *sertão* has thorn scrub vegetation called *caatinga* with annual rainfall of 270 to 800 millimeters. The *agreste*, located between them, has rainfall of 800 to 1,200 millimeters, thus providing favorable environment for tubers such as manioc, an important staple food crop in the Northeast. WEBB's definition of the *zona da mata* is narrower and more restricted to the coast than that of ANDRADE.

The state of Paraíba provides an excellent

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field for studying the relationship between land use and natural environment, for the *zona da mata*, *agreste*, and *sertão* are clearly differentiated there within a short distance of the coast. This may be the reason why Japanese geographers at the University of Tsukuba (formerly Tokyo Kyoiku University) have actively studied Paraíba's environment and land use on six different occasions since 1966/67. HAYASHI and NUMATA (1976) defined the *zona da mata*, *agreste*, and *sertão* by examining the general vegetation cover, indicator plants, cultivated crops, and density of *açude* (artificial ponds) for 250 kilometers inland along national highway BR-230 from Cabedelo on the coast. Their definition is more restrictive than that of WEBB, for the indicator plants used in the classification, including *imbaúba* (*Cecropia palmata*), are generally found neither on farmland nor on pasture but only in forest. MACHIDA (1976), who also examined annual precipitation, evapotranspiration, and topography in his regionalization of the natural environment, agreed with HAYASHI and NUMATA in defining the three regional divisions. YAMAMOTO (1975), on the other hand, studied the socioeconomic integration of the sugar economy of the *zona da mata*, the peasant food-producing economy of the *agreste*, and the livestock economy of the *sertão* with a focus on the *usinas*, or modern sugar factories, of the coastal region. These contributions by Japanese geographers are qualitative rather than quantitative in attempting regionalizations.

The present study investigates the pattern of land use in Northeast Brazil in an attempt

to identify criteria capable of quantitative measurement for regionalizing the landscape. It also attempts to propose quantitatively based regional divisions. For this purpose, an intensive field survey was undertaken in July and August of 1984 in the state of Paraíba from the *município* of João Pessoa on the Atlantic coast to the interior *município* of Patos. A supplementary field investigation was conducted in 1986.

The study area extends across some 270 kilometers from Cabo Branco to Patos. Land use was surveyed in plots of one square kilometer every ten kilometers along the survey route (Figure 1). In the coastal region where topographic maps at a scale of 1:25,000 were available, the field surveys were conducted every five kilometers. In and around Campina Grande, where topographic maps at scales of 1:25,000 and 1:100,000 were not published, distance markers on national highway BR-230 were used to locate plots at 12 kilometer intervals along the curving road between Salgado de São Inez and Sítio Mumbuca, 70 and 130 kilometers from the coast respectively. A detailed land use map was drawn for every one square kilometer plot based on field observations. Five dominant land use types were recorded and plants such as sisal and fruit trees and types of fences were noted. Livestock and crop production patterns were then analyzed employing 1980 agricultural census data (IBGE, 1983). Furthermore, direct sales of farm produce along the roadside were examined on the assumption that such commercial activities reflect the regionality of agricultural production.

Fig. 1 Survey route and locations in the state of Paraíba.

II. East-west differences in land use

1. Coastal region

1) **Vicinity of João Pessoa:** Location 0, facing the Atlantic Ocean, is just west of Cabo Branco, the easternmost part of the South American continent. Here *tabuleiros*, low coastal tablelands, have 30 meter high cliffs overlooking the ocean and support small landholdings of *capoeira* type pasture with a few kitchen gardens. *Capoeira* is a term that refers to a secondary growth forest. Sited in the eastern part of João Pessoa, the capital city of Paraíba with the population of some 330,000, this location, with a large housing development nearby, will become an upper class residential district on the coast in the near future.

Location 0.5, five kilometers from the ocean, is just west of the Federal University of Paraíba. Faculty and public housing and other housing land accounts for some 30 percent of its total land use. Although an urbanized part of João Pessoa, a reserved forest dominates the area. Location 1, 10 kilometers from the ocean, encompasses the junction of João Pessoa's loop road and the Recife-João Pessoa highway (BR-101). It has residential and industrial land, but a large *açude* occupies the largest area. Coconut palms reflect the coastal character of this area. Location 1.5, situated east of the João Pessoa airport, is dominated by housing development, but pasture and *capoeira* wasteland are also important landscape features.

These locations within 15 kilometers of the ocean are under the strong influence of

João Pessoa's urbanization (RODOLIGUEZ and DROULERS, 1981). The pasture which appears in each location is mostly devastated and therefore can be viewed as social fallow awaiting a rise in land values (SINCLAIR, 1967).

2) **Sugar cane and root crop region:** Sugar cane, the single most important commercial crop of the coastal region, appears in the location 2. The sugar cane fields are mainly in the southern part of the section, while *capoeira* type pasture predominates over the north. Manioc is widely cultivated in the valley of Riacho Tibiri which dissects the *tabuleiro* surface. This location appears to have a transitional landscape between the urbanized area and a sugar cane region further inland.

