THE BRAZILIAN FOREST ECOSYSTEMS AND THE PANTANAL[1)]

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Introduction

Brazil is a very big country, which has the territorial area of about 8,511,965km^2 and has a great variety of fauna and flora. For purpose of studying brazilian forest ecosystems, it is necessary to divide the national territory into five regions: north, north-east, center-west (Pantanal), south-east and south region, based on the distribution of the States. The north region has 355 million ha of land area, in which the natural forest area is 316 million ha, 89% of this north region area. The north-east region has 154 million ha, among them the natural forest area is 21 million ha, 13% of this north-east region area. The center-west region includes the Pantanal area, has 188 million ha of land area, in which the natural forest area is 57 million ha, 30% of this center-west region area. In this district there is the Pantanal area, this Pantanal has 15 million ha, among them the natural forest area is 13 million ha, 87% of the total Pantanal area. The south-east region has 92 million ha and in this region the natural forest area is 16 million ha, 17% of the total south-east area. In the last the south region has 56 million ha, among them the

[1)] This paper will be present at the 17th World Planning Congress with the theme "Local Development and Planning in the 21st Century, October 11~13, 2000, Onyang, Korea.

natural forest area is 7 million ha, 12% of this south area.

The Pantanal, which is a paradise of animals and plants as well as a largest land of waters in the world, is located in the center-west region of Brazil. Three states and the Federal District form the central-western region, with an area of 187.9 million ha. Around 80% of this area is covered by "Cerrado". Since these two areas (center-west and Cerrado) are both large it is necessary to interrelate them in terms of data collection and data analysis. Because of that, this center-west region of Brazil was analyzed mostly in this study and at the last the main development macro-vectors were investigated as the degradation elements of the natural vegetation.

Forest Area

The total forest area of Brazil is 429 millions ha, occupy 50.7% of all brazilian land area. Among the forest area the natural forest area is 404 millions ha, 47.6% of the total brazilian land area and occupied 94.2% of the total forest area. The area of Pantanal is 13 million ha, 1.6% of the brazilian land area and occupy 3% of the forest area in Brazil. This area is bigger than the korean land area and two times of the korean forest area (6.5 million ha). The forest plantation has 12 million ha and occupy 1.4% of the Brazil area.

Brazilian Macro Forest Ecosystems and the Pantanal

In the identification of the great individualized areas, of relatively uniform traits, on which will be developed environmental planning actions, the grouping of ecosystems did not take into consideration, deliberately, the methodological tendency which proposes the regional division through biological area, an inadequate concept for the purposes of this work.

Amazon Forest Ecosystem

The mean pluviosity of this forest ecosystem is around 2,500 mm/year, with no prolonged dry spells. In many areas the rainfall occurs in late afternoon or early evening as a function of convective heating. The temperature is typically high, with mean temperature above 26º C. The Amazon forest ecosystem occupy a surface of about 400 million ha. The native waters and vegetation still cover 92% of its area. The use and occupation of the land are characterized by the animal and vegetal extraction – mostly the lumber extraction by livestock raising and subsistence agriculture, as well as the cultivation of bush and tree vegetal species of medium and large cycles.

Atlantic Forest Ecosystem

This ecosystem occurs practically from the south to the north of Brazil, principally occupying areas near the coast. This wide geographic extension is accompanied by large climatic variability. The pluviosity ranges from 800 to 4,500 mm/year and in some areas depends exclusively on orographic rainfall.

The ecosystem of this region here mapped, presents a surface of 41.5 million ha. The native vegetation does not cover 36% of the area, and even there it is severely altered. The use and occupation of the land is characterized mostly by the exploration of animal and vegetal species in the fluvial-marine and fluvial lake ecosystems, by urban, port, tourism and leisure infrastructure and in some points by agriculture, pastures and forest extraction.

Dry Forest Ecosystem (Caatinga)

This is the driest biome of Brazil, with regions where annual precipation is less than 300 mm. In the dry season, the mean temperature is 27ºC, slightly less than in the rainy season, with large thermal variation between day and night. This ecosystem occupies a surface of 93.9 million ha. Approximately 60% of the area is covered by the native vegetation in higher or lower levels of alteration. The degradation – which exceeds 50% of the natural areas – was

and is caused by the exploration of the wood, cattle and its occasional devastation by fires. Its worth mentioning that , as the herbal strata disappear in the dry season, on the contrary of what happens in the cerrado, there is no practice of fire utilization with the objective of improving the natural pastures. The use and occupation of the populated land is essentially for short cycle agriculture and livestock raising.

