

A Case Study in Brazil: The Main Challenges Faced by Land Administration ¹

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Key Words: Institutional Arrangements, Land Policy, Core Geodetic and Mapping Information, Land Administration.

ABSTRACT

This paper analyses land administration in Brazil, existing land policies and available land information to proceed and audit main problems and current barriers. The author also reports on issues related to the decision of a land administration plan that needs to be integrated at federal, state and municipal level. Besides, the author also reports on resource allocation to provide for the modernization of basic mapping production.

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1. NATIONAL CONTEXT

Brazil is in the Americas. It occupies the central and east portion of South America. The Equator and the Tropic of Capricorn run through the country. Most of Brazil lies between the lowest latitudes of the planet, a fact that gives Brazil the characteristics of a tropical country.

With a total area of 8,514,046.79 km², Brazil is the largest country in South America. To the east, its border is with the Atlantic Ocean. Brazil has administrative jurisdiction on several oceanic islands, including Fernando de Noronha, Abrolhos and Trindade. To the north, the west and the south, Brazil shares borders with almost every country in South America, except for Chile and Ecuador.

The *República Federativa do Brasil* (Brazilian Federation) defined its administrative and political organization in the Federal Constitution of October 5, 1988. The country is organized in a *União* (Union), the *Distrito Federal* (Federal District), the *Estados* (States) and the *Municípios* (Municipalities). Following the 2000 Demographic Census (IBGE, 2000), Brazil has 26 (twenty-six) States, the Federal District and 5,560 Municipalities. As of September 13, 2004, population was 181,956,000 distributed following a historically-based pattern of land settlement. Most of the population resides in highly concentrated areas on a strip of land situated along the coastline, of approximately 450 km wide.

The country originates in the XVI century, as a Portuguese colony. Land settlement starts with the foundation of cities along the vast Atlantic Ocean coastline. Each city has a number of dependent urban settlements that, gradually, penetrated inland and settled the vast territory that the country occupies. These urban systems, together with the scattered, but somehow dependent, rural population, were separate economic regions. They were not interconnected and gave rise to the so-called 'Archipelago' Economy. It was only after the industrialization period that a true national urban network emerged; it was the result of connecting those separate and diverse regions. As a direct consequence, a nationwide marketplace was born. It was only in the 20th century that all these processes were complete.

In the North and Central-West Regions of Brazil, population migrated to the new urban centers that emerged inland, favored by the development of transport road corridors. The building of Brasilia (Brazil's capital city since 1960) was a hallmark in this process.

The current distribution of Brazilian population tends to be structurally stable in the long run. It also features, to a great extent, the impact of these road corridors. A fact that deserves to be outlined is the alignment of cities along two road corridors: Belém - Brasília and Cuiabá - Porto Velho. In the northern and eastern Amazonia, the settlement programs implemented since the 1970's changed the traditional demographic distribution pattern. Historically,

people had settled along the river corridors, not along road corridors. On the other hand, the western Amazonia still features, to a large extent, the traditional patterns of population distribution.

In the southern part of Brazil, the culture of coffee extended into the State of São Paulo —the most densely populated in the country— in the beginning of the 20th century. This provided for the development of the railroad that, in turn, contributed to the acceleration of the country’s integration process and to the settlement of the national territory.

In the Northeast, demographic patterns rank among the most stable in Brazil. The coastline concentrates the most dynamic economic activities, most of the population and the largest cities. Cities loose density as you penetrate deeper inland, into the country.

Brazil’s population is predominantly urban: almost 80% of people live in cities. There are ten large metropolis. The São Paulo Metropolitan Region holds almost 18 million people and the Rio de Janeiro Metropolitan Region, a number of people that is closer to 11 million.