Locations 2.5 and 3 are characterized by a monoculture of sugar cane, though its area is surpassed by forest (*mata* and *capoeira*). While the *tabuleiro* surface was entirely covered with tropical forest in 1970/71 (Figure 2-a), the forest was cut, excepting in a forest reserve around Açude dos Reis, and replaced partly by sugar cane, particularly along the road (Figure 2-b). An area of *capoeira* (secondary forest) appears likely to be changed to sugar cane fields in the near future. The recent land use transition from forest to *capoeira* and then to sugar cane has been largely promoted on the *tabuleiros* by the Brazilian government's program to produce alcohol (PROALCOL) mainly for automobile fuel.

Sugar cane ranks first in the land use of locations 3.5 through 5.5. The present sugar cane region is considered to be the western part of the *tabuleiros* along the Paraíba River, once called the "sugar river." According to MATSUMOTO (1983), *tabuleiros* are widely found

Fig. 2 Land use change in Tibirizinho (location 3.5).

Fig. 3 Land use of Mata da Bandeira (location 5).

from the coast to the *várzea* (flood plain) of the Paraíba River (location 4). West of the river, the land surface has been substantially dissected. Although HAYASHI and NUMATA (1976), based on existing vegetation cover, would place location 3 (30 kilometers from the coast) at the western margin of the *zona da mata*, we consider location 4 (40 kilometers from the coast) as its western limit.

Here it should be noted that where sugar cane ranks first in land use, such subsistence crops as manioc, yams, or maize-beans rank either third or fourth. In location 5 (Mata da Bandeira) for example (Figure 3), sugar cane and pasture are followed in importance by manioc fields and yam fields. A *lagoa*, or shallow pond created by chemical solution on the *tabuleiros*, bordered by sandy soils is situated in the southern section of the plot. A rotation of cropland and pasture seems to be occurring (SARTO *et al.*, 1986), for the land that is presently pasture is shown as under sugar cane on a topographic map dated 1971/72. Yams, an expanding crop in the region, are raised with their vines growing around poles as in Japan, though the tubers there are much larger than Japanese ones. Pineapples are beginning to penetrate the region.

Although sugar cane is found in location 6 in the *várzea* of small creeks, it is unimportant there. Thus the sugar cane region is a 35 kilometer wide region, from location 2 through location 5.5, within which the dissected *tabuleiros* west of the Paraíba River constitute a root crop producing sub-region. The decline in precipitation from the *tabuleiros* inland to the dissected *tabuleiros* probably influences the transition from sugar cane to root crops.

3) **Cattle region of the *agreste*:** The topography changes from one of *tabuleiros* in location 5.5 to one of rolling hills in location 6. The area along BR-230 from Riacho Ipanema to Riachão do Baomarte belongs to the depression zone whose general inclination is lower than that of *tabuleiros*. According to the landscape survey, pasture ranks first in land use across the 30 kilometers from location 6 to location 9, which thus constitutes the cattle region in the *agreste*. The *Atlas geográfico do estado do Paraíba* (1985) describes this region as a dissected area of low relief, where scattered evergreens, *juazeiro* (*Zizyphus undulata*), are a distinctive feature of the pasture. We call it a parkland type pasture or a savanna type pasture to distinguish it from pasture in the sugar cane region characterized by *pangola* grass. The difference between the parkland type pasture and savanna type pasture is that the latter has a greater variety of trees with *avelós* (*Euphorbia heterodoxa*) hedgerows.

The *agreste's* cattle region has maize and bean fields following pasture in the land use order. Beans, locally distinguished as *feijão* (beans) or *fava* (lima beans), are commonly cultivated with maize in the upper part of the piedmont (MELO, 1980). In the *agreste*, precipitation increases with altitude, providing better conditions for such food crops. The importance of food crops in this cattle region reflects the presence of peasant farmers and *moradores* (resident farm workers) in cattle fazendas.

Cultivation of *palma santa*, or simply *palma*, and elephant grass, both important feeds during the dry season, is another characteristic of this pasture region. It indicates the intensive nature of cattle grazing mainly oriented toward fattening, as compared to that in the *sertão* where cattle breeding is the major activity. *Açudes* and wind pumped wells are numerous, and elephant grass is grown where water is available. Small areas of herbaceous cotton appear in this region, but recent epidemics of insects (*Anthonomus grandis* Bodeman) have sharply decreased the area in cotton (EMBRAPA-EMATER, 1984). In 1986 some recovery was observed in cotton cultivation.

2. Borborema Plateau

1) **Brejos and dense *caatinga*:** Locations 10 and 11 belong to the piedmont slope of the Borborema Plateau. These locations on BR-230 are areas of *brejo* with the characteristics of higher rainfall and humidity and constitute a part of the Anel do Brejos which goes through Campina Grande, Esperança and Areia. Although *brejos* in the *agreste* and *sertão* develop forest similar to that of the *zona da mata* due to orographic precipitation and humidity, our survey plots on BR-230 are devoid of the forest cover due to a long history of human occupancy. Pasture with exposed crystalline rocks are striking landscape features.

Although Esperança and Alagoa Nova, which are also part of the Anel do Brejos, grow Irish potatoes, vegetables, bananas and sugar cane, locations 10 and 11 do not have these crops and instead resemble the pasture region of the *agreste*. Figure 4 shows location 10, for which there are no topographic maps. The parkland type pasture dominates land use in location 10, while maize and beans are also found together with the houses of a few *moradores*. Elephant grass is seen along a creek near the road, and very small areas of manioc, though not shown in the figure, are also evident. Such a combination of land use typifies the *agreste*. It is an intensive cattle and food producing region.

