

Land and Settlement on the Recent and Ancient Quaternary Along the Railway Line of Bragança, State of Pará, Brazil

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WE have chosen as the topic of this article a small well-known region situated on the Amazon delta, on which is located the Instituto Agronômico do Norte, organ of the Brazilian Federal Government, whose principal purpose is the study of equatorial agriculture for the geoeconomic region of northern Brazil.

The main branch of the I. A. N. is situated in Belém, capital of the State of Pará, on an area of Quaternary origin, the upland part of which is ancient Quarternary near the roadbed of the Bragança Railway, and a second area of recent quaternary origin on the right side of the Guamá River inundated periodically by it with the influences from the tides.

The choice of this region for the topic under consideration is justified, since we are dealing with one of the most typical examples which we were able to observe with relation to the use of the land and the study of sociology. In this piece of Brazilian land, imprudence, ignorance of the nature and composition of the soil and lack of any systematic planning have led govern-

mental and private initiative to commit grave errors both in the exploitation of the land and in the question of social organization.

Primarily we will consider the region on which the I. A. N. is situated; but our thesis will apply to the greater part of the Bragança Railway area as well, including, under the same conditions, the higher Quaternary and the Tertiary zone through which the Bragança line runs.

This brief survey which we are presenting for the consideration of the members of the Inter-American Conference on Conservation of Renewable Natural Resources will prove the urgent necessity of breaking with the agricultural practices of the past. At the same time, it will serve as a warning to the Amazon region as well as to the whole New World, to be ready for a crisis in the near future brought on by the unbalanced relation between food production and population increase. This is threatening the whole world as a result of errors of the past and present.

This area, located on the outskirts of Belém, is well suited as a topic for our article not only because it constitutes a typical example for section III (Land Use and the Social Sciences) but also because it represents the gateway to a region consisting of about 4 million square kilometers and surely capable of supporting within a few decades a good percentage of the popu-

lation of the world, relieving us of the nightmare which ever hangs over us and even more so over the Old World and Asia.

According to figures available at present, the world has a population of $2\frac{1}{4}$ billion inhabitants, and at the present rate of increase this should double within a century. Geographers, statisticians and students of sociology have been gravely preoccupied in recent times with the survival of humanity. According to data generally known, each human being needs 1 hectare of cropland and an added hectare of pasture land for his maintenance. For the survival of the human species, then, 2 hectares are necessary per person, one for agricultural and the other for pasture purposes.

As mentioned in the preliminary announcement distributed by the Organizing Committee of the Inter-American Conference on Conservation of Renewable Natural Resources, the world does not have even 2 acres of agricultural land available for each human being. Here we are confronted with the stark problem of hunger throughout the world, and it awaits us if we do not take the necessary steps to avert the force of its crisis.

For this purpose even scientific birth control has been suggested; however, this can never be successful, whether for religious reasons or popular beliefs. The nations of the new continent, welded by a spirit of cooperation and mutual understanding of the domestic troubles and of the foreign situation to which it is impossible for them to be indifferent, have before them the necessity of studying carefully the problem of the survival of humanity within the norms of human rights and under the enlightenment of technical planning.

The Highlands of the Quaternary

The highlands of the I. A. N., as well as all the land which divides the

coastal region of Pará from the right margin of the Guamá River, belong to the oldest part of our Quaternary formation to the point along the railway line where it crosses the central part of the municipality of Castanhal. Once the railway has crossed the watershed of the Quaternary, the railroad bed continues on along the Tertiary division until almost reaching Bragança (3).

In spite of the difference in geological origin of the lands which form the greater part of the railroad bed of the Bragança Railway, the climatic conditions of this humid equatorial formation make them all about the same as to their utility for mankind.

There is, however, a marked difference between the highlands, which are to be found along the railroad, and the periodically swamped strips of land along the edge of the Guamá River and known locally as *igapó*. The uplands on the I. A. N. grounds near the railroad line are a typical example of the high Quaternary or old Quaternary, whereas the lowlands (*baixadas*) belong to the low or recent Quaternary. The lands of the upper Quaternary were formed by deposited sand, a veritable dune which was formed towards the beginning of the Quaternary era, having here at the I. A. N. a depth of 17 meters.