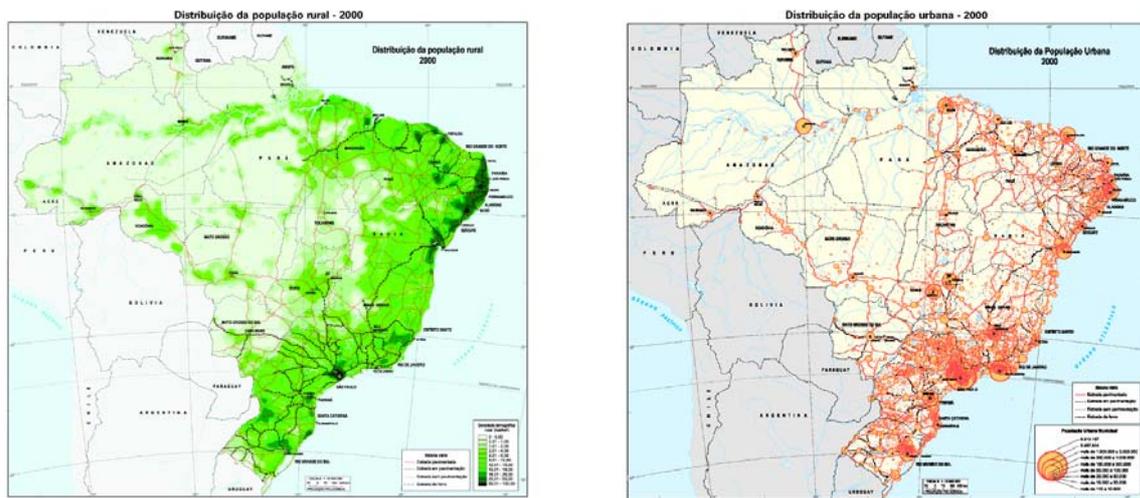


Figure 1: Distribution pattern of rural population (on the left) and of urban population (on the right) in Brazil in 2000 (IBGE, 2003)

The distribution pattern of rural population is similar to that showed by urban population (Figure 1). Some densely populated rural areas match some densely populated urban areas. This happens in São Paulo and its Region, Curitiba, Porto Alegre and the coastline, in the Northeast. This phenomenon partly derives from the settlements established around the big urban centers, subsequent to the recent urban sprawl on areas that used to be formally classified as rural. However, some land is used for farming production to supply food to the big cities. Some acreage of land is also dedicated to traditional farming and features a high density of rural population. This occurs in the Northeast, that is semi arid and wild. It is also true in the western part of the State of Santa Catarina, in the south of the country. In the north of Brazil, other areas featuring a high density of rural population were recently settled especially, Rondônia; some territories along the Transamazonic Highway; in the State of Pará

or along the river corridors that cross the Northern Region, since they are natural access corridors that lead population inland, into the country.

As to land policies and their evolution within the national context, it was only in the 20th century, after the 1930's, that the Government started adopting policies related to land administration and aimed at establishing guidelines for an industrial development model in the country. This was the beginning of the social and economic planning process.

In order to reach this goal, the Brazilian Government created the agencies that would contribute to the design of nationwide land administration policies. Therefore, in 1934, the *Instituto Nacional de Estatística* (National Institute of Statistics) was founded, followed by the *Conselho Nacional de Geografia* (National Geography Council) in 1936. These two institutions were merged in 1937 and renamed *Instituto Brasileiro de Geografia e Estatística*, IBGE (Brazilian Institute of Geography and Statistics). IBGE's aim is to produce economic, social and demographic statistics and to develop a standardized mapping system. The knowledge of the national territory and the identification of its characteristics and imbalances resulted in two land administration projects designed to achieve national integration and regional development. As an example, we may mention the *Plano de Metas* (Goals Plan) from President Juscelino Kubitschek in the 1950's. That Plan included the building of roads and of the country's new capital city—Brasilia— as a tool to draw settlement inland. In the 1970's, the Plan also created regional development agencies in the Northeast and in the Amazonia; the *Planos Nacionais de Desenvolvimento Econômico e Social* (National Plans for Social and Economic Development) and the *Programa de Integração Nacional* (National Integration Program). The most recent projects will be examined in the section of this paper relative to land policies (*Plano Plurianual*, PPA (Multi-Annual Plan) and *Zoneamento Ecológico-Econômico*, ZEE (Ecologic and Economic Zoning)).

In the early 1990's, the IBGE launched the development of a spatial data infrastructure in digital format that will be achieved thanks to the digitalization of data. Between 1994 and 1996, the IBGE published its first digital product. It was associated to the *Diagnóstico Ambiental da Amazônia* (Environmental Audit of the Amazonia) a program that included the development of the municipal digital tissue in 1991.

By the late 1990's, the 2000 Demographic Census, the development of the *Sistema de Vigilância da Amazônia*, SIVAMA (Surveillance System of the Amazonia), the progress made with remote sensing and in the digitalization of spatial data collected by *Instituto Nacional de Pesquisas Espaciais* (National Institute of Spatial Research) together with the need to design environment markers fostered the introduction of radical changes in the process of establishing a digital base of spatial data. This was especially required in those networks that divided the country into territorial units, at different scales (units from the Federation, meso-regions, micro-regions, municipalities, rural and urban sectors). Digital data —geology, geomorphology, vegetation and soils—of the Amazonia natural resources were also published. As of the late 1990's, data digitalization and mapping bases in digital format became part of IBGE's mapping data production.

The association of digital databases and the use of GIS (Geographic Information Systems) is fully expanding and has become an important tool to support land assessments and audits while, at the same time, provides support to land administration policies.

At present, a bank of spatial metadata is being developed. This bank combines spatial data and mapping bases in digital format. This model follows the example set by the FGDC (Federal Geographic Data Committee, FGDC, 2004) and by NSDI (National Spatial Data Infrastructure, NSDI, 2004).