Location 11 has a federal police office and location 12 embraces Botafogo Lake, both in the vicinity of Campina Grande (population 248,000), the second largest city of the state. The land use of these locations is under the strong influence of the city.

Fig. 4 Land use of Fazenda Santa Candia (location 10).

Fig. 5 Land use of Palestina (location 16).

Although *caatinga* vegetation characterizes the land use of locations 13 through 22 on the Borborema Plateau, that in locations 13 through 16 is designated as dense *caatinga* to be distinguished from sparse *caatinga* west of Soledade. Dense *caatinga* consists of straight bushes three to four meters high with *jurema* and xerophytes such as *mandacaru*, and with well developed undergrowth. Here the *caatinga* grazing field is dominant, where 10 to 15 hectares of land is required to support a head of cattle. It is extensive land use compared to the *agreste* pasture.

Maize and cotton are frequently observed in dense *caatinga*, as in location 16 (Figure 5). Although *caatinga* pasture is the dominant type of land use, maize, cotton and *palma* account for some one-third of the total area. In order to protect crop fields from an animal intrusion, vertical brush fencing is widespread (MATHER and HART, 1954). This type of fencing becomes a general feature of the landscape west of location 16, where goats are more common. The land use of dense *caatinga* areas resembles that of the *agreste*.

2) **Sparse *caatinga*:** From location 17 to location 22, sparse *caatinga* pasture is the predominant form of land use. Here undergrowth is sparse. Although yellow and purple flowering *mata pasto* (*Cassia bicapsularis*) plants are common, they are stunted and separated one from another. The sparse *caatinga* here may reflect the original meaning of the term "white forest." West of location 20, the study route follows state road 228 in order to maintain an east to west course.

Location 18, totally covered with *caatinga* pasture, well exemplifies the land use in this region. Exceptions are location 20 with

Table. 1 East-west survey of land use in the state of Paraíba, 1984.

Location			Land use					Fence	
No.	Northwest corner*	Altitude (m)	1 st	2 nd	3 rd	4 th	5 th	Other	Barbed wire fence
0	300—9210	0—37	<i>Capoeira</i> type pasture	Atlantic Ocean	Kitchen garden	—	—	—	
0.5	295—296	28—53	Forest	Houses and housing land	Pasture	<i>Capoeira</i>	Kitchen garden	Sisal	x
1	290—9208	22—48	<i>Açude</i> Houses	Houses	Pasture	Factories	Coconuts	—	x
1.5	285—286	30—62	Houses	Housing land	Pasture	<i>Capoeira</i>	Military facilities	—	
2	280—9210	25—73	<i>Capoeira</i> type pasture	Manioc	Sugar cane	Maize	—	—	
2.5	275—276	35—81	<i>Capoeira</i> Forest	Forest	Sugar cane	—	—	—	
3	270—9204	87—91	Forest	Sugar cane	—	—	—	—	
3.5	265—266	65—96	Sugar cane	Pasture	Manioc	Maize+beans	Yams	—	
4	260—9205	28—57	Sugar cane	Pasture	Manioc	Maize+beans	Sweet potatoes	—	
4.5	255—9205	65—89	Sugar cane	Beans	Yams	Manioc	Pasture	—	x
5	250—9205	77—97	Sugar cane	Pasture	Manioc	Yams	Maize+beans	Sweet potatoes	x
5.5	245—246	86—104	Sugar cane	Pasture	Maize+beans	Yams	Manioc	—	x
6	240—9208	85—94	Parkland type pasture	Elephant grass	Maize+beans	Urban	Sugar cane	<i>Avelós</i>	x
6.5	235—236	110—240	Savanna type pasture	Maize	Beans	Manioc	—	—	x
7	230—9206	107—137	Parkland type pasture	Maize	Sorghum	Manioc	—	—	x
7.5	225—226	105—132	Parkland type pasture	Cotton	Maize+beans	—	—	—	x
8	104—105	113—148	Savanna type pasture	Maize+beans	Maize+beans +cotton	<i>Palma</i>	Kitchen garden	<i>Avelós</i>	x
9	116—117	150—230	Savanna type pasture	<i>Capoeira</i>	Maize+beans	Maize	—	<i>Avelós</i>	x
10	128—129	270—313	Parkland type pasture	Maize+beans	<i>Capoeira</i>	Maize	Elephant grass	<i>Avelós</i>	x

Table. 1 (Continued)