According to the soil study profile n. 397 (1) collected by the author in 1941 and analyses at the Instituto Agronômico de Campinas, São Paulo, the soil is extremely poor, lacking nutritive reserve elements. As pointed out by J. E. de Paiva Netto, the productivity of the soil resides in the water in circulation. In the solid part, M. Gutteman, carrying out spectrographic analyses, found on the average 98 per cent quartz grains, which points to a shortage of mineral substances which, on decomposing, may furnish chemical elements indispensable to plant life. Rubens Ayres do Nascimento collected in 1942 various soil profiles (2) on the sands of our Quaternary, and his findings were the same: lands extremely poor. In fact the result could not have

been otherwise for dune formation under the action of a humid equatorial climate.

In spite of the extreme paucity of mineral salts, the region was once covered with enormous forests which followed along both sides of the Bragança Railway. As every soil specialist knows, in the sedimentary soils rich in silica, of humid equatorial regions, the mineral reserves are found more abundantly in the plant tissues than in the soil itself. Once the forest is destroyed the fertility of the soil is lost (5).

Along the Bragança Railway line, forests that were centuries in growing have been destroyed by fire for two or three crops of *farinha* (cassava meal) or cereals. Then the land is abandoned as unproductive and becomes transformed into a dense thicket or worthless second growth within several years. Even the farmers say that the land is fertile only as long as the forest ashes remain on it.

The poor farmers of this region, bound by routine agricultural practices without receiving any aid or technical orientation, wander ever onward cutting down one forest after another just as the Indians before them—leading a nomadic life and making use of little after the felling and burning of the greatest forest giants which they wantonly destroy. Unwittingly they continue a crime against the future, a crime against the unrenewable resources of nature. Unrenewable indeed, because one of the most serious troubles, slow and expensive in correcting, in a humid equatorial climate, is that of an excessively siliceous soil.

All settling work up to now which has been done along the Bragança Railway has consisted simply of the destruction of all unrenewable natural resources. The *caboclo* (peasant), as he advances with his machete and ax, unconscious of his work of destruction, leaves poverty and want which are sustained by the meager production of wood and charcoal obtained from the scrawny second growth, the

ultimate spoils from an outraged nature.

The inhabitants seek the villages and towns, and for the most part the food-stuffs which should be grown in the region are imported from Belém. And some of the products such as milk, butter, beans, lard, etc., come from the south of Brazil or even from other countries. The amount of rice and *farinha* yielded by the region in no way justifies the continuing destruction along the lines it has followed since the beginning of the laying of the Bragança line.

It is irrelevant for us to look for the technical reasons behind the planning of the Bragança Railway. We know that the first plans were made in 1870 and that the first phase of its construction was begun on July 24, 1883. The first section, 299 kilometers, connecting Belém with Benevides, was begun November 9, 1884, and after 25 years of sacrifice the railroad was finally completed to Bragança (4). The construction of the railway in extremely poor land exacted an enormous sacrifice throughout the quarter of a century of its construction. Cesino Santos (4), general accountant for the Bragança Railway, in a report to be found in *Dados Históricos, Relatos e Estatísticas da Estrada de Ferro de Bragança*, has this to say:

The first piece of virgin woods was pierced at a point where all was fecund and coursed in a "mysterious flow of sap," as if auguring well for this remarkable enterprise.

But it didn't take long for fate to appear on the scene, and, from one collapse to another and from one regime to another the years rolled by in a long drawn out procession until finally only after 25 years, in 1908, was the last section of the railroad, by then known as the Estrada de Ferro de Bragança, laid.

And further on:

The production of cotton, rice, corn and cassava meal, the main crops here, in 1927, amounted to 61,295 tons valued at . . . \$22,836.47 [U.S.], or only 29 percent over total annual cost.

For fertile lands, as are the 6,000 square kilometers which are served by this line which are available for cultivation of these



FIGURE 1.—Gathering firewood near the highway, near Benevides.

crops, the above yield is, as already stated, relatively deficient.

It should now be expected along the Bragança Railway in accordance with the original plans of one-half century earlier, executed for the exploitation of the lands, that there be an intense crop production organized and efficient, endowed with modern farming equipment capable of making use of the richness which is reflected from the beginning to the end of a region so fertile and so magnanimous.

The crises, one after another, and the adversities, however have not permitted the achievement of this goal yet. There are relatively few places where one may see intensive farming.

If settlement was one of the principal purposes of building the Bragança Railway, this objective never has been and never will be achieved. Cesino Santos (loc. cit.) further states:

Since the grantee had no guarantee of interest on his investment from the Government, an additional contract was drawn up on July 16, 1883, in accordance with the Provincial Law n° 1100 of November 8, 1882 obliging, among other things, the introduction of 10,000 farm-workers (4).