2. INSTITUTIONAL ARRANGEMENTS

The *República Federativa do Brasil* (Brazilian Federation) is organized in three branches: the Executive, the Legislative and the Judicial, as shown by Figure 2, below.

Organizational Chart

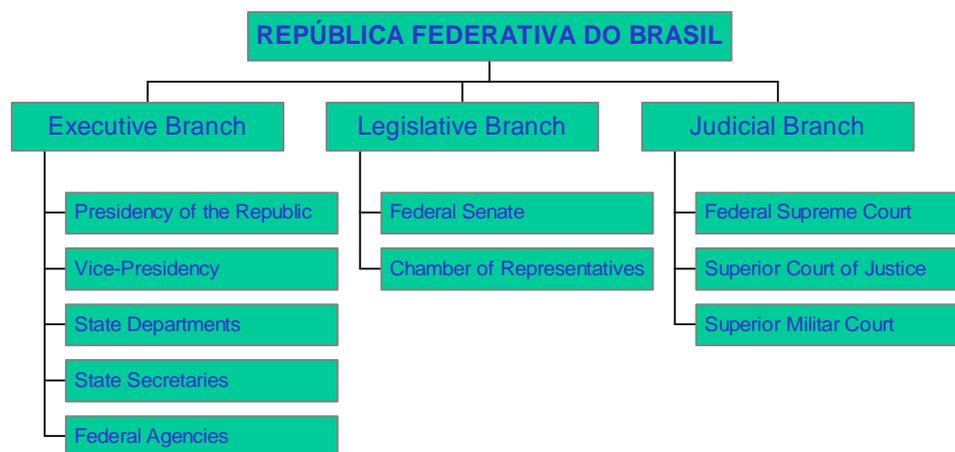


Figure 2: Organizational Chart of the Brazilian Federation

The State Departments of the Executive Branch are responsible for most of land administration activities. We can mention the following:

2.1 Department of Agriculture, Cattle Raising and Supplies (MAPA *its acronym in Portuguese*)

The *Empresa Brasileira de Pesquisa Agropecuária*, EMBRAPA (Brazilian Company for Agriculture Research) carries out research projects for the sustainable development of agribusiness in Brazil. This is achieved by the production, adaptation or transfer of technologies. This Department coordinates the *Sistema Nacional de Pesquisa Agropecuária*, SNPA (National System of Agriculture Research) formed by federal and state government agencies, universities, private companies and foundations focused on research on several geography and scientific knowledge fields (EMBRAPA, 2004a). As an example, we may mention the following projects: *Brasil visto do Espaço*, (Brazil as Seen from Space), *Monitoramento Orbital das Queimadas* (Satellite Monitoring of Burnings), *Sustentabilidade Agrícola na Amazônia* (Agriculture Sustainability in the Amazonia) and *Rio Demene* (Demene River) (EMBRAPA, 2004b).

The INMET (National Institute of Meteorology) also reports to this Department. This institute is responsible for meteorology in Brazil and represents the country before the WMO, World Meteorology Organization, a United Nations agency for meteorology and hydrology matters (INMET, 2004). We should also be mentioning Agritempo, the agro-meteorological monitoring system. This system provides its users on-line access to weather and agro meteorology information from several Brazilian municipalities and states. Besides reporting on the present weather conditions, the system feeds data to the *Rede Nacional de Agro meteorología*, RNA (National Network of Agro-meteorology) that is also part of MAPA. This network has basic information that guides agriculture zoning in Brazil. (AGRITEMPO, 2004).

2.2 Department of Cities

The objective of the National Secretary of Urban Programs is to arrange for an orderly occupation of the urban space so as to ensure sustainable access to urban land. This is achieved by the *Programa Nacional de Apoio à Regularização Fundiária Sustentável* (National Program in Support of Sustainable Urban Land Registration) and by the *Programa de Reabilitação de Áreas Urbanas Centrais* (Urban Areas Rehabilitation Program) (MCIDADES, 2004).

2.3 Department of Science and Technology

The *Programa Piloto da Proteção das Florestas Tropicais do Brasil* (Pilot Program to Conserve the Brazilian Rain Forest) was designed to ensure the environmental benefits of Brazilian rain forests. This program is a model of partnership between the Brazilian government, the civil society and the international community. Among the many projects associated with this program, we should highlight: the *Subprograma Unidades de Conservação e Manejo de Recursos Naturais* (Subprogram of Natural Resources Management and Conservation Units), the *Subprograma de Política de Recursos Naturais* (Subprogram for Natural Resources Policies), the *Projeto Reservas Extrativistas* (Rain Forest Extraction Reserves Project), the *Projeto de Apoio ao Manejo Florestal na Amazônia* (Project to Support the Management of the Amazonian Rain Forest); the *Projeto de Manejo dos Recursos Naturais da Várzea* (The Várzea Project: Floodplain Resources Management in the Amazon), the *Projeto Integrado de Proteção às Terras e Populações Indígenas da Amazônia Legal* (Comprehensive Project for the Protection of Aboriginal Land and People in the Amazonia Legal)² and the *Projeto Apoio ao Monitoramento e Análise* (Project in Support of Monitoring and Assessment) (MCT, 2004).