No.	Location		Land use						Fence	
	Northwest corner*	Altitude (m)	1 st	2 nd	3 rd	4 th	5 th	Other	Barbed wire	Brush fence
11	140—141	360—465	Savanna type pasture	Maize+beans	Urban	<i>Palma</i>	Kitchen garden	<i>Avelós</i>	x	
12	152—153	535—585	Suburban housing	Social fallow	Lake	Maize+beans	Factories	Pasture (6 th)		x
13	830—9206	590—680	<i>Caatinga</i> pasture	Maize+beans	Maize	<i>Palma</i>	—	Sisal/ <i>Avelós</i>	x	
14	820—9209	570—620	<i>Caatinga</i> pasture	Sisal/ <i>caatinga</i> pasture	Maize	Beans	<i>Palma</i>	Sisal/Cotton/ <i>Avelós</i>		
15	810—9212.5	548—580	Sisal/ <i>caatinga</i> pasture	Sisal	Maize	<i>Palma</i>	—	Sisal/ <i>Avelós</i>		
16	800—9216	550—569	<i>Caatinga</i> pasture	Cotton	Maize	<i>Palma</i>	—	Sisal/ <i>Avelós</i>		xx
17	790—9220	515—530	Sparse <i>caatinga</i> pasture	<i>Açude</i>	Housing	Maize	—	—	x	
18	780—9223	570—589	<i>Caatinga</i> pasture	—	—	—	—	Sisal		x
19	770—9220	574—580	<i>Caatinga</i> pasture	<i>Caatinga</i>	Maize+cotton	<i>Palma</i>	—	Sisal/ <i>Avelós</i>	x	
20	760—9219	545—570	Cotton	<i>Caatinga</i>	<i>Caatinga</i> pasture	Maize	<i>Palma</i>	Sisal/ <i>Avelós</i>	x	x
21	750—9218	570—590	Maize+beans	Maize+cotton	Pasture	<i>Palma</i>	Housing	—	x	xx
22	740—9216	430—550	Bare ground	Sparse <i>caatinga</i>	Sisal	<i>Palma</i>	Maize+beans	—	x	xx
23	730—9214	360—462	Sparse <i>caatinga</i> pasture	Cotton	—	—	—	—	x	x
24	720—9213	318—348	Sparse <i>caatinga</i> pasture	<i>Açude</i>	<i>Vazante</i> farming (maize/vegetables)	—	—	—	x	x
25	710—9215	300—352	Sparse <i>caatinga</i> pasture	Pasture	Cotton	—	—	<i>Avelós</i>	x	xx
26	700—9220	250—289	Steppe type pasture	<i>Capoeira</i> type pasture	Cotton	Sheep pasture	Maize+cotton	Cotton in pasture	x	x

Note: x: Presence

xx: Frequent appearance

*: Numbers indicate the northwest corner on topographical maps.

many peasant farmers, and location 21 where Assunção's urban land use occupies a substantial area. Where peasant farmers are present, maize and arboreous cotton are interplanted, contrasting with the maize-bean complex in the *agreste*.

Throughout the Borborema Plateau, sisal was once an important commercial crop. Only two locations have sisal fields today but relics of the plant are frequently observed in *caatinga* fields. Sisal's styles, notable from a distance, are used as temporary cattle fencing in the twon of Assunção while the leaves, after being dried and softened, provide fibers to tie up firewood.

3. *Caatinga* on the slope of Patos Basin

The eastern slope of the Patos Basin (locations 22 through 26) appears to be the driest part of the Paraíba *sertão*. Inselbergs created by mechanical erosion and dwarfed *caatinga* vegetation prove its aridity. Located 220 to 260 kilometers inland from the ocean and in the upstream area of the Rio Espinharas of the Piranhas system, it has mostly a thorn bush vegetation without undergrowth so that the sandy ground surface is largely exposed to the sun. Goats are the principal animals kept here. Instead of the vertical wooden fences so common along the major road in the eastern *caatinga*, the brush fences in these locations are horizontal wooden bars attached to posts. On grazing grounds where wooden poles and barbed wire fences are installed, goats wear a pillory, or a triangular wooden frame, around their necks to keep them outside the field. Cattle and goats carry cowbells as well. Cowbells can be obtained at livestock husbandry supply stores in the towns of the *sertão*.

Location 25 (Largadouro) has a land use pattern representative of all locations 22 through 26 (Figure 6). *Jurema* and *favela* (*Conidoscolus phyllacanthus*) provide cattle with important feed and characterize the vegetation of the sparse *caatinga*. Pasture with arboreous cotton is present, and cotton fields are also observed. This location on the eastern slope of Patos Basin may have peasant farming elements, for *vazante* agriculture (YAMAMOTO and HIRAOKA, 1977) is practiced nearby. Stubble grazing occurs generally in

Fig. 6 Land use of Logradouro (location 25).

the maize-bean fields and the maize-cotton fields of the *agreste* and *sertão* during the dry season after harvest.

Table 1 summarizes the results of the survey. The location of the northwest corner of each one square kilometer plot is provided based on topographic maps.

III. Zonal patterns of agricultural landscape

1. Examination of north-south patterns of land use

The analysis of land use has so far been entirely linear, based on surveys of locations along an east-west trunk road in the state of Paraíba. The question may be raised as to whether the locations could possibly exemplify the general zonation of land use from the coast inland, for the road might be assumed to promote commercialization in adjoining areas by providing for better accessibility to the major market. In order to examine the validity of our sample, land use was surveyed along a north-south axis in five locations at five kilometer intervals, covering 20 kilometers north-south and two kilometers east-west. The results are summarized in Table 2.