The Pantanal and the Forest Ecosystem

The Pantanal is located in the heart of South Amrrica and is part of the Upper Paraguay River Basin, which comprises about 365,000 square kilometers. This system, located within the borders of Brazil, Bolivia and Paraguay, is bigger than the United Kingdom (approximately 244,000km^2). The whole plain that is known as the complex of Pantanal holds an area of approximately 155 thousands km^2, consisting of the states of Mato Grosso do Sul and Mato Grosso in Brazil, and part of the lands of Paraguay and Bolivia. From this amount, almost two thirds are situated in Mato Grosso do Sul state.The natural landscape is composed of various geo-morphologic units of alluvium plains. Only a small part of the plains (20%) are not flooded. Predominant soils are the hydromorphic podzol, the plintosol and verilsols. The great variety of fauna and flora in the Pantanal is naturally influenced from these forest ecological regions.

This “land of waters” constitutes an environmental unit with a variable dry season that lasts up to four months per year. The water level varies several meters. Mean annual rainfall is 1,000 to 1,400 mm, with occasional frosts in the months of July and August. Two seasons, a rainy and a dry, are easily differentiated, which is similar to that for Cerrado areas. The region is characterized by depressed plains. The vegetation of the Pantanal is strongly dependent on the hydrographic system which predominates in this landscape with very low declivity. The Pantanal has a great variety of micro-landscapes and flooding regimens, causing differences in the vegetation covering each area.

For the forest-ecological sites of the Pantanal there are seven

characteristics: grass lands, mountain range, semi-deciduous forests, thorny vegetation, savanna, gallery forest and tree island.

Consequently the Pantanal areas present a great variety of micro-landscapes and flood regimes, causing natural differences in the vegetation covering each area.

Pine Forest Ecosystem

This region is located in the southern region of Brazil, this is characterized by climatic condition similar to boreal regions. Two native species of Araucaria predominate the landscape. This ecosystem covers a surface area of more than 22 million ha. The remaining native vegetation represents only 23% of the total area. Apart from being in great part degraded, a substantial part of the remaining area is fields and bushes. The use and occupation of the land consists mostly of complex agricultural systems.

Savanna Forest Ecosystem (Cerrado)

The "Cerrado" is a sequence of vegetation physiognomies, along a gradient of aboveground biomass, from open areas only with grasses to forest formations. These physiognomies are characterized by soil types and floristic composition define the names used for each type. The "Cerrado" is a natural vegetation type, covering over 189 million ha, representing 22% of Brazilian territory. In terms of area, it is exceeded by only one vegetation formation in Brazil, the Amazonian tall forest, which covers approximately 350 million ha (about 40% of the country). As is well known, a dynamic relationship existed between these two vegetation types during the Pleistocene, with expansion of the "Cerrado" area and contraction of the Amazon area into refugia during the glacial periods and the opposite occuring during the interglacials periods. These processes have produced a complicated distribution patterns in both flora and fauna, and fragmentation of populations has probably led to exuberant specification. The combination of the great age of the Cerrado and the relatively recent (Pleistocene) dynamic phase in their distribution patterns

has probably led to their exceptionally rich overall biodiversity, estimated as totaling 60,000 species of plants, animals and fungi. New studies have identified the existence of 6,429 plant species in this biome (Table 1).

Table 1. Natural vegetation of the Cerrado

Group	Family	Genera	species
Pterophytes	19	51	267
Gymnosperms	1	1	2
Angiosperms	150	1,092	6,060
Total	170	1,144	6,429

Source: Imana-Encinas et al. (1998)

The Cerrado Biome is considered in the literature as the Brazilian savanna. The climate of these savannas is characterized by dry winters and rainy summers with annual mean precipitation around 1,500mm. The rain is concentrated in the months of November to March. Even though the Cerrado covers a wide geographic range, its climatic characteristics are similar over its whole extension. The dry period is characterized by low relative humidity. Using Koppen's classification, the Cerrado is classified as a tropical rainy climate. In terms of phyto-physiognomic origins, the Cerrado is characterized by a great number of environments. The interaction of morpho-climatic, structural and lythologic factors in the Cerrado resulted in the division of this area into great geo-morphologic units distributed in different altitudes, called "chapadas", plateaus and platforms which results on diverse erosion phases.