The *Agência Espacial Brasileira*, AEB (Brazilian Space Agency) reports to this Department. This agency is responsible for the *Programa Nacional de Atividades Espaciais*, PNAE (National Program of Space Activities) designed to develop action plans in remote sensing, meteorology, oceanography, communications and navigation, development of spatial systems

² *Transl. Note: Amazonia Legal: a geographic and administrative division created in 1966 following the initiative of the military government to facilitate planning issues.*

(especially, satellites and launching vehicles) and allied technologies and space sciences (AEB, 2004).

Brazil also has the *Instituto Nacional de Pesquisas Espaciais*, INPE (National Institute of Space Research) that is responsible for the development and application of space technologies in the following fields: space and atmospheric sciences, research and development in space engineering and technology, remote sensing, *Programa Amazonia* (Amazonia Program), research and development in meteorology, technologies associated to the space field (INPE, 2004a) and the *Projeto Observação da Terra*, OBT (Earth Observation Project) that focuses on scientific and technological knowledge on remote sensing and geo-processing, natural resources surveying and environment monitoring (INPE, 2004b).

The *Instituto Nacional de Pesquisas da Amazônia*, INPA (National Institute of Research on the Amazonia) is focused on creating and disseminating scientific and technological knowledge on the Brazilian Amazonia. This knowledge will preserve the environment and will provide for a sustainable development of natural resources so as to benefit, mainly, the people living in that region (INPA, 2004). It is in charge of developing the *Capacidade de Suporte Humano, Impactos Ambientais de Desmatamento e Sustentabilidade do Desenvolvimento*, AGROECO (Human Resources Capacities, Environmental Impacts of Cleaning and Development Sustainability). This is aimed at developing the available database on the impacts derived from converting the Amazon forest into farming land and from giving other uses to the land. It even focuses on impacts related to the global warming (AGROECO, 2004). It is also developing the *Experimento de Grande Escala da Biosfera-Atmosfera na Amazônia*, (the Large-scale Biosphere-Atmosphere Experiment in Amazonia, LBA). The LBA is a multi-disciplinary, international research effort, designed to understand the climatological, ecological, biogeochemical and hydrological functioning of Amazonia, its interaction with the Earth system, and its response to land use change. The LBA aims at assessing the impact of land use change not only in the Amazonia as a regional entity but also how land use change will affect the biological, chemical and physical functions of the global climate system. (LBA, 2004).

The Goeldi Museum also reports to this Department and carries out studies on natural and social systems in the Amazonia (MGOELDI, 2004).

2.4 Department of Defense

The *Serviço Geográfico do Exército* (Army Geography Service) provides support to the *Departamento de Engenharia e Comunicações* (Engineering and Communications Department), also part of this State Department on issues related to mapping. The *Centro de Cartografia Automatizada do Exército* (Army Automated Mapping Center) and the divisions dedicated to the surveying of mapping data perform these activities. These agencies produce the Army mapping documents from digital data that are updated on the field. They may survey properties, demarcate aboriginal areas or others allocated to the settlement of families benefited by the land reform (DSG, 2004). This Center updates the charts by using satellite images from LANDSAT and SPOT (CCAuEx, 2004) artificial satellites. The Army Geography Service Direction is responsible for the Army Base Mapping Chart.

The *Instituto de Cartografia da Aeronáutica*, ICA (Aeronautics Mapping Institute) is responsible for planning aeronautical mapping activities. These activities are performed by means of geodetic and topographic surveys carried out following the needs of the aerial space control infrastructure and of the aeronautical charts production agencies. This Institute is responsible for the Aeronautical Mapping Chart (FAB, 2004).

The *Diretoria de Hidrografia e Navegação do Comando da Marinha* (Navy Command Hydrographic and Navigation Direction) is responsible for the *Plano de Levantamento da Plataforma Continental Brasileira*, LEPLAC (Plan for the Surveying of the Brazilian Continental Shelf) the purpose of which is to determine the outside boundary of the Brazilian continental shelf. This Direction is also responsible for the Nautical Mapping Plan (DHN, 2004).

2.5 Department of Agriculture Development

It has jurisdiction on land administration through the *Secretaria de Desenvolvimento Territorial* (State Secretary for Land Development) that provides support to the designing of the *Planos Territoriais de Desenvolvimento Sustentável* (Sustainable Development Land Plans) (MDA, 2004)).

