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Cartography and Law in Territorial Formation and Property Configuration in Brazil

Cartografia e Direito na Formação Territorial e na Configuração da Propriedade no Brasil

Claudia Robbi Sluter [1], Andrea Flávia Tenório Carneiro [2], Andrea Lopes Iescheck [3], Daniela Regina Pontes [4] e José Antônio Peres Gediel [5]

1 Universidade Federal do Rio Grande do Sul, Departamento de Geodésia, Porto Alegre - RS, Brasil. robbi.sluter@ufrgs.br
ORCID: https://orcid.org/0000-0002-6765-9526
2 Universidade Federal de Pernambuco, Departamento de Engenharia Cartográfica, Recife -PE, Brasil. andreaftenorio@gmail.com.
ORCID: http://orcid.org/0000-0002-2445-2330
3 Universidade Federal do Rio Grande do Sul, Departamento de Geodésia, Porto Alegre - RS, Brasil. andrea.iescheck@ufrgs.br
ORCID: http://orcid.org/0000-0002-8390-435X
4 Universidade Federal do Paraná, Departamento de Geomática, Curitiba, Brasil. danielepontes.ufpr@gmail.com
ORCID: https://orcid.org/0000-0003-1043-9327
5 Universidade Federal do Paraná, Departamento de Direito Civil e Processual Civil, Curitiba, Brasil. jagediel@gmail.com
ORCID: https://orcid.org/0000-0002-4139-8559

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Abstract: The dialogue between Cartography and Law allows us to discuss and evaluate the historical consequences of land demarcation, titling, and registration in Brazil. This dialogue between areas of knowledge guides the development of interdisciplinary research, seeking to recover, in their respective areas, the historical path of techniques and regulation. Therefore, the discussion and the questions formulated in this research are related to the need for integration between topographic mapping and Cadastre; to the lack of topographic mapping; to legal problems of demarcation and titling of public and private lands; and the diagnosis of the current situation concerning Cadastre and its relationship with the topographic mapping. Thereby, this paper presents the arguments with which we establish a research project whose primary goal is to understand the historical consequences of the lack of topographic mapping in land demarcation and registration in Brazil and its relationship with the current regulatory framework. The analysis shared among researchers of this group denotes absences and contradictions, which point to the need to search for common conceptual elements, problematizations, and questions to identify and solve problems.
Keywords: Topographic mapping. Cadastre. Territorial legislation.

Resumo: O diálogo entre Cartografia e Direito permite discutir e avaliar as consequências históricas dos processos de demarcação de terras e de titulação, e do registro de propriedades, no Brasil. Esse diálogo entre áreas do conhecimento orienta o desenvolvimento de pesquisa, com viés interdisciplinar, que busca recuperar, em suas respectivas áreas, o percurso histórico de técnicas e normas. Por isso, o debate produzido e as questões formuladas nesta pesquisa dizem respeito à necessidade de integração entre o mapeamento topográfico sistemático e o cadastro territorial; à ausência do mapeamento topográfico; aos problemas jurídicos de demarcação e titulação de terras públicas e privadas; e ao diagnóstico da situação atual do cadastro territorial e sua relação com o mapeamento topográfico sistemático. Este artigo apresenta, assim, os argumentos com os quais se estabelece um projeto de pesquisa cujo principal objetivo é entender as consequências históricas da ausência de mapeamento topográfico na demarcação e no registro de propriedades no Brasil, e sua relação com o arcabouço normativo vigente. As análises compartilhadas entre os pesquisadores deste grupo de pesquisa denotam as ausências e as contradições que apontam para a necessidade de busca de elementos conceituais, problematizações e questionamentos comuns na identificação e solução dos problemas.
Palavras-chave: Mapeamento topográfico sistemático. Cadastro territorial. Legislação territorial.

1 INITIAL CONSIDERATIONS

This paper presents the arguments to propose a research project whose primary goal is to identify topographic mapping deficiencies in land demarcation and registration in Brazil. Also, in its relationship with the current regulatory framework, by analyzing the process of territorial occupation and the Brazilian land and agrarian legislation. Hence, there is a chronological discrepancy between the territory occupation, legislation, and mapping.

Topographic mapping is the spatial reference for any activity in a society focused on territory planning, use, and occupation. In turn, the territorial Cadastre describes the relationship between people and land, serving as a basis for land and land use management, including territorial planning, and supporting sustainable development and environmental protection. This concept of territorial Cadastre, proposed in FIG (1995), is adopted by several other institutions and authors, such as UNECE (1996), UNECE (2005), Williamson et al. (2010). Therefore, an efficient cadastre relies on mapping the spatial units' boundaries according to their legal situation, confirming the interdependence between these systems. In this context, Cartography and Law are summoned to provide an interdisciplinary perspective on the conformations, representations, and interpretations of the portrait of contemporary Brazilian territoriality, based on the reconstruction of events and circumstances that have characterized its passage and permanence in time.

If the two areas have particular and distinct languages in form, they walk side-by-side in content and purpose. Thus, the description, appropriation, use, occupation, justification, control, and power over the land produce officialities and legitimacy, taking on several hierarchies affect the drawing of borders, including belongings and identities and, thus, the ways of realizing life and relationships with space.

Each epistemology establishes in the diversity of its fields of analysis the production of realities and, therefore, the pictures that inhabit the imaginary of the land's social invention (MAIA, 2008), especially the "*Brasilis*" land, recognized for the violent constitution of a colonial territory. The proposed temporal frame does not ignore or minimize all of the preexisting reality. Instead, it places itself on the hegemony of the forms assumed from the event of colonization and the sudden ruptures that add up in time. The historical path of the interweaving of Cartography and Law takes place in this environment, absolutely imposed and influenced by how the external agent, materialized in the nation-state figure, exercises what they understand as organization and control. In this environment, norms for the definition of territorial organization policy and the initial constitution of territorial units and their respective political, administrative, and formal domains, gain prominence. With this perspective, in both disciplines lies the expectation for solutions that affirm or confirm certain "realities" based on the technique that strives for certainty and precision, with its instruments par excellence: the mapping and the laws that establish the institutionality foundations formalizes land management.