Gallery Forests

These are a dense tree formations that accompany water courses. As a function of the width of the rivers or streams and soils these formations present diverse physiognomic sub-types. These formations have several

names in the literature, also being called riparian forests or ciliar forests. The characteristics of these forests are the formation of a closed canopy, trees with straight trunks, with the tallest individuals reaching 20 to 30 m. Generally the species are evergreen. Almost always they are surrounded by non-forest formations on the edges farthest from the water course.

In the interior of these forests, the humidity is relatively high, even in the dry season. The presence of buttress roots is not pronounced in many species. The number of species of epiphytes and orchids is generally high. The soils are much more fertile than in the other physiognomies in the Cerrado region. The gallery forests can also be classified as inundated or non-inundated based on the variation in the water.

Dry Forests

These forest formations are very similar in structure to gallery forest, but they are deciduous and encountered where are no superficial water courses. Their classification in evergreen, semi-deciduous and deciduous is based on the soil. The mean height of the trees is between 15 to 25m, with erect truncks. In many areas the canopy is not completely closed.

Cerradao

This is a dense tree community with xeromorphic aspects and is the most open of the forest formations in the Cerrado. The tree layer is between 8 to 15 m and the canopy is generally open. These conditions permit fairly high luminosity in the undergrowth, facilitating growth of shrubs and herbs. Few trees species are deciduous and the majority of trunks are erect. Epiphytes are scarce. The soils are acid, well drained, deep and generally infertile. However there are two types which are distinguished based on the fertility of the soil, the dystrophic Cerradao (poor soils) and the mesotrophic Cerradao (richer soils).

Degradation of the Natural Vegetation

At present, Brazil has a population of over 165 million, of which approximately 10 million live in the central-west region, where there is the Pantanal. In 1970, there were 93 million and since then the annual growth rate has been around 2%/year. Due to this increase, anthropogenic forces altered the structure and floristic composition of many years in the Cerrado. The use of the soil and degradation of the natural vegetation occurred through eight different processes: intensive agriculture, forest exploitation, energy utilization, industrialization, urbanization, circulation, mineral exploitation and international fluxes. The consequences of these processes were that the natural vegetation became more open. Also several exotic plant species were introduced, which form the basis of several industrial processes. During these anthropogenic processes the natural vegetation was completely removed in many cases.

Agribusiness

For many years many governmental programs contributed to the idea that the Cerrado was the grainbelt of Brazil. Agricultural expansion was incentivated until the beginning of the 1990's. Several agricultural products, such as coffee, sugarcane, citrus, manihot, peanuts, rice, soybeans, corn, etc. were introduced for large scale production. The earning from these products obviously produced great savings for Brazil. However, the natural vegetation also disappeared on a large scale over large areas. During the last three decades over 40% of the original area of the Cerrado was converted to agricultural use. This was to introduce changes into the technical standards of agricultural production which converted them into modern agricultural ones (Table 2), either as improved pastures planted with exotic grasses or as arable areas for the cultivation of annual crops. Between 1970 and 1985, there was an increase of 5.4 million ha (from 4.1 to 9.5 million ha) in the cultivated area in the Cerrado, by soybeans, corn, rice, beans, coffee and cassava plantation. The expansion of the agriculture frontier in the Cerrado was based on the

utilization of mechanization, fertilizers, chemical soil improvements and the availability of credit.

Table 2. Loss of forest cover due to deforestation in central-west region of Brazil (unit: millions of ha)

	Forest Area			Deforestation for Agriculture/Pasture		
Year	Dense Forest	Cerrado	Total	Dense Forest	Cerrado	Total
1975	31.3	38.4	69.7	0..0	0.52	0.82
1980	29.9	36.3	66.2	0.28	0.42	0.70
1985	28.6	34.4	63.0	0.26	0.38	0.64
1990	27.4	32.5	59.9	0.24	0.38	0.62
1995	26.3	31.0	57.3	0.22	0.30	0.52
2000	25.5	29.7	55.2	0.16	0.26	0.42

Forest exploitation

Parallel to the clearing of land for agricultural use, the forest formations were used for production of stakes and poles for fences and for use in construction. The production of firewood and extraction of commercially valuable timber species also were important as part of these anthropogenic actions. Analyzing the growing demand for forest products the forestry sector contributed to the deforestation process, especially in the center-west region (Table 3).