The *Instituto Nacional da Reforma Agraria*, INCRA (National Institute of Land Reform) has jurisdiction on land administration through the program called *Gerenciamento da Estrutura Fundiária* (Land Plot Management) that includes activities related to Land Use Georeferencing and Surveying for the National System of Rural Cadastre. The program mainly focus on the geographic location of rural properties and facilities, boundary demarcation and land use (INCRA, 2004a).

To guarantee security of tenure of public and private lands, the Federal Government created the *Sistema Público de Registro de Terras*, SPRT (Public System of Land Registration) (SPRT, 2004) that works together with the *Ordem dos Advogados do Brasil*, OAB (Brazilian Professional Association of Lawyers), the *Instituto de Registros Imobiliários do Brasil* (Real Estate Records of Brazil), the *Associação Nacional dos Órgãos Estaduais de Terras* (National Association of Public Land Agencies), the *Associação dos Notários e Registradores* (Professional Association of Notaries and Registrars) and the Federal Public Ministry.

Law number 10,267 of August 28, 2001 provides that the geo-referencing of rural properties is mandatory and creates the National Cadastre of Rural Properties. This Cadastre will allow the identification of rural facilities and will provide for their location, area, denomination, data from the descriptive memory, Azimuth distances, and a chart that will be geo-referenced to the *Sistema Geodésico Brasileiro* (Brazilian Geodetic System) (INCRA, 2004b).

2.6 Department of National Integration

The Secretary of Regional Development Policies guides land administration actions (MI, 2004).

2.7 Department of the Environment

It defines the national policy on matters related to the environment, water resources, environment protection policies, ecosystems conservation and sustainable use, biodiversity and forests, the strategies, the economic and social instruments to enhance the quality of the environment and the sustainable use of natural resources; policies focused on the integration of the environment and productive activities; environment policies for the *Amazonia Legal*, and the Economic Ecologic Zoning (MMA, 2004a).

This Department also coordinates the *Plano Nacional de Gerenciamento Costeiro* (National Plan for the Management of Coastlines) (MMA/GERCO, 2004 e MMA, 2004b).

2.8 Department of Mining and Energy

Centrais Elétricas Brasileiras, S.A. (ELETROBRÁS) (Brazilian Power Utility) performs studies on the emission of greenhouse effect gases in reservoirs; the environmental management of large transmission lines; the standardization of environmental regulations applicable to the energy industry and the organization of scientific contributions and accomplishments (ELETROBRAS, 2004). Petrobrás has jurisdiction on sustainable development and environmental management system (PETROBRAS, 2004). The *Departamento Nacional de Produção Mineral*, DNPM (National Department of Mineral Production) is responsible for managing the mining resources in Brazil (DNPM, 2004). The Brazilian Geologic Service develops the Land Management Program in metropolitan areas (CPRM, 2004).

2.9 Department of Planning, Budgeting and Management

The IBGE produces the Base Geodetic Map and the Base Mapping Chart as provided by Decree Law number 243 of February 28, 1967. The IBGE is also responsible for the coordination of the National Statistic System, following the *Plano Geral de Informações Estatísticas e Geográficas*, PGIEG (General Plan for Statistical and Geographical Information) set forth by Law number 5,878 of 1973, approved by Decree number 74,084 of May 20, 1974 (IBGE, 2004).

The IBGE supports the National Mapping Commission (CONCAR), a collectively operated agency that is part of this Department, as provided by Decree number 3,224 of October 28, 1999, Decree n/n from May 10, 2002 and Decree number 4,781 of July 16, 2003. This Commission was created to provide consultancy services to the State Department in matters related to the monitoring of the National Mapping System and to coordinate the implementation of the National Mapping Policy. This National Mapping Commission is

formed by representatives of State Departments that are related to activities connected with mapping. (CONCAR, 2004).

3. LAND ADMINISTRATION PLAN

Brazil does not currently have a national land administration policy that may integrate all the plans, the initiatives and the investments made in infrastructure and development at the different government levels (federal, state and municipal). This Plan would ensure the continuity of public actions and interventions on land issues that are aimed at guaranteeing a better quality of life in urban, rural and regional environments.

Within 2004, the State Secretary of Regional Development Policies, that is part of the Department of National Integration should design the grounds for the National Plan of Land Administration. These grounds will be submitted before the National Congress to be given statutory footing.

4. LAND POLICY

The National Plans for Development, the National Policy of Integration, the Development Area for the Amazonia, and the Development Area for the Central-West Region were all created in the 1970's to develop the infrastructure for regional development. The economic crisis of the 1980's put a halt to this initiative and resulted in a relative absence of land policy.