Location N1, in the meanders of the Rio Gurinhém, a tributary of Paraíba River, where the town of Fazenda Sobrado is located, is on state road 079 connecting BR-230 and Sapé. Sugar cane ranks first in the land use pattern there, closely followed by pasture, and then by maize, maize-beans, and yams. As a topographic map dated 1971 shows *cana* (sugar cane) on fields now occupied by pasture, it may be assumed that field rotation is conducted here too.

Table. 2 North-south survey of land use in the state of Paraíba, 1984.

Location			Land use					
No.	Northwest corner	Altitude (m)	1 st	2 nd	3 rd	4 th	5 th	Others
N1	252—9210	35—62	Sugar cane	Steppe pasture	Maize	Maize+ beans	Yam	Sisal
5	250—9205	77—97	Sugar cane	Pasture	Manioc	Yams	Maize+ beans	Sweet potatoes
S1	252—9200	55—95	Savanna type pasture	Sugar cane	Maize+ beans	Manioc	Yams	<i>Avelôs</i>
S2	250—9196	35—75	Pasture	Sugar cane	Urban	Maize+ beans	Manioc	Yams
S3	250—9191	88—109	Sugar cane	Pasture	Manioc	Yams	Sweet potatoes	<i>Avelôs</i>

Location S1 is along an unpaved road connecting BR-230 to Pilar, an old administrative center on the Paraíba River. While pasture with *avelôs* hedgerows heads the land use list, sugar cane is in second place followed by maize-beans, manioc, and yams. A number of *açudes* are observed and elephant grass is cultivated along creeks. The land use of location S2 resembles that of location S1, excepting that sugar cane leads pasture. Sugar cane and pasture are also in first and second place respectively in location S3, located south of Pilar and east of Itabaiana. Other land uses are fields of manioc, yams and sweet potatoes.

Locations N1, S1, S2, and S3 in the north-south axis have many land use characteristics in common with location 5 on BR-230. Sugar cane and pasture are the leading land use elements, followed by such food crops as manioc, yams, maize-beans, and sweet potatoes. *Avelôs* hedgerows in pastures are another common feature. These locations well represent the food producing economy located between the *zona da mata* and the *agreste*. Yams appear to be an indicator crop of the region.

The surveys suggest that, unlike advanced capitalist economies where agricultural commercialization proceeds along major communication routes, the land use in our study area is a direct reflection of the natural environment where annual precipitation declines with distance from the coast (NISHIZAWA, 1976) and agricultural mechanization remains minimal excepting for sugar cane cultivation. Such

longitudinal similarities of land use were also observed west of the north-south survey line between Caja and Itabaiana. Therefore, we are convinced that our sample locations along the state highway closely reflect the east-west pattern of land use.

2. Comprehensive analysis of landscape patterns

Figure 7 offers a comprehensive representation of landscape transition based on the field survey of 35 locations in an east-west transect along BR-230 and state road 228 from Cabo Branco on the Atlantic coast to a point east of Patos. There are eight locations, one every five kilometers, near the coast, and 27 locations, one every ten kilometers, farther from the coast. The north-south deviation of these locations being only 19 kilometers, they may be considered to be in a latitudinal line. Although the threefold regional division of *zona da mata*, *agreste*, and *sertão*, and the geomorphological classification of coastal *tabuleiros*, Borborema Plateau, and Patos Basin have been widely accepted, our landscape survey suggests more detailed regional units reflecting the natural environment, vegetation cover, and agricultural activities in this 270 kilometer-long belt.

Land use in the area from the Atlantic Ocean to a point 15 kilometers inland on *tabuleiros* is under the strong influence of the city of João Pessoa, for devastated pasture awaiting a rise of land values is a striking landscape feature. The original *tabuleiro* surface is well preserved for 40 kilometers from the ocean,

Fig. 7 Patterns of land use between João Pessoa and Patos, Paraíba.

protected from erosional processes by the coastal forest to which the name “*zona da mata*” (forest zone) has been applied. Farther west, beyond the Paraíba River, the *tabuleiro* surface remains only in patches (MATSUNOTO, 1973). Sugar cane cultivation, promoted by the recent PROALCOL program of the federal government, predominates over the preserved *tabuleiro* surfaces. Here the prevailing features of the landscape appear to have changed through time from forest to *capoeira*, and most recently to sugar cane. This process has provided urban centers with building materials as well as fuel for domestic consumption and business use, including bakeries and brick-making.

Sugar cane also leads land use in the region 40 to 45 kilometers from the coast, but pasture, manioc, and yams increase in importance. In particular, yam cultivation has been expanding in recent years. This region, belonging to the transitional zone between the *zona da mata* and *agreste*, is labeled as an intensive root crop producing district. These three regions, the urbanized region of João Pessoa,

the sugar cane region on *tabuleiros*, and the root crop producing region on dissected *tabuleiros*, can therefore be considered as subregions of the *tabuleiros* in the *zona da mata*.