Another factor in the degradation was fire, a procedure frequently utilized in management of native pastures. Frequent fires alter the original structure of the vegetation, provoking changes in the density of woody species, both trees and shrubs.

Table 3. Demand and consumption of wood in the center-west region of Brazil (unit: millions of m^3)

Equivalent in wood						
Year	Firewood	Woodchips	Paper	Panels	Other uses	Total
1975	7.9	1.0	0.43	0.12	0.20	9.65
1980	8.7	1.5	0.83	0.21	0.27	11.71
1985	10.2	2.2	1.50	0.34	0.35	14.59
1990	11.7	3.1	2.70	0.53	0.47	18.50
1995	13.2	4.4	4.70	0.81	0.61	23.72
2000	14.9	6.0	7.83	1.16	0.71	30.63

Energy utilization

The relationship between energy and the environment in the Cerrado area is intense, owing to the utilization of natural resources (petroleum, water and biomass) and to the environmental impacts involved along the chain of production, transformation, transport, distribution, storage and final utilization of the energy. Three hydroelectric plants, of medium size, were constructed in the Cerrado and around these sites, several industrial centers in the central-western region have flourished. Evidently these activities have also contributed to new land usage patterns and destruction of native vegetation.

Industrialization

The relatively recent industrialization in Brazil took to the extreme the technological pattern that emerged after the Second World War, that is large scale production, with intense utilization of natural resources, elevated consumption of energy and accelerated mobility of the work force, A large part of the environmental impacts of these productive activities in the Cerrado, is concentrated in metropolitan regions and not in the marginal areas of national economy. This industrialization process was responsible for

a double movement that directly affected the Cerrado ecosystem. On one hand, the depletion of the natural resources, both non-renewable and on the other hand, the contamination and pollution of air, water and soil, by emissions and industrial residues of all kinds.

Urbanization

The cities in the Cerrado region represent the most intense symbol of the process of anthropomorphic transformation. The evolution of the population in the center-west region, was from 1.2 million inhabitants in the year 1940 to 9.4 million in the year 1991. Only 22% of this population lives in rural areas. In 40 years, the number of municipalities (smallest Brazilian political-administrative unit) in the center-west region increased from 112 in 1950 to 379 in 1990. This value demonstrates that the process of formation of cities still persists and is very dynamic.

Circulation

Two modes can be considered in the middle-west region, which imply in distinct timings and speeds. First, the one concerning the increases in productivity in the agriculture, particularly in relation to soybeans and second in relation to the importance of road transportation in the movement of grain. This region has a road network of 224,685 km, of which only 16.8% are asphalted.

Mineral exploitation

To summarize the situation of the mineral exploitation is very difficult, first because of the complexity of the published data and second due to the relation between the raw material and the final product. In the Cerrado region, mineral exploitation activities are intense.

International fluxes

One of the most complex and interesting phenomena of the recent years, is the accelerated globalization of international fluxes. This process is more consolidated in some sectors, such as communications and information in general and the financial fluxes, but its tendency if to involve rapidly all of the world's system of exchange of merchandise, goods and services of all kinds. It is unanimous the observation that the new configuration of the world policy, with the end of the bi-polarity and the tendency to multi-polarity has been responsible for the creation of an environment more and more supportive of initiatives that promote the extroversion in international relations. The result is that, besides globalization, the dominant strategy in international relations currently has been the multi-lateralism, with direct consequences on the way the nations have defined and operated their external policies, there included the definations of preferential partnerships for all kinds of agreements and general commercial exchanges.

Conclusions

A high degree of environmental alteration of the ecosystems of the Pantanal region has occurred in the last 20 years. The processes of devastation of forest areas and soil degradation caused by agricultural and livestock expansion, industrialization, forest and mineral exploitation are a consequence of the actual situation. Some years ago the Federal Government developed procedures to protect the integrity of a physical and biotic medium as well as the social groups which depend on them. Development of the Pantanal region must take account of the conservation of the environment. That is, the concept of the sustainable development should be applied to the Pantanal region for the future.

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