It follows that Cartography and Law, as they stand, are products of the same historical time and serve the purposes of colonial conquest and national states. The beginning of the 19th century, given the States' configuration and the concern with territorial control and planning, changed the notion of mapping and territorial rights. France, with the Napoleonic Cadastre, changed the size, scale, and map contents at the same time that the Napoleonic Civil Code established the new property figures of the land, with the emergence of the public-private division and the regime of properties and possessions. Influenced by European models, though in a diverse context and conditions, attempts were made to establish state policies in Brazil, especially in the post-independence period. These policies provided the implementation of cartographic bases and the inauguration of regulations on the disposition of public lands to create private properties, a fact that can be observed, initially, in the advent of the Land Law in 1850. Given the precarious conditions and the utterly hostile environment to such novelties, we lack concurrence between discourse, practice, and reality. From the Cartography standpoint, illustrative nature's distortions in the "Map of the Empire of Brazil" are in conjunction with the new provision for private property defined in Brazil's first Constitution (1824). This property regime provided for the exact definition of territorial units, which constitutes an "institutional untruth."

Brazil has never had a complete, updated topographic mapping on the scales necessary for implementing a territorial cadastre to support land policies and adequately meet the legal standards on territorial issues. Currently, the available mapping corresponds to 5% of the Brazilian territory on the scale

1:25,000 and 24% on the scale 1:50,000 (SLUTER et al., 2018), which is insufficient to support the territorial Cadastre and to apply the legislation on territorial planning.

Some basic concepts of Cartography are explained herein due to the importance of precisely understanding their meanings. Topographic maps are a type of general reference map (SLOCUM et al. 2008), and, as such, topographic mapping is reference mapping. However, the other way around is not necessarily true. This understanding is essential since one of the historical milestones fundamental to this analysis is France's mapping, known as Cassini's "map of France" (THROWER, 2008). This mapping introduced systematic mapping, called topographic mapping. Since Cassini's mapping of France, topographic mapping is the technique that features its products with the highest accuracy and precision allowed by current technology.

For this reason, it is this mapping technique that should be the spatial reference for any activity of society focused on planning, use, and occupation of territories. It is also essential to understand that any graphical representation of the environment can be called a map, and therefore any product of Cartography can be called a map. Accordingly, we must consider the cartographic representations known as plans to establish some distinctions between the historical evolution of measuring methods and graphic representations of agricultural uses and urban occupations. We use two designations in this article: plan and map. Plans are cartographic representations of small regions of the Earth's surface, which utilize the topographic plane as the reference surface.

This research project and the partial results presented in this paper will allow us to understand the historical consequences of the demarcation and registration of properties in Brazil by establishing common categories of analysis. To understand the relations and dependencies of the Law with topographic mapping and with a territorial cadastre, the discussions conducted here concern the modern Cadastre and its relations with the history of topographic mapping; the formation of territory and property in Brazil; the lack of topographic mapping and the problem of land demarcation in Brazil, and, finally, the diagnosis of the territorial Cadastre's current situation and its relationship with topographic mapping.

2 THE MODERN CADASTRE AND ITS RELATION TO THE HISTORY OF TOPOGRAPHIC MAPPING

The oldest cartographic representations we know about it depict boundaries of agricultural lands, such as in Val Camonica, Italy (ARCÀ, 2004), and a human settlement in Çatalhöyük, Anatolia region, Turkey (CLARKE, 2013), both from the neolithic period. Around 2300 BC, the Babylonian people built the oldest historical map, called the Acadian map, in which they draw the Mesopotamia region. In this map, the East, the West, and the North are on the top, bottom, and right, respectively. Some geographic features can be identified, such as water streams, people settlements, and mountains. The Babylonians also built the oldest map of the world, around 600 BC. That map illustrates how the Assyrian people understood the world: Mesopotamia in the center with an ocean that encircles the lands, the terrestrial ocean, and the distant places, the Seven Islands, marked by triangles. River Euphrates is also represented, from its source in the Armenia mountains to its mouth in the Persian Gulf. In this map, several cities are depicted by circles; and some of them are identified by their names. Among the Mesopotamian maps, there is a plan of part of a town called Nippur. The town plan shows water channels, the wall with its gate and moat, houses, and yards, among other features, and was built on a clay plate in about 1500 BC (THROWER, 2008; MILLARD, 1987).

The Acadian map, a Nippur city plan, is a large scale map in which the geometric shapes and distances are precise. On the other hand, the Mesopotamian and the World maps are graphic representations of the Assyrians and Babylonians' understanding of that region. In the same clay plate of the world map, a text describes the cuneiform writing. Reading that text made it possible to understand the astrological and religious meanings of the map. Either the Mesopotamian map (medium scale) or the world map (small scale) are illustrations of the Assyrians and Babylonians' mental map of the region they lived in and their world (THROWER, 2008; MILLARD, 1987).

The historical registers that the Egyptians paid income taxes and fees on agriculture harvest in the Ancient Egipt allows us to conclude that they knew land surveying and, consequently, geometry. However, there are no maps or draws related to public cadastral surveying (SHORE, 1987).

The strong and significant influence of Classical Greece in the History of Cartography is more related to theoretical development than to practical solutions for land surveying (HARLEY; WOODWARD, 1987). Unlike Classical Greece, land surveying techniques were developed in the Roman Empire either for cadastral plans or engineering plans of tunnels, aqueducts, and drainage systems. The oldest Roman map of the land survey dates around 170 to 165 BC. The Roman cadastral maps represented the *centuriation*[1] , which was one element of the land registration system. The government administration also used the cadastral maps to define government administration strategies besides the land registration. In the book, *Corpus Agrimensorum*[2] is written that Julius Ceasar started an organized system for land surveying and registration. Emperor Augustus's government improved that system (DILKE, 1987).