In 1988, when the new Federal Constitution (BRASIL, 1988) was passed, the Union was given more responsibilities on the "*design and implementation of national and regional plans on land administration issues and on economic and social development matters*". It was also made responsible for the definition of guidelines on urban development. Following the 1998 Constitution, the Union, the States and the Municipalities are responsible for protecting the environment. The Municipalities are responsible for the land administration of the urban land.

In the 1990's, the Multi-Annual Plan (1996-1999) set forth a framework that provided for a new stage of land planning with spatial references, since the Plan introduced national integration and development into the country's agenda. This experience continued in the second Multi-Annual Plan (2000-2003) as well as in the third one (2004-2007).

Thanks to these Plans, land was used once again as a reference for public policies integration. Meanwhile, the State is no longer the largest investor, but an agent that tries to foster and encourage the private sector to make investments. The Multi-Annual Plan became the main guidance for Brazilian public policies.

In 2004, within the scope of the Multi-Annual Plan, the PPP (Public Private Partnership) Law was drafted to appeal to private investors, both national and foreign. The law also aimed at encouraging these potential investors to make investments in the areas the Government sees as priorities. The public private partnership agreement is a contract between the Government

and private companies that legally binds them to implement or manage services and activities of public interest with funding and investment from the private sector.

The Government agrees to offer the private partner an additional revenue that would increase any income from the service provided to the public. The agreement is valid for a term of up to 30 years. When the public private partnership term is complete, the property of the asset goes to the State.

The *Zoneamento Ecológico-Econômico*, ZEE (Ecologic Economic Zoning) is yet another instrument for land administration. It is coordinated by the Department of the Environment and implemented under the responsibility of the States (MMA, 2004c).

At local— municipal— level, the local authorities are responsible for land administration. Local land administration is delivered through Master Plans, mandatory to all the municipalities that hold at least 20,000 people.

5. LAND AND MAPPING INFORMATION

As United Nations stated, “mapping is not only a basic tool for economic development, but the main tool to be used before being able to work with other tools”.

In Brazil, systematic topographic mapping is under the responsibility of the IBGE and of the Brazilian Army. The IBGE also produces the International Chart at the Million-User Scale, thematic maps and territorial units.

These activities are performed with the cooperation of national and regional research institutes, universities and in association with other institutions. Today, there are several institutions that work on mapping activities in the country, under the coordination of the *Comissão Nacional de Cartografia* (National Mapping Commission) (IBGE, 2002).

The IBGE performs geodetic surveying and cartographic surveying. These two activities are the main source of data to produce the maps. Any supplementary data come from several public or private institutions that are part of the National Mapping System (SCN) or that produce land information (IBGE, 2002).

6. LAND AND GEODETIC INFORMATION

Geodesy is defined as the scientific discipline that deals with the representation, the measurement of the Earth and with its gravitational field. The geodesic problem is geometrical and physical in nature and can be treated as the definition of a coordinate system that defines certain points that allow the representation of the physical surface of the Earth (the topographic surface).

The system of coordinates associates with the family of descriptive points that is called the Geodesic System (IBGE, 2001b). The Brazilian Geodesic System is defined by the set of geodesic stations deployed on the portion of the surface of the Earth delimited by the country's borders. These stations are positioned by strict operational procedures. The

coordinates are determined following high-precision geodesic models that are compatible with the objectives they are intended to be used for (IBGE, 2001b).

The last decade witnessed a true revolution driven by the use of GPS (*Global Positioning System*) technology in the fields of navigation and positioning. Geodesic and topographic measurements can now be performed fast, with high precision and at low cost. These advantages increase as the equipments, observation methods and processing techniques evolve. This is the context for the *Rede Brasileira de Monitoramento Contínuo*, RBMC (Brazilian Network of Continued Monitoring) that uses GPS technology (Fortes, 1997; IBGE, 2001a).

The RBMC is formed by continuous tracking stations of GPS satellites deployed across the country. These stations are equipped with high-precision geodesic tracking systems with remote operation by the IBGE so as to obtain data to be processed by scientific applications. The RBMC produces data and information needed for the public use of GPS technology in Brazil. The RBMC is the connecting link with international reference systems. All the data that the stations obtain in 30 days of tracking are available in the RBMC website (www.ibge.gov.br) (IBGE, 2001b). The RBMC plays a key role in the country's land administration because it provides referencing for any positioning required in the country (that is, to determine any coordinates, latitude, longitude and altitude).

The *Sistema de Referência Geocêntrico para as Américas*, SIRGAS (Geocentric Reference System for the Americas) (SIRGAS, 2004) is an international initiative under the coordination of the IBGE to develop a new reference system in the continent. To such end, Brazil will officially adopt the new system —SIRGAS2000— for geodesic and mapping purposes.