The area 60 to 90 kilometers from the coast belongs to the depression zone where inselbergs and rolling hills are dominant geomorphological features. This is the intensive cattle raising region of the *agreste*, where a parkland type pasture leads the land use with such cultivated feed as *palma* and elephant grass. Maize, beans, and cotton are also important here. On the eastern slope of the Borborema Plateau precipitation increases with altitude. The region 100 to 120 kilometers from the coast, which can be seen to have *brejo* conditions, is considered a western extension of the *agreste* cattle region, for intensive farming as practiced in Esperança and Alagoa Nova, both belonging to the Anel do Brejos, is not observed here. In addition, the suburban influence of Campina Grande is observed. In the area 130 to 160 kilometers from the coast, dense *caatinga* predominates where sisal was once an important commercial crop, and

maize and beans retain importance as in the *agreste* cattle region.

West of this region, from 170 kilometers to Patos, the land surface is almost entirely covered with sparse *caatinga*, and goats are important animals. On the eastern slope of the Patos Basin, also covered by sparse *caatinga*, arboreous cotton is an important landscape element.

As indicated above, consideration should be given to replacing the traditional threefold classification of the cultural landscape from the Paraíba coast to Patos with our eight regional divisions: 1) urbanized region of João Pessoa, 2) sugar cane region on the *tabuleiros*, 3) root crop producing region on the dissected *tabuleiros* on the margin of the *zona da mata* adjoining the *agreste*, 4) intensive cattle raising-parkland pasture region in the depression zone with the cultivation of maize, beans and cotton, 5) *brejos* on the eastern slope of the Borborema Plateau with maize-beans and savanna type pasture, 6) dense *caatinga* pasture region on the Borborema Plateau, 7) extensive livestock grazing-sparse *caatinga* region of the Borborema Plateau, and 8) sparse *caatinga* pasture region of the Patos Basin (see the bottom portion of Figure 7).

IV. Statistical analysis of the land use zonation

1. Regional patterns of livestock raising

In order to verify our regionalization of land use, data in the agricultural census of 1980 are examined (IBGE, 1983). Figure 8 shows the pattern of livestock raising by *município* in a 35 by 300 kilometer belt extending from the coast to Santa Terezinha just west of Patos.

In the Northeast of Brazil, cattle and horses are mainly raised by *fazendeiros*, and mules, burros, goats and sheep are kept in *sítios* (small farms). Hogs and domestic fowl are important animals for the subsistence of *moradores* in the countryside, while in *favelas* on the urban fringe migrants from the *sertão* also keep them for domestic consumption. Livestock units are calculated in order to obtain a general picture of livestock raising, for the animals raised differ not only in size

and weight but also in the role they play in agricultural management. Each head of cattle and horse is considered one livestock unit, each mule and burro 0.5 unit, each hog, goat, and sheep 0.1 unit, and each domestic fowl 0.01 unit.

The number of livestock units differs substantially from one *município* to another, partly in accordance with the size of the *município* and the type of animal husbandry practiced, and ranges, for example, from 31,904 in Campina Grande to 116 in Cabedelo. Thus, livestock units per 100 hectares are portrayed in Figure 8-b to show the overall pattern of intensity of animal raising. The highest density appears in the *município* of Gurinhém (148), followed by Massaranduba, São Sebastião de Lagoa de Roça, Pilar, São Miguel de Taipu, Areia and Serra Redonda, all exceeding 80 livestock units per 100 hectares. In general, the *agreste* as a whole, including these *municípios*, has high livestock densities. On the other hand, the *sertão* west of Campina Grande is characterized by low livestock densities, with *municípios* of 10 to 20 livestock units per 100 hectares predominant. The lowest densities are found in the coastal region, where Cabedelo (3.5) and Santa Rita have particularly small figures. This overall pattern supports our field survey findings as regards the combination of pasture types and feed crops raised.

The livestock units for the state of Paraíba as a whole are naturally dominated by cattle (85.4 percent), followed by goats and sheep (4.5 percent), horses (3.5 percent), domestic fowl (2.2 percent), and hogs (1.2 percent). Considering the regional pattern, cattle ratios are low in the east around João Pessoa and high in the *agreste* and Patos Basin (Figure 8-c). The milking cow ratios, on the other hand, are high in and around João Pessoa and Campina Grande with their large urban populations, and low in the *agreste* (Figure 8-d).

Sheep and goats, both well adapted to aridity, have high ratios to the west of Campina Grande, particularly in Pocinhos (19.3 percent) and Soledade (15.9 percent) (Figure 8-e). This pattern confirms our field survey observations, though the area where sheep and goats exceed cattle in actual numbers is much smaller than

Fig. 8 Regional patterns of livestock raising in the state of Paraíba, 1980.

Municípios: 1. Cabedelo 2. João Pessoa 3. Bayeux 4. Conde 5. Santa Rita 6. Cruz de Espírito Santo 7. Sape 8. São Miguel do Taipu 9. Pilar 10. Mari 11. Caldas Brandão 12. Mulungu 13. Gurinhém 14. Mogeiro 15. Alagoa Grande 16. Juarez Távora 17. Serra Redonda 18. Ingá 19. Alagoa Nova 20. São Sebastião de Lagoa de Roça 21. Lagoa Seca 22. Massaranduba 23. Esperança 24. Areia 25. Montadas 26. Puxinanã 27. Pocinhos 28. Campina Grande 29. Olivedos 30. Soledade 31. Juazeirinho 32. Gurjão 33. Junco do Seridó 34. Salgadinho 35. Taperoá 36. Santa Luzia 37. São Mamede 38. Passagem 39. Quixaba 40. Cacimba de Areia 41. Patos 42. Santa Terezinha 43. São José do Bonfim 44. Mãe d'Água 45. Teixeira 46. Destêrro

(Source: *Censo Agropecuário, Paraíba, 1980*)

we expected in the field. The field observations suggested that, in addition to the above two *municípios*, Olivedas, Juazeirinho, Gurjão, and Passagem would have high ratios of sheep

and goats. The domestic fowl ratios are high around urban centers such as João Pessoa and Campina Grande, reflecting the development of large scale fowl farms keeping Angola and

other types of fowl for eggs and meat (Figure 8-f).