In the Roman Empire, a land surveyor was called "*agrimensor*"; therefore, the origin of the word "*agrimensura*" is in the Latin language what means land measurement or land surveying. The "*agrimensores*" executed the conquered land parcels' cadastral surveying under a well-established method encompassing technical, legal, and administrative issues. The entire process and the cadastral map were registered in bronze, wood, or marble plates called *formas* or *aes*. Those documents included cadastral data, such as parcel area, owner name, legal regime. Those cadastral registers were prepared in two copies, one of them was sent to the municipal or colonial archives, and the other was to file in the *tabularium* of Rome (ÁLCAZAR MOLINA, 2007; DILKE,1987).

The difference between a large and a small scale representation is essential for us to understand the evolution of map-making of small regions such as agricultural lands and towns and large regions such as kingdoms and the world. The first ones were built based on land surveying of small regions, also called "*agrimensura*." The second one, the determination of latitude and longitude of specific point locations, was prepared based on cosmography. The latter were called cartography. These two technical professions were independently developed for centuries. That means that, for centuries, the techniques developed for land surveying were not used in cartography, and vice-versa. Combining methods and techniques developed for cartography and land surveying made it possible to map a large land extension at a high precision level, such as the Kingdom of France by Colbert and Cassini. On the other hand, Colbert and Cassini's topographic mapping methods enabled Napoleon's Cadastre, the modern Cadastre's precursor.

Two scientific institutions created in the XVII century played a fundamental role in developing methods and techniques that made France's topographic mapping possible. Those institutions are *Académie Royale des Sciences* of France and the *Royal Society*, formally *The Royal Society of London for Improving Natural Knowledge* of the United Kingdom. The scientific academies' members developed studies and research to understand and solve many scientific problems related to mapping and navigation precision. One of the famous British scientists was Edmond Halley, who is the author of the oldest known thematic map, the map of the isogonic line of the Atlantic Ocean (THROWER, 2008).

Although the significant developments of the scientific methods for astronomical observations and geodetic triangulations made it possible to make topographic maps of large portions of land, there were not enough maps at the end of the XVII century at large scales of a whole kingdom. Those maps would be useful for planning transportation, public administration, and military strategies. The Map of France was the first topographic mapping at enough high accuracy and precision for being published at a much larger scale than every previous mapping of a whole country. Furthermore, it was the first to be printed in paper sheets limited by latitude parallels, and meridians formed a net of spherical quadrilaterals (KONVITZ, 1983; THROWER, 2008).

In 1668, Jean-Batiste Colbert and the minister of finances of King Louis XIV proposed the Map of

[1] (Oxford Dictionary) Roman History: “The method, process, or practice of dividing agricultural land into a regular pattern of centuries, especially as part of the foundation of a colony.”

[2] (Wikipedia) “The Corpus Agrimensorum Romanorum is a Roman book on land surveying which collects works by Siculus Flaccus, Frontinus, Agennius Urbicus, Hyginus Gromaticus and other writers. The text is preserved in the fifth or sixth-century uncial manuscript known as Codex Guelfferbytanus 36.23 Augusteus 2, held in the Herzog August Bibliothek in Wolfenbüttel. It is one of the few surviving non-literary and non-religious illuminated manuscripts from late antiquity. The text was first printed in 1554 by Adrianus Turnebus, under the title De Agrorum Conditionibus et Constitutionibus Limitum.”

France under the French court support. To accomplish that challenging task, Cobert hired an Italian astronomer and professor at the University of Bologna, Giovani Cassini. In 1669, King Louis XIV invited Giovani Cassini to be a scientist in the *Académie Royale des Sciences* of France. One year later, Cassini was designated the director of the *Observatoire de Paris*. His first task was to measure the length of one meridian arc of the Meridian of Paris, which Abbé Picard accomplished, a famous geodesist, by geodetic triangulation. Based on Picard triangulation, they built nine topographic charts of the Paris region. Although Picard died in 1682, the geodetic triangulation work was extended from the English Channel's cost until the Pirineus mountains. The construction of the geodetic benchmarks set by triangulation in the whole country made it possible to make topographic maps of entire France with much higher accuracy and precision than every mapping already made in history until then. Consequently, it made it possible to make topographic maps at a much larger scale, 1:86.400, than the reference maps that had been making so far in History (THROWER, 2008).

The Map of France of Cassini established the method to making systematic topographic mapping that it is until today the method to build topographic charts of a whole country, that is, the country's topographic mapping (THROWER, 2008). The great challenge of mapping a so large country, such as the Kingdom of France, was only possible because brilliant geodesists and cartographers had worked together, in cooperation, in order to establish the modern method to making topographic mapping. The method encompasses four stages: (1) the definition and construction of the geodetic system; (2) the definition of the methods and techniques to surveying the geographic features; (3) the definition of the country divisions limited by parallels of latitude and meridians, called topographic map series; and (4) the preparation of the topographic charts for print and publication. Besides the innovation of the establishment of map series in different but related scales, the Map of France was planned to be implemented by map symbols convention, which means that every topographic map was built with the same symbols.

The highest expertise in Cartography and Geodesy in France of the XIX century than any other country provided suitable conditions for the proposition and development of a modern cadastre, broader than parcel or property taxation (PHILIPS, 2003). From 1793 and 1794, the National Convention of France proposed the General Cadastre of the Nation, which included evaluating every real property. On November 23rd, 1798, a law regulated property taxation. In 1801, Napoleon, at that time, the first consul of France, established a commission to study equity property taxation. In the so-called Instructions Related to Cadastre published in 1808, we can find the basis for cadastre execution. Still, in 1807 a commission was created to develop a plan for a systematic surveying classification and evaluation of more than 100 million parcels. That plan was approved, started in 1808, and it was finished in 1850. In 1811, a compendium called *Recueil Méthodique des Lois, Décrets, Regléments, Instructions et Décisions sur le Cadastre de France* was published with every Law, Decree, Regulation, and instructions related to Cadastre. According to Williamson (1983), one of the more crucial French cadastre contributions was to realize the importance of large-scale topographic maps and a systematic land surveying method for establishing a modern cadastre. Although that Cadastre was set for taxation, Napoleon understood that the surveying tasks could be useful for other purposes, including property warranty.