The plan for the construction of a railroad line was born simultaneously with the plan for colonization. Dr. Amaro Theodoro Damasceno, Jr., former physician of the municipality of Igarapé-Assú and hygienist for the State of Pará, who practiced for a long time in the heart of this region, referring to the work of the *nordestino* (persons from northeastern part of Brazil), about 30,000 of whom came from Ceará after the great drought of 1915 and settled along the margin of the Bragança Railway in the vicinity of Castanhal, told us: "The work of these people was to destroy what there was of gold in order to produce silver." And that is exactly what they did. Destruction of the forest was the destruction of the gold, and the production of *farinha*, rice and such crops was the transmutation of the gold into silver. Dr. Damasceno could not have chosen a better comparison, and, what is worse, even today this same senseless destruction goes on.

In Igarapé-Assú, the Brazilian Government set up an Agricultural Experiment Station, run at first by

technicians of great ability; but as time passed and the administrations changed hands, the scientific part was neglected, and, by 1920, the Station was transformed into a relic of the past.

Cesino Santos (4) supposed that the exodus of the rural population to the edge of the Igarapé (at Castanhal) was due to the establishment of a leprosarium, Leprosario do Prata, on July 24, 1924. But the truth is, as Dr. Damasceno pointed out, that it was hard to make the few settlers leave who resided on the area appropriated for the Leprosario.

The abandonment of farms has only one explanation: the low productivity of the soil and the agricultural practices then in vogue. Poor lands are unable to hold the settler, especially when the indispensable technical orientation for a rational exploitation is wanting.

Hence, the construction of the Bragança Railway, instead of creating values for Pará, has created, with the exploitation of the land along the railway line, a situation of extreme poverty and need. The main fault lay in attempting to settle a region without being acquainted with it, and expecting to yank from it by main force rice, *farinha*, corn, etc., on land where 2 or 3 years of agricultural activity ruined what had taken years to form—a virgin forest.

Rectifying the Errors of the Past

It is absurd to cogitate on the removal of the railroad track from the Bragança Railway, as was done with the streetcar tracks of certain cities in favor of the bus lines. It is, however, necessary to change agricultural policies as soon as possible, in order to save natural resources for the benefit of future populations.

It is urgent that nomadic agriculture come to an end; it is indispensable that the settler fix his residence and cease

the felling of virgin forests on the uplands for the illogical planting of rice, cassava, or other herbaceous plants with a short crop cycle, which need constant work with soil and, consequently, render it useless for future generations.

A radical change in the agrarian policies of the region is called for which will reserve the terrain of the uplands solely for the planting of forest trees, since shade is needed to protect the physical, biological and chemical composition of the soil. Let us emphasize that the uplands should be restricted to the planting of woody elements, important forest species, trees which yield oil, and others which cast their shade over the soil surface. The raising of herbaceous plants such as rice, sesame, corn, beans, and jute should find a soil in a suitable site.

Growing Herbaceous Plants in "Igapó" Land

In the Amazon region an *igapó* is land which is periodically swamped by water from the rivers. In the lower Amazon the invasion of the waters into the land is a result of the annual rising of the river level from 4 to 6 meters between the dry (*verão*) and wet (*inverno*) seasons. Here, the forests are continually inundated for a period of about 5 months.

Along the Guamá River and other rivers near Belém and in many parts of the islands the *igapó* is the woodland invaded daily by high waters in the period of high tide. These *igapó* lands are completely invaded every 12 hours, from the end of December to the end of April. The tide is beneficial because it irrigates the land without cost, depositing on the land the sediment brought in by the muddy waters of the river. In this way the soil is irrigated naturally without the costly installation of pumps.

In February and March the waters of the Guamá rise over the marginal land for a distance of from 500 to 2,000

meters, inundating the lowlands which are clayey in nature and of recent Quaternary origin. These lowlands, consisting of land-in-formation, represent the new soils of the Amazon. In the I. A. N. two-thirds of the area are made up of *igapó*, that is, clayey land covered with woodland and subject to the invasion of tidewater. A stretch of farm land for herbaceous crops which presents a great capacity for intensive agriculture for the raising of foodstuffs and installation of dairies extends from Belém to São Miguel, which marks the limit of the reach of the tidal bores.

The rural populations should come down out of the uplands of the ancient Quaternary and even of the ancient Tertiary in order to settle and farm both the recent and very recent Quaternary lowlands. In this region located near Belém, the original *igapós* of the Guamá River constitute a tremendous reserve of land capable of fixing settlers and organizing agricultural nuclei in the strict sense of the word.