2. Regional patterns of cultivated crops

Figure 9 shows the planted areas of five major crops by percentage of total cultivated land area in the 19 *municípios* through which our survey route (BR-230 and state road 228) passes. The *município* names are arranged on the horizontal axis of the graph in relation to the distance from the center point of the *município* to the coastline. The percentage of each crop is plotted on the vertical axis for each *município*. Figure 10, on the other hand, represents the crop acreage ratios by *município* in map form.

Sugar cane, the leading commercial crop of the coastal zone, is predominant for 50 kilometers inland from João Pessoa. The *municípios* of Santa Rita, Cruzeiro do Espírito Santo, and Sapé have particularly high ratios of sugar cane, reaching 36 percent in Cruzeiro

do Espírito Santo. The sugar cane zone suggested by the census data corresponds well with the results of the land use survey which recognized a sugar cane region as extending from 20 to 55 kilometers from the ocean. While sugar cane occupies nine percent and 14 percent of the cultivated land in João Pessoa and Bayeux respectively, our field survey plots, located in the vicinity of the state capital, understandably lack this commercial crop. Bayeux's high ratios of beans, maize, and yams appear to reflect food production in the vicinity of the metropolis, where newcomers from the *sertão* reside and cultivate such staple foods.

Yams are important in Sapé and Caldas Brandão, located 40 to 60 kilometers inland, while sugar cane sharply declines in the latter *município*. On the other hand, beans, maize, and cotton increase in importance to the west, in the *municípios* of Gurinhém, Mogeiro, and Ingá, 60 to 90 kilometers from the coast.

Fig. 9 Percent of cultivated land in major crops, by *município*, in the state of Paraíba, 1980.

(Source: *Censo Agropecuário, Paraíba, 1980*)

Fig. 10 Regional patterns of major cultivated crops in the state of Paraíba, 1980.
(Source: *Censo Agropecuário, Paraíba, 1980*)

These facts suggest that the region from 40 to 90 kilometers from the coast is an intensive food crop producer situated in the *agreste*. This supports our field survey findings.

With the increase of altitude on the Borborema Plateau, maize, beans and herbal cotton decrease in importance, only accounting for 3.2 percent, 2.2 percent and 1.0 percent of the cultivated land respectively in the *município* of Campina Grande. Sisal, both actively cultivated and in residual forms, is

observed west of Campina Grande at a distance of 150 kilometers from the coast, and accounts for 8.6 percent of the cultivated land in the *município* of Pocinhos.

The area 150 to 300 kilometers from the coast belongs to the *sertão* where *caatinga* vegetation predominates. Maize and beans have widespread presence here, though their ratios are less than one percent except in Juazeirinho where they occupy fairly large acreages. The major commercial crop of the

region is arboreous cotton. It covers to nine percent of the cultivated land in Juazeirinho, 15 percent in Passagem, and 11 percent in Patos. Particularly high ratios are found on the eastern slope of Patos Basin.

These analyses of agricultural census data by *município* verify the agricultural regionalization into eight regions based on our point sampling landscape survey.

V. Regionality of direct sales of agricultural products

On BR-230, the main artery of the state of Paraíba, peasants often sell their products directly to passersby. The products, including fruit and other specialties, reflect the subsistence as well as the semi-commercial economy of each locality. We therefore examined such direct sales activities.

Two stands that sell coconuts, oranges, papayas, and pineapples are found some 40 kilometers from João Pessoa, in the midst of the sugar cane region. Nearby, a temporary orange stand is located near a bridge across the Paraíba River. The coconuts and papayas are locally produced, while the oranges and pineapples probably come from other areas, including the *brejos* of Salgado de São Félix (Saito *et al.*, 1986).

Where the dissected *tabuleiro* surface remains in patches some 45 to 60 kilometers from the ocean, 11 stands are found, often in the shade of cashew trees. Papayas, coconuts, oranges, manioc, sweet potatoes, yam, and squash are their main commodities. Being in the intensive food crop producing region of the *agreste*, all these products except oranges are locally grown. Upon the request of travelers, large, fresh, and juicy papayas costing some 400 to 500 cruzeiros (40 to 50 yen) are cut and served with spoons on the site. The high density of such stands may partly owe to the fact that the area is about midway between João Pessoa and Campina Grande.