Jean-Courret (2020) described Napoleon's Cadastre's proposition and execution from the legal, administrative, and technical points of view. He emphasized the historical importance of the set of documents generated at that time. Regarding the technical issues, the author describes the parcel surveying, which was written on the map. The same identification relates the parcel description to the persons related to it. The cadastral map provided a complete, careful, and precise representation of the land occupation and the built and non-built spaces, essential information for the tax calculation.

Bullock (1983) outlined the main stages of the French cadastre work, listed by Dowson & Sheppard on 1956 (apud BULLOCK, 1983): (a) establishing of a local triangulation network; (b) organizing a list of land owners, with the related taxation and parcels limits; (c) defining the parcel as a portion of land divided by any physical boundary, under the same law obligations and owned by the same person; (d) notifying the parcel owners and their employees about the cadastre surveying of their properties; (e) enumerating the parcels by one single system represented in a 1:1250 or 1:2500 cadastral plan; (f) calculating the area of the parcels; (g) organizing a parcels index they showed the names and addresses of the owners, every parcel that was onwed

by the same person, the kind of agricultural culture of every parcel and the characteristics of the constructions; (h) publishing the cadastre surveying results; (i) classifying every parcel in accordance with land use, venal value and taxation; (j) organizing a list of the owners in alphabetic order; (k) in the first years of the French Cadastre the parcels and owners index was updated every year based on the list provided by the Real Estate Registration Office.

The French Cadastre, considered the starting point of the modern Cadastre, started some years after the Map of France of Cassini. Generating a topographic mapping in large scale and high accuracy was only possible because Colbert and Picard could accomplish the measurement of one arc of the Paris meridian with accuracy and precision appropriate for being the basis of mapping at a larger scale than 1:100.000. Besides the possibility of mapping France's whole territory at a precision and accuracy compatible to a large scale, it was necessary to establish geodetic benchmarks in all the French territory. When the National Convention of France decreed the organization of the General Cadastre of the Nation and a few years later every Law, Decree, Regulation, and instruction about Cadastre was published, there already was an accurate and precise geodetic system that was monumented in the whole country. Since the Map of France of Cassini and the General Cadastre of the Nation, we know that an accurate and precise cadastral mapping needs a large-scale topographic mapping, built on high precision, that demands to be continuously maintained.

3 INACCURACY AND ADAPTATION OF LEGAL INSTRUMENTS AS POWER STRATEGIES IN BRAZILIAN TERRITORIAL FORMATION

3.1 Configurations of the legal cartographic normative model

The colonial enterprise took over territories (spaces molded by native peoples) to extract products with commercial value in Europe. The colonial metropolises used three concomitant and interdependent instruments: Law, Cartography, and war to establish this domain. These instruments are conceived from the feudal social organization before expanding the maritime mercantile economy that extrapolated the limits of the Mediterranean at the end of the 15th century. They were then adapted to the purposes of the new economic and socio-political configuration that began to take shape in Europe during this period. The use of these instruments in the face of new challenges has always been precarious, but it has generated certain effects.

The Treaty of Tordesillas (1494), for example, is a typical legal instrument of the "law of war" since it intended to prevent conflicts (wars) between the colonial powers of Portugal and Castile over the political domination of the territory and the legal ownership of the lands of the newly discovered American continent. It was signed in 1500 before the Portuguese had even landed on what is now the Brazilian coast. This treaty derived from papal mediation, a central aspect of the politics of feudal kingdoms. Its purpose was to define unknown lands' frontiers, many yet to be conquered and others non-existent, based on what was imagined and described by travelers and medieval chroniclers. Therefore, the Portuguese domain was stipulated by this treaty as "about three hundred and sixty leagues west of the Azores Islands," indicating the ignorance and inaccuracy of information about the world to be conquered. This stipulation of the land domain is undoubtedly a legal abstraction that only became a reality because of the war against the native peoples and the subsequent conflicts between Brazil and neighboring countries colonized by Spain. This inaccuracy and legal abstraction moved from inadequacy to a territorial expansion strategy that Brazil would use as far as the First Republic (1889-1930), known as the Acre War against Bolivia (1899-1903).

The political control of the entire territorial extension, as indicated in the Treaty of Tordesillas, is also justified by a formula drawn from Roman legal practice and assimilated by international war law. This international war law is synthesized in the Latin expression "*uti possidetis, ita possideatis*" (as you possess, so may you possess). That is, as one already de facto possesses, one shall continue to possess lawfully. That formula allowed the victor in a war to become legitimate lord of the assets of the vanquished and establish full dominance over their land. In Brazil, the novelty is that victory was already anticipated for a war that had not even begun. With these legal strategies, the Kingdom of Portugal began the military occupation and economic-commercial exploitation of Brazil's coast. It proceeded to determine the legal ownership of the lands of the Colony. Thus, territorial settlement and land appropriation in Brazil began in 1530, under the absolute control

of the Kingdom of Portugal and its ruler.

In the colonial period, we highlight that legal control over the Colony lands was attributed to the Portuguese Crown and the Order of Christ, an organization linked to the Church of Rome, whose Grand Master was, coincidentally, the King of Portugal. Besides, the Kingdom of Portugal deemed all the lands in this territory vacant, disregarding the presence of the native peoples. The Colonial State of Portugal employed military strategies several times to execute the conquest. It made use of various preexisting legal instruments to grant lands to its subjects who could economically exploit the Colony, whether they lived in Brazil or not.

The essential instrument for granting lands was the *Sesmarias*, inspired, as Paulo Carneiro Maia describes it, by the legislation of Dom Fernando I's Burgundy dynasty in the year 1375 that reformulated in terms of the Ordinances of the Kingdom (MAIA, 2012). This original legislation was linked to a parcel or portion of land held by a subject whose concession of ownership was registered and protected by the sovereign's act, pending the symbolic act of taking possession of the land by the beneficiary. In the legal regime of *Sesmarias*, if the subject of the concession did not occupy the land and effectively rendered it agriculturally productive within a period of up to five years, they should return it to the Crown. This resolutive condition from Portuguese Law was not enforced in Brazil. The beneficiaries of *Sesmarias* did not suffer any sanctions for not having cultivated the land, mainly because the colonial enterprise initially aimed only to extract natural resources unrelated to agriculture. Some scholars have identified this characteristic of territorial occupation and the absence of inspections by the Crown as the most remote origin of unproductive latifundia in Brazil. Over time, the Crown began to demand confirmation of the *Sesmarias* Royal Concession and the payment of an annual amount to formally control the beneficiaries' compliance with their obligations.