On the uplands of the Bragança Railway, 1 hectare of rice produces 700–800 kilograms of seeds, whereas in *igapó* in the same area the yield is more than 3,000 kilograms. Native fiber plants (Malvaceae) yield 700–800 kilograms of fiber in the uplands per hectare and 2 tons (metric) of jute in the same area in *igapós* along the Guamá.

Thirty-three hectares of land cultivated in jute for seeds, in Belterra, in a soil about the same as that of Castanhal produced 1,033 kilograms of seeds. From 25 hectares of *igapó* along the Guamá, we have already gathered 8,500 kilograms, and the harvest is not over yet.

While the soil of the uplands is continually wearing out and losing its fertility with the farming of annual crop plants, the *igapó* soil is daily being built up. Its clayey nature allows for much more lucrative crops; and within 5 years, with the rotting away of stumps and roots, it will be possible to farm the land with machinery, reducing the cost

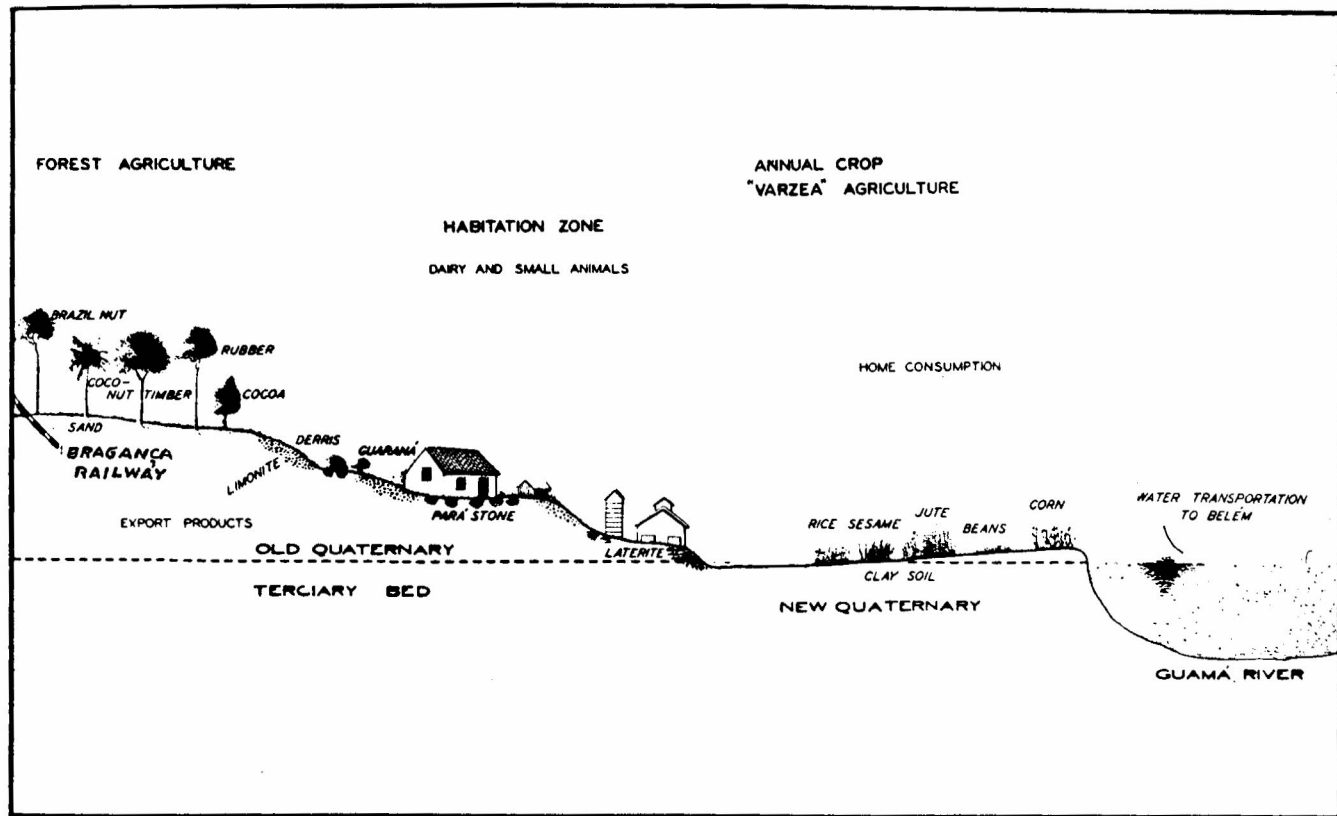


FIGURE 2.—Scheme of systematized exploitation of the region of the Bragança Railway to the margin of the Guamá having as its aim the settling of the region and preservation of the renewable natural resources.

of farm labor and contributing thus to a reduction in living costs.