Brazil, as many other developing countries, does not have a full mapping coverage of its territory at the scales and with the precision that require the pace of development and the demand for spatial data. The country is very large; there is difficult access to many regions and the reduced investments of the 1980's impacted negatively on the systematic mapping activities. These difficulties were contemporary with the emergence of new technologies that revolutioned mapping production procedures. The initial investments made on equipment, technical training and satellite imaging were offset by the future benefits and added value to data that were traditionally obtained by on-site observation and by flying over the targeted area.

The new digital mapping data capturing and processing methods replaced conventional procedures, facilitated mapping and charts reproduction in magnetic means. Besides, the development of modern GIS associate geographic aspect to statistical and thematic data, that is, associate graphs to alphanumeric data. These new tools facilitate the space analysis process and diversify formats and products the accomplishment of which is, to a great extent, a widening of the number of producers and users for this type of information (IBGE, 2002). Furthermore, they make mapping and geodesic knowledge accessible to everybody.

Big efforts are being made to technically and methodologically update the IBGE, so that it can respond to the increasing demand of updated mapping data. In the Southeast Region, there is an increasing demand

to extend the present mapping coverage. Apart from dealing with these challenges, the IBGE requires to graphically represent the territorial borders of Brazil. This task increased a lot in recent years due to the creation of hundreds of new municipalities. The IBGE is also responsible for systematizing information on natural resources and for carrying out regional geography studies (IBGE, 2002).

Below, a detail of the purposes and percentages of the mapping coverage already complete in Brazil. The pertaining scale is indicated. (IBGE, 2002).

Scale 1:1,000,000 – Provides information on general and strategic aspects, across the continent. It has national coverage and so far, has covered 100% of the country. It includes a set of 46 charts. The most recent edition was completed in 1999. In 2003, the corresponding digital product was published; data were vectorial and integrated for the whole of Brazil.

Scale 1:250,000 – It supports regional planning and projects that focus on the environment. It has national coverage and so far, has covered 72% of the country.

Scale 1:100,000 – It represents densely occupied areas, ranked by their need of government investment. It has national coverage and so far, has covered 72% of the country.

Scale 1:50,000 – It is a cartographic representation of densely populated areas. It is an appropriate tool for social and economic planning and for the formulation of engineering projects. It has national coverage and so far, has covered 14% of the country with a focus on the Southeast and South Regions.

Scale 1:25,000 – It is a cartographic representation of certain specific areas, with high levels of human occupation. It contributes some elements to social and economic planning. It also provides elements for engineering projects. This mapping survey, because of the characteristics that are proper to this scale, is basically used for areas located in the metropolitan regions. So far, only 1% of the country has been covered at this scale.

Since the 1990's, the IBGE is dedicated to develop a project that focuses on the dissemination, in digital format, of the systematic, topographic and geographic mapping results (IBGE, 2002). This project includes the automated capture of existing cartographic databases; the production of new databases by digital stereo-compilation; the organization, validation and management of a Digital Topographic Map-Library; and the production and reproduction of both originals and cartographic mappings. This project allows a response to the demand of digital cartographic data structured for a Geographic Information System (GIS).

An ongoing update of data in the Digital Topographic Map-Library will achieve a Database of natural and artificial elements of the geographic landscape, represented in their graphic and

semantic aspects by means of the cartographic language. This IBGE's project involves the production and reproduction of thematic maps and of territorial cadastres from the census and research studies performed by statistical sampling. The Digital Topographic Map-Library offers a geometric reference for the State to develop geographic information systems extremely suitable for urban and regional planning purposes. Table 1 summarizes the progress made, so far, in the digitalization of urban and regional planning.

Table 1: Progress made in the digitalization of cartographic documents

Scales	% in terms of the total coverage				% in terms of the surveyed area			
	Printed	Raster	Vetor	Printed, no raster	Printed	Raster	Vetor	Printed, no raster
1:50.000	14	12	9	0,3	100	86	60	2
1:100.000	72	61	37	4	100	84	51	5

Source: IBGE

In spite of all the efforts made towards digital cartographic production, the cut down on investments by late 1980's also resulted in the outdating of available cartographic information and thus impacted negatively on its possible use to support the development of the country.

7. FUNCTIONS OF LAND ADMINISTRATION

Brazil's agriculture industry is extremely concentrated. In 1992, according to the National Institute of Land Reform, rural properties under 10 hectares in size amounted to almost one million units but only covered approximately 1.5% of the total area of surveyed properties. On the other end, properties above 1,000 hectares in size covered 50% of the total surveyed area but amounted to only 41,000 units.

This situation, that derives from the historical development of land settlement started in colonial times, continued until recent years, specifically, until the 1970's when Brazilian agriculture began its modernization process. This modernization meant that agriculture equipment and industrial inputs were more intensely used. Besides, capitalistic labor relationships were adopted in large rural properties that were converted into agriculture companies.