The "*Sesmarial* System" in Brazil was the legal formula applied to transfer lands from the Portuguese Crown (what nowadays would be referred to as public lands) to private individuals, under certain criteria, up until 1822. This year marks the Colony's political independence and the Brazilian Empire's installation, still linked to the metropolis by family ties with the Lusitanian monarchy. It is noteworthy that, according to the Regulation, the *sesmarias* that had been measured, drawn, demarcated, or confirmed valid would be recognized, after 1822, by the imperial power. These *sesmarias*, however, made up only a small part of the system. The majority of the lands that did not have all these records, often because the beneficiaries of these concessions were people who held prominent positions in the new monarchic State's administrative apparatus. They held possession of the lands even with inaccuracies and problems known since the Permit of October 5th, 1795.

The Permit's justification text had already highlighted the damaging absence of criteria for measurement, delimitation, and land distribution. Furthermore, there were not enough skilled professionals to handle the Brazilian territory's entirety (PINTO, 2001). In this sense, the *sesmarias* became the first major formal issue related to Brazilian land ownership about colonization, beyond, of course, the frauds and territorial inequality, among other issues already indicated.

The Kingdom's legal instruments were gradually adapted to the needs of the colonial enterprise. The land titles granted based on these adaptations were validated by subsequent legislation of the Empire, thus constituting the basis for Brazil's property titles. Upon Brazil's independence, the 1824 Constitution of the Empire incorporated, to a certain extent, liberal ideas about private property, but also secured the continuity of the *sesmarias* concessions and, although there was a rupture with the colonial political system, the legal formulas of the Kingdom remained in force.

Between 1822 and 1850, the Empire's constant political changes, the dissatisfaction of political and economic elites in the provinces, and the haziness of the legal regime over the land led to the instruments of Law becoming obsolete or distorted adapted to these situations. During this period and due to the same factors, new and significant land parcels were the occupation target by possession, frequently exercised by the owners of the *sesmaria* or by influential subjects of the local elite. These possessions were also the basis for the consolidation of private property's legal regime, instituted in the second half of the century to align the control over the land with Brazilian capitalism's demands, sustained by agricultural products' export. As previously stated, after 1822, due to Brazil's political independence, the original legal regime of *sesmarias* was abolished. However, the Brazilian Empire continued to grant titles to private individuals using royal charters. These titles

resembled the *sesmarias* in all aspects and were registered with the parishes of the Catholic Church.

Until 1850, there was no comprehensive legislation to regulate property titles' granting, although the Constitution of 1824 recognized the right to private property and the exceptional right to expropriation. In addition to the areas titled by *sesmarias* or royal charters, possessions were expanded in occupied areas. The possessors fully, directly or indirectly, sought titling from the imperial administration since all the untitled lands remained under the Brazilian imperial Crown's legal domain, heir to the Portuguese Crown. Many of these possessions resulted from *sesmeiros* expelling other landholders who did not have the same financial and military resources, as was the violence with which indigenous populations were driven out of their lands.

Law Nº 601 of 1850 aimed at identifying vacant lands for proper registration by the State to constitute a land appropriation regime according to the property institution. This Law officially recognized title-holding ownership of land, legitimized possessions, and allowed public lands' alienation, especially for national and foreign companies' colonization projects. For this purpose, it was necessary to set up a system that would support this new form of ownership. The agency designated to conduct the territorial surveys in Brazil was named the General Office of Public Lands. In 1850, the agency's founding regulations stipulated the professionals in charge of the delimitation procedures, mainly engineers. It also stipulated: (1) the allocation of lands for the "colonization of indigenous peoples" and other colonizations of Brazilians and foreigners; (2) the settlements and the lands for usual public purposes; (3) the control over the use of vacant lands and over those that could be the object of public alienation; and (4) those lands resulting from the possession of private individuals. The agency was also responsible for measuring, dividing, describing, and locating vacant lands. This matter would have repercussions in the definition of parameters for other lands, either occupied or vacant.

The organization chart, established in the regulations that dealt with the land law's particularities, indicated that the provinces would have their agencies linked to a central entity. These agencies would be called Special Departments of Public Land, subordinated to the provinces' presidents but administered by a deputy appointed by the central organ, a fiscal officer, and other officers to carry out the registrations ordained by imperial decree. These Special Departments would be responsible for the general management of the *Comarcas*. They would also establish relations with the districts. There would be professionals, surveyors, drafters, and scribes, all nominated by a general inspector, approved by the provinces' presidents. It was also expected that specific standards would be set.

The unit of measurement chosen was *braça*[3]. Arranged in squares and subdivided into lots, the measuring was based on the rope measurement method under the surveyor's responsibility, who was supposed to produce three copies of the maps and the descriptive memorials. An issue that draws attention to this land registration period is that workers involved in land measurement and inspection were paid for products delivered instead of having wages paid by the State. Although it cannot precisely be stated what this meant, it is not negligible to remember that, given the absence of effective inspection and public representatives' connivance, many documents were prepared without the correspondence or concordance with the existence or characteristics of the lands in question.

Public access to records, maps, and descriptions in official documents would occur upon payment of emoluments. Regarding private lands, the measuring would take place in the molds of those deemed vacant. It so happens that any title considered to be "legitimate," even if the lands were not measured, confirmed, or even cultivated, would be validated as private properties. The titles were confirmed whenever the payment of taxes for the land transfer was ratified. In cases of legitimization of private lands or conversion of the *sesmarias*, the activities of measurement and delineation would be carried out by Commissioner Judge of Measurements, as defined in Decree Nº 1318 of 1854:

> Art. 35 Surveyors shall be persons qualified by any national or foreign School, recognized by the respective Governments, in which land surveying is taught. In the absence of a qualified professional, candidates will be qualified by an exam conducted by two Officials of the Board of Engineers or two persons, who will take the Military School's full course, with the Examiners being appointed by the Presidents of the Provinces.