Five stands carrying squash, yam, and maize are clustered just west of Caja at the intersection of BR-230 and the road to Itabaiana. These stands are casual, often with keepers who appear only when prospective customers visit. Riachão do Baomarte has

two stalls carrying huge squashes. The area between the Itabaiana junction and Riachão is the intensive cattle fattening district of the *agreste* where maize and beans are also important. There, five or six vendors are constantly selling ears of maize broiled on a stick. They generally locate themselves at the top of rolling hills on the highway so as to be easily seen from approaching automobiles. Raw maize is also sold. BR-230 has two paved traffic lanes. An additional unpaved lane on each side provides space for such roadside businesses.

On the Borborema Plateau direct sales activities have different patterns. No roadside stands are found near the city of Campina Grande, probably because snacks, fruits, and vegetables are widely available in the city. The highway east of Soledade, some 180 kilometers from the ocean, supports vendors of fresh water shrimps. They once were supplied with shrimps from Açude Soledade located nearby, but recent overexploitation of the pond has almost exhausted the resource, so most of the shrimps now sold are brought from other lakes. Between the town of Soledade and the junction of BR-230 and state highway 228 in the *caatinga*, five or six stands selling *pinhão* are concentrated just west of Juazeirinho, midway between Campina Grande and Patos. One stand also has squashes and watermelons. *Pinhão* seems to be attracting interest as an oil seed crop in the *sertão* (HANADA and ODA, 1981). Further west, state highway 228 has no direct sales stands because traffic is minimal.

Direct sales activities vary from weekdays to weekends and from one season to another. However, our survey of the products available in direct sales stands during a limited time of the year very well confirms the regionality of peasant agricultural activities and supports our regional divisions.

VI. Conclusions

Although the *zona da mata*, the *sertão*, and the *agreste* have long been recognized as major zones of Northeast Brazil, their demarcation and the criteria for their classification have not been clear. The present study describes

the zonal pattern of land use and landscapes in the state of Paraíba and proposes a quantitatively based regionalization. Across 270 kilometers from the Atlantic coast directly westward to Patos, 35 locations were chosen, one every five kilometers near the coast, every ten kilometers inland. At each location the land use of a one square kilometer plot was intensively surveyed by field observation. The focus was not only on cultivated plants and types of pasture, but also on topography, types of fencing and relic plants.

Our analyses of the field survey data suggested that the cultural landscape of the state of Paraíba is composed of eight distinct regions. The coastal zone consists of the urbanized region of João Pessoa, the sugar cane region on the *tabuleiros*, and the root crop producing region on the dissected *tabuleiros*. In the *agreste* appear the intensive cattle raising-parkland pasture region of the depression zone with the cultivation of maize, beans, and cotton, the *brejos* region on the eastern slope of the Borborema Plateau with maize and beans and savanna type pasture, and the dense *caatinga* pasture region on the Borborema Plateau. The *sertão*, generally characterized by extensive livestock raising and sparse *caatinga* vegetation, is composed of the Borborema Plateau and the Patos Basin.

This regionalization pattern, based on field survey data, was supported by agricultural census data for *município* and by observations of direct sales activities of farmers along the survey route. Domestic fowl are numerous near large urban centers, while cattle are important in the *agreste* and goats, sheep and cattle characterize the *sertão*. Among agricultural crops, coconuts are predominant in the coastal urbanized region, sugar cane on the *tabuleiros*, and yams in the transitional zone between the *zona da mata* and the *agreste*. Maize and beans lead in the *agreste*, sisal in the dense *caatinga*, and arboreal cotton in the *sertão*. In the root crop producing region between the sugar cane region and the *agreste*, roadside stands sell papayas and coconuts. Squash and maize are sold directly in the depression zone of the *agreste*. In the *sertão*, fresh water shrimp, watermelons and *pinhão* are sold.

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ブラジル北東部、パライバ州における土地利用の地帯的变化

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ブラジル北東部は伝統的に海岸部のサトウキビ地帯、内陸部のセルトン（半乾燥地域の粗放的牧畜地帯）および両者の漸移地帯のアグレステに区分されてきた。しかし、その区分の指標は必ずしも明確ではない。

本稿ではパライバ州の海岸部カーボブランコから内陸部のパトスまで、ほぼ東西に10 km（海岸部は5 km）ごとに1 km²の調査地点85カ所を選定し、土地利用調査を実施した。つまり、1 km²内の栽培作物、果樹、牧場の形態等を記載する集約的調査と地形、牧柵、残象作物等の景観観察を併用することによって、東西270 kmにわたる土地利用の地帯的变化を明らかにすることを目的とした。

その結果、海岸部はジョアンペソアの都市化地区、タブレイロスのサトウキビ栽培地区、パッチ状タブレイロ

スの根茎作物栽培地区の3地区に区分された。また、アグレステは地形性凹地・トウモロコシ・フェジジョン・綿花栽培・パークランド型牧場地区、地形性多雨・トウモロコシ・フェジジョン・サバナ型牧場地区、密生有刺灌木林牧場地区に区分された。さらに、粗放的牧畜によって特色づけられるセルトンは、疎生有刺灌木林のボルボレマ高地区とパトス盆地地区に区分された。したがって、全体的にみるとパライバ州の農業的土地利用は、景観的にも8つの農業地区から成立していることが明らかになった。

以上の結果は家畜飼養と栽培作物のムンシビオ別統計分析および道路脇の小商品農産物の直売店の観察からも裏付けられた。

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