However, agriculture systems of production in Brazil are far from being uniform. The Northern Region features low demographic density. This fact does not prevent the presence of violent conflicts for land tenure. Conflicts exist, for example, in the State of Pará, as a consequence of the extension of acreage devoted to agriculture in the neighboring State of Mato Grosso. In the Northeast, large holdings—predominant form of land tenure—co-exist with small and mid-size holdings. Small and mid-size properties outnumber large holdings in the semi-arid *sertão*. The Southeast, the most industrialized region of the country, features a

less concentrated agriculture pattern. When compared with other regions, it is possible to see a larger participation of mid-size properties that mainly focus on commercial agriculture. The South Region features the best land distribution pattern, with a larger participation of small holdings. Finally, the Center-West shows a larger participation of large holdings and is mainly dedicated to highly mechanized crops.

8. URBANIZATION

All through the 20th century Brazil witnessed a continuous urbanization process. This process was especially significant since the 1950's, when it accelerated its pace. Consequently, the 1960's were a turning point: from being basically a rural country, Brazil became urban. Urban population went up from 45.5% in 1960 to 56.8% in 1970. This trend remained firm until the end of the century and, in 2000, reached a peak of 81.3%. This made Brazil one of the most urban countries in the world. The urbanization process lived by the Brazilian society cannot be dissociated from the progress made by industrialization. This started in the 1950's, when large urban conglomerates became attractive to a large number of migrants, since labor was in high demand in urban productive activities.

In the 1970's, urbanization and rural emigration got a new momentum in virtue of the powerful economic growth lived during that decade. At the same time, agriculture was modernized and labor was no longer required in the same proportion in rural activities. Therefore, metropolis grew, especially cities over one million people got larger and resulted in a new hierarchy of cities in the country. These metropolitan cities are urban spaces that feature the largest offer of assets and services in the country. They also project their influence over large areas.

Metropolis consolidation was a process that the Government finally acknowledged in the 1970's. Regulations provided for the creation of nine metropolitan regions: San Paulo, Río de Janeiro, Belo Horizonte, Recife, Salvador, Porto Alegre, Fortaleza, Belém and Curitiba. However, it is worth outlining that Brazil, unlike most Latin American countries, does not feature the phenomenon called urban macrocephalia, that is, the development of only one huge metropolis, much larger than any other city of the urban network. In Brazil, urbanization was better spread. In 2000, there were 23 officially acknowledged metropolitan regions, including the *Distrito Federal* and its surrounding ring.

9. ASSESSMENT AND IDENTIFICATION OF PROBLEMS AND BARRIERS

Land administration involves each and every planning area that relates with land organization. As already explained, Brazil does not have an integrated system of land administration that provides for coordinated actions at the different levels of government. This diversity of instruments, programs and actions focusing on land administration resulted in much harm to the country, especially in resource allocation for the social and economic development.

In order to properly develop land administration projects, it is necessary to have precise mapping information, updated data, at the proper scale that may feed systems associated to new technologies, such as GIS, a significant tool for planning and decision making.

The 1988 Constitution integrated these activities into the following articles:

“ Art. 21. It is the Union’s responsibility:

IX – To design and implement land administration in Brazil,

....

XV – To organize and maintain official services of statistics, geography, geology and cartography at national level;

....

Art. 22. It is the exclusive responsibility of the Union to rule on:

XVIII – National statistics, cartography and geology systems;...”

It is important that the State should establish cooperation agreements so as to keep a data bank with geographic information at national level that will ensure the consistency of land information.

When asked the different Departments that play a role in areas such as: economic planning, agriculture, farming policies, food production, industrial development, education, the environment, urban planning, basic infrastructure (e.g., transportation, roads, sewage, electric power and supplies) we can see that all of them, directly or indirectly, play some role in land administration. That role is usually based on some plan or project related to their specific field.

The transfer to other sectors (e.g., the environment, health, education, etc.) of resources for basic mapping activities faces difficulties vis-à-vis the implementation of plans related to land administration. Therefore, it is of outmost importance to identify the resources for the updating and the production of mapping products. This identification should be performed by programs and projects linked with the other sectors, especially, those that may receive funding from international development agencies.

10. POTENTIAL TOPICS OR CHALLENGES A GOVERNMENT OFFICER SHOULD CONSIDER

Defining a modern plan on land administration that is integrated at federal, state and municipal levels, so as to achieve appropriate and sustainable use of land.

Allocating resources to activities related to the production of geodesic and basic mapping infrastructure, in digital format, taking advantage of benefits from new technologies available, especially those associated with GNSS (*Global Navigation Satellite Systems*) and new remote sensing equipment.

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