[3] *Braça* is an obsolete measure of length equal to approximately 2.2 meters, or 7.2 feet.

The measuring was also intended to provide a record of the legitimization of possessions and define third parties' boundaries: the border territories. The lands not demarcated for revalidation and legitimization within the Provinces' Presidents' period would be characterized as commission lands. In turn, the measured and demarcated vacant lands lacking the ownership or document records could be sold at public auction. Moreover, the remaining lots could be acquired by private individuals directly, based on the best offer. On reserved lands, Art. 73 established that:

> Art. 73 The Inspectors and Surveyors, having learned of the existence of these hordes on the vacant lands they have to measure, will seek to learn of their genius and character, of the probable number of souls they contain, and of the ease, or difficulty, that lies in their settlement; and they will inform the Director-General of the Public Lands, through the Delegates, of all things indicating the most suitable place for the settlement and the means of obtaining it, as well as the extension of land necessary for this purpose.

The first urban and rural land parcels were established in this Regulation from 1850. The new settlements would have to designate public areas, and the urban plots would have to be at least ten *braças* wide and 50 long, while the rural plots would be at least 400 *braças* wide and "so many long," while the remaining plots would be divided into emphyteusis. The planning of these new settlements was to be undertaken by the Director-General of Public Lands.

Considering the limits and capacity of public records, it became up to each parish's vicar to replace the State to carry out the titrations, and such information was published at church meetings. The records were to be kept in the respective books and charged for the respective emoluments. Those who were caught issuing false statements could be sentenced to fines and, in some cases, up to three months in prison. Copies of the records were kept in the Parish Archives. The original books were forwarded to the Delegate of Public Lands of the Province for the Land Register's general organization.

Because of all the difficulties related to the absence of a structure that could support the new proprietary system, new regulations were introduced to address this issue; however, they came from other sources. In 1864, the Mortgage Law included the institution's text and the first procedures for general land registration via transcription. This rule fully manifested the parcelled constitution of the land, in the form of property, as a skillful object of economic value that could be offered as a guarantee, using a title that would unbind from then on the ownership of the property by the respective holder of the proprietary right, as recognized by the State. Therefore, when the land becomes exchange value liable as a guarantee to the creditor, a definitive divorce can be recognized between any need for coincidence between the owner and the paper holder that confers the property's right.

It is also important to note that there was practically no reference to the properties' location or specification in handling the general registration issue. The legislators' main concern was the sale contract and the guarantee contract, as amended by Decree 169-A of 1890. The consequences of this discrepancy would never be resolved; they would be seen in many other places, and, even two centuries later, their effects would still be felt. As Brandão pointed out (2003, p.15-16), "*in Brazil and most countries of the world, in general, there is no interconnection between the systems of Cadastre and registration, which are generally in different institutions. Usually, the Cadastre is made for tax purposes, and the legal registration is made without cadastral information*".

The first concern with the property's correct location and specification was addressed only with Torrens Registry Decree. These specifications included: the relative heights of each instrument station and the approximate altimetric or orographic conformation of the land; the existing constructions and their uses, fences, and walls; water situation; roads; bearings; accidents; geological profile; among other issues, and the scales set according to the size of the property. Finally, the norm established the responsibility of engineers or surveyors in performing such activities. However, registration was optional, and very few properties were registered in these terms.

This decree was revoked, and the norms that targeted greater topographic identification were abandoned soon after. Its reintroduction occurred in the 1939 Code of Civil Procedure, which had a specific chapter on the subject, followed by the Law of Public Registries in 1973. It follows that the Torrens Registry

continued not to be the most widely used form of land registration. The Torrens Registry manifested structural, legal problems because such pretension would not be achieved given the nature of the Law's mutability and, therefore, of its social and technical adequacy to the new realities. These legal problems happened even with the *Juris et de jure* presumption for this type of registration, which means the absolute assumption of the truthfulness and perenniality of that information, despite all social transformations. Albeit more reliable, this register would be attached to new conditions like the rest of the norms registered in the *Juris Tantum* presumption, that is, in the relative presumption of veracity. Thus, the revocability of the norm occurred, as can be perceived in the changes in its scope, through revisions and re-editions, and the unusual prediction that: "*The property registered for the purposes of Decree n. 451-B, of 31.5.1890, will be forever subject to the regime of this regulation*" cannot be recognized even if it was reincorporated in the new legislation, including in the Law of Public Records, under a specific chapter on the subject. Despite its intention, Torrens does not dispense, like the other registers, a particular fiction that is only apparently more precise.

In 1917, the Civil Code's enactment attempted to consolidate the proprietary regime proposed in the middle of the previous century. This regime involved acquiring real estate through the transcription of titles. Other acquisition forms were admitted from the proprietary structure point of view, such as usucaption, accession, and inheritance. The distance between Cadastre and registration was maintained. With the new norms, detached from Brazil's reality, the separation between ownership, use, and property aggravated the picture of inequality, injustice, and territorial imprecision. The juridical security is derived from the power to make the State recognize something as belonging to someone. Since a significant part of the population did not have access to legitimization resources, few could appropriate land under the established regime.

Throughout the 20th century, the issue of acquisition and registration of properties only become more complex. Urbanization, industrialization, and demographic growth led to new land division forms altering housing regimes' structure. Moreover, the concern with public assets suggested the need for a revision of private property rights. As early as the 1930s, the allotment regimes and demarcations of environmental areas had already identified the need to add more information about the registers' assets. Concerns about public assets and expropriations were also present over the following decade. From now on, many legislations about property registration were established concerning the form of protection or use of assets. Examples of these legislations are the Land Statute, the Housing Finance System, and the Forest Code.

Throughout this period, the institution of the colonial privilege of registration and the transfer of lands to those who had access to the state apparatus was still present. It was also present the unconcern about the critical combination of the territory knowledge and the construction application of norms. The proprietary and register system's bases, the sesmarial system, the vicar's registry, the absence of universal criteria of measurement, specification, location, and the very specificity of the territory's original occupation generated ambiguities and inaccuracies. This fact deepened the land's conflicts, denying legitimate and traditional possessions, evicting holders entitled to permanence, and subsidizing the industry of territorial frauds that used and surpassed the notarial apparatuses, infiltrated the local and supralocal administrations, and further gained airs of veracity with the judicial decisions.