For centuries the *igapós* along the Guamá have been untouched, while everyone erroneously has sought a solution to agricultural problems in the farming of the upland watersheds, a practice which has served only to destroy the land. In our region, man must descend to the mud from whence he has sprung and from which he was formed according to the doctrine of Christianity. The settling of the Belém area should be done with methodical and rational planning according to the following scheme.

Plan for Use of the Bragança Railway Region

SCHEMATIC SECTION OF THE ZONE UNDER CONSIDERATION

Lands of the I. A. N.

GEOLOGICAL FORMATION

To the left, sand deposits of the ancient Quaternary; to the right the most recent Quaternary, *varzea*,¹ *igapó* and finally a section through the Guamá River.

AGRICULTURAL EXPLOITATION

On the uplands by the Bragança Railway (at the left side of Figure 2), all annual crops should be forbidden, contrary to the present practice which entails so much sacrifice and damage to soil fertility. Very sandy upland soils should be reserved only for reforestation, allowing only those trees

which shade the soil, such as Brazil nut, rubber tree, crabwood (*andiroba*), mahogany, cocoa, oil-yielding palms, and the use among the trees of leguminous plants which will serve to protect the soil, etc.

Between the highest sandy uplands and the *igapó* there exist intermediate terraces of varying size and forms, beaches of the old Quaternary. Here, *guaraná* and *timbó* (Derris) can be planted on the first terrace, the other two being left for construction of residences and for the installation of dairy plants and for the raising of small livestock. To the right we see the most recent land, *igapó*, which at present is separated from the mainland by a permanent table of phreatic water which usually rises from lateritic horizons formed directly above the Tertiary clays, found on a level between the ebb and flow of the tides.

Under normal conditions, this water table is a permanent source of water for the breeding of malarial and other disease-bearing mosquitoes, which have served to keep many people away and prevent the *igapós* from being tried for their farming possibilities.

This water table is permanent, and its water is fresh and running; however, not all of it filters into the Guamá and at high tide this water impedes the penetration of the muddy waters to the margins of the *terra firme* of the Quaternary highlands.

With the draining of these *varzeas* by means of wide and deep ditches 400 meters apart, dug by machinery in a direction perpendicular to the Guamá, and with the felling of the forest, the pure phreatic waters which are a focal point for malarial mosquitoes will have free access to the Guamá; and at the time of high tide the muddy river will be able to invade the inner *igapó* depositing sediment and raising the height of the deposition day by day.

From a *varzea* thus artificially brought into being, two crops per year

¹ Flood-plain, somewhat like Florida Everglades, but with more trees than palms.

are possible. The first is of rice, sesame or jute, which require more water. For this crop, seed plantings should be made in January, at the onset of the rains. At the end of the first crop in May or July (at the beginning of the dry season) the same land may be prepared once again for beans, legumes, watermelons, various gourds and even corn. Within several years, it will be advisable to form pasture lands as a means of rotating croplands. Even in the *igapó*, it would be perfectly feasible to plant some forest plants such as rubber trees, *ucububa* (*Virola surinamensis*), etc., which are native to *igapós*.

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Economics of Soil Conservation and Land-Use Planning with Reference to Free Competition in World Markets¹

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A BROAD definition of soil conservation is given as any act reducing the rate of loss of either soil particles themselves or any beneficial constituent of the soil for the avowed purpose of improving the present or future welfare of mankind.

It should be emphasized that the time involved in renewing soil resources varies tremendously, the difference being that soil which is lost by erosion requires thousands of years to replace while fertility leached from the soil may be replaced by one fertilizer application.

The three possible results of man's management of the soil—exploitation, management conservation, and improvement—may be viewed in the light that only one of the three can be economic for a given homogeneous area.

Accelerated soil erosion always results in economic loss and planned conservation farming can be conducted on an economic basis. At least it will result in no economic disadvantage to the farmer in his present life and will always result in an advantage to posterity provided that soil losses are important in the absence of such practices.

Conditions in Mexico can be cited as an example showing how conservation farming could result in great economic improvement to the people. Experimental evidence shows that

¹ Abstract of paper.