Although they eventually touched on sensitive points of the problems cultivated during the entire previous history of land formalization, the new norms that sought changes could not change behaviors that were and still are based on a mentality anchored in privileges. Thus, even with the important legislation of the 1970s, the creation of the National System of Rural Registration, the Law of Public Records, and the Law of Urban Land Division, the system's restructuring took place slowly and did not necessarily lead to the resolution of the problems. In many cases, it ended up founding a set of "new land irregularities" in the Brazilian territorial framework, aggravated by judicial understandings.

3.2 The foundations of the 20th-century land register legal system: latifundium and Agrarian Reform

The registration model adopted by the 1916 Civil Code had the purpose of consolidating the properties that had already been titled under the Land Law based on documents and inaccuracies regarding the properties' location and size. This model does not require any cadastral element that objectively describes the property

since it is merely based on documents abstracted from concrete situations. Therefore, it ultimately validates them and gives a legal appearance to all sorts of illegalities and acts of violence that occur in the constitution of these properties as possessions, through titles of *sesmarias* adulterated in successive transcriptions, or through rulings issued by the judicial authorities in disputing the hereditary succession of these lands.

A new restructuring of the land registers happened only in 1973, maintaining central elements of the previous registers' conformation, unifying several kinds of registers, and delimiting the items related to the properties' specialization.

The legislative changes on the legal regime of public and private lands in Brazil since 1850 were made under different political regimes. However, all of them had an untouchable core of the absolute protection of private property, which has generated countless conflicts for land ownership and use in the countryside and Brazilian cities since the imperial regime.

In closing the cycle of dictatorial governments and advocating the reduction of material inequalities in Brazilian society and the reduction of poverty (COMPARATO, 1998) – through the Law, through the actions of the Justice System, and through public policies of the Social Democratic State of Law –, the 1988 Federal Constitution, despite the limits and concerns exposed in the National Constituent Assembly by the defending congressmen committed to the *status quo* (FACHIN, 1987), tackled the land issue and provided legal instruments for the Agrarian and Urban Reforms, to adjust the use and usufruct of properties to the interests of society and not just of a single owner. To support this land policy, art. 5, item XXIII of the Constitution established "the social function of property" as one of the fundamental principles of the national legal order, altering the determination of the ownership content by understanding the importance of centers of interest beyond the owners (TEPEDINO, 1999) both collective and diffuse.

The predominantly economic character of this objective pursued by the Brazilian Republic affects private relations within the market. It entails free access for all social value goods, including land suitable for agricultural production and housing. Through Agrarian Reform, the Brazilian State can intervene in the economy and private property to mitigate the fundamental material inequality between landowners and non-owners, whose economic and cultural condition makes their physical and social survival reliant on access land, labor, and agricultural production. Such access is impossible under the current terms of the Brazilian economy and under the absence of published information to clarify the territorial models' limits adopted thus far.

This intervention in the market's economic domain and the specific domain of agrarian economy required, evidently, changes in the norms related to the legal regime that regulates the exercise of privately owned lands in rural areas. The Constitution warrants the individual right to property. However, it allows state control over the faculties that make up the legal content of this subjective right of proprietary and private nature, conditioning its exercise to fulfill legal obligations provided in articles 5, XXIII, and 186. Thus, private subjects are obliged to fulfill landowners' social obligations, which cannot be detrimental to third parties. The guarantees are usually linked to property; notably, that of exclusion of ownership claims by others must be removed when they are devoid of legitimacy in light of assessing their social function. As rightly emphasized in contemporary German doctrine, the norm of social binding of property is not only about the use of the good, but about the very essence of this right. Those who do not fulfill the property's social function lose the judicial and extrajudicial guarantees of protection of ownership (COMPARATO, 1998).

Thus, the owner's right exercise continues to be based on subjective and abstract data, in the form of a subjective right, and incorporates a given social purpose expressed in certain obligations. Under this constitutional formula of property, two aspects of the Rule of Law are evident: the classic liberal one, which recognizes subjects as holders of rights, among them that of property, and that of a democratic social state, committed to pursuing material equality. Supported by this duality of political aspects, one markedly liberal and another of a social-democratic nature, the Brazilian State does not seem to have had enough strength to eliminate conflicts over land ownership and use in the Brazilian countryside. This fact denounces that something in the constitutional architecture failed to alter the social relations between landowners and rural workers in Brazil and, consequently, alter the Law and the conceptual approach that determines the judicial power decisions.

When it comes to access to and use of rural land, these limitations result, above all, from the non-

existence of a constitutional provision to any limit on private ownership and use of productive land. In this aspect, unlimited freedom of private appropriation was safeguarded, as long as the property fulfills its social function, simultaneously complying with: the requirements of rational and adequate use of the land; fair use of available natural services and preservation of the environment; observance of the provisions that regulate labor relations; exploitation that favors the well-being of the owners and workers (items I, II, III, IV of Art. 186 of the Federal Constitution). On the other hand, article 185 of the Federal Constitution establishes that productive properties may not be expropriated out of social interest for agrarian reform purposes. Thus, the fulfillment of its social function is restricted to the fulfillment of the required land productivity. In addition to the obstacles in establishing limits to the privileges mentioned above, the systems' precariousness conceals the stealing of public lands in the rural areas and the cities. That allows some people to develop a "fait accomplis" culture through declaratory measures of territorial indications in official cadastres and subsequent land registration. At the same time, it rigidly punishes legitimate possessors who recurrently suffer violent eviction processes by individuals or by the State itself. This State of affairs can be visualized in the maintenance of the terms of obsolete registration legislation due to its underlying foundations and the most recent regulatory laws, as was the case with the 2012 Forest Code and the 2017 Land Regularization Law. Both ultimately failed to address the problems inflicted in the distant and recent past and, to a large extent, may accentuate known and recurring illegitimacies, once again distorting territorial relations that are important for the settlement of a territorial reality consistent with the civilizing principles outlined in the constitutional text.

Although Cartography allows for a greater understanding of the Brazilian territory, undoubtedly, looking back to the past allows for recognizing the roots of contemporary problems, of inaccuracies, and of a discourse that did not find and does not find in reality the elements necessary for its practical realization. Law has only recently been open to dialogue with other areas. This encounter incorporates public ownership as an essential element of the concretization of the values outlined in the Constitution. Mapping and Cadastre are sensitive and essential elements in this process. They render decisions visible and find normative solutions and interpretations, within the administrative and judicial spheres of their application, in the day-to-day reality of territorial issues. By lifting the veils that cover up past mistakes and tightening the bonds of the two disciplines walking hand in hand, we can potentialize the successes of new ways of dealing with the appropriation of land and its uses and respect to the people of this vast territory.

4 THE LACK OF TOPOGRAPHIC MAPPING AND THE PROBLEM OF LAND DEMARCATION IN BRAZIL

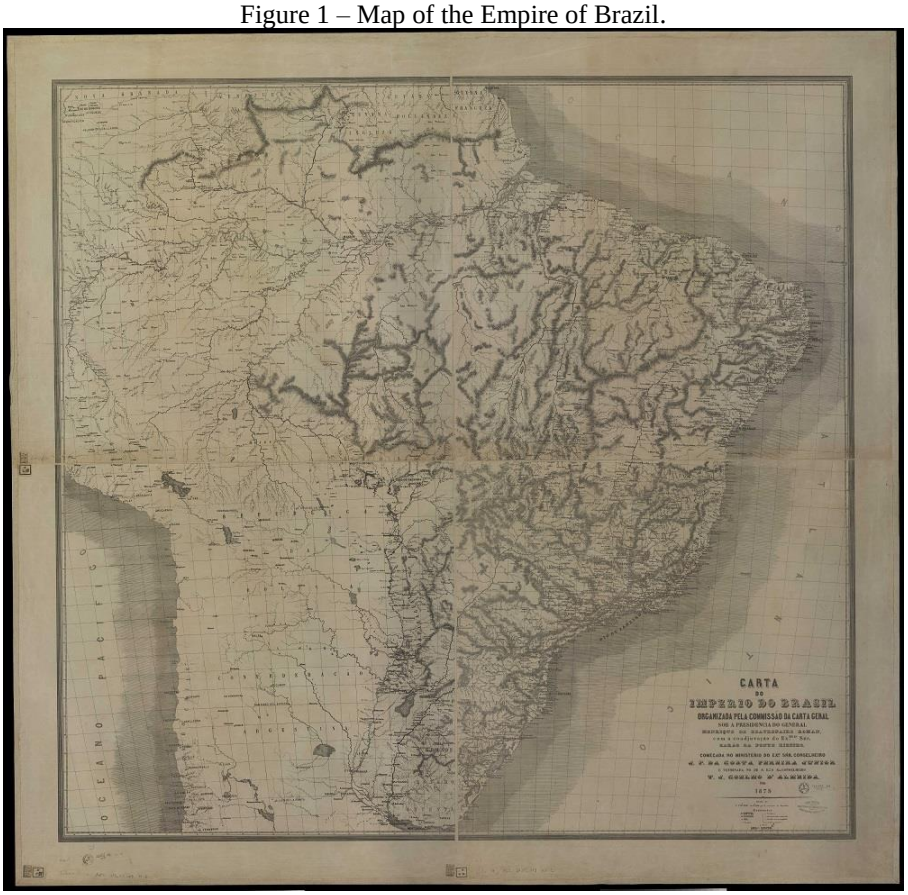
The policy of a colonial State that held the entire territory's domain demarcated the first phase in the evolution of the Brazilian territorial occupation and land legislation. Its purpose was to assign private property to the groups that supported the monarchical government. The history of mapping the Brazilian territory started in this period, with the first astronomical observations in Rio de Janeiro and São Paulo from 1781 to 1795 (GESTEIRA, 2017). In the second phase, Empire, there is a gap in allocating public lands to private individuals. This fact led the Brazilian agrarian economy to seek an expansion of land properties through the legal status of possession. The next moment coincides with the first attempt of modernization (read legal modernity based on individual private property) by establishing the enclosure of public lands to transfer them just to those who had access to the state apparatus (Land Law of 1850). This Law was regulated by decree 1318 of 1854 that also determined the land measurement and created the Commissioner Judge of Measurements. However, these processes occurred without having a particular concern with the cartographic aspects related to the precise demarcation of land boundaries, i.e., the concern was only with the boundaries of the Colony and Empire, but not with the boundaries of the domains and possessions of subjects.

In more than 300 years, the Brazilian territory occupation occurred without being correctly mapped and, therefore, be known. In 1864, almost 100 years after the first astronomical observations, there was an attempt to map Brazil based on technical and scientific criteria, with the creation of the Commission of the General Map of the Empire. The Commission's mission was to establish a geodetic referential using triangulation and produce a map of 42 sheets for the entire Brazilian territory. In 1871, 31 sheets were ready (MENEZES, 2007). Published at the 1: 3,710,220 scale, due to its low accuracy, the Map of the Empire of

Brazil (Figure 1) was presented at the Vienna National Exhibition in 1875 and the 1876 Philadelphia Universal Exhibition.

The first step towards considering the precise demarcation of properties took place in the republican period. The Federal Constitution of 1891 transferred to the States the domain of vacant lands. In 1901, the Ministry of Military Defense developed a project called "General Map of Brazil" in order to produce a topographic map using geodetic, astronomical, topographic, and cartographic operations. This project established survey procedures, map projections, scales, and map formats for the General Map of Brazil (BERNARDINO, 2012). This project's execution began in 1903, with the General Map Commission's settlement in Porto Alegre - Rio Grande do Sul State (DSG, 2014; IESCHECK et al., 2014). The results, however, were far below planned. It was supposed to make 3,000 sheets at the 1: 100,000 scale, but just 53 were finished. Moreover, the main cities were mapped at the 1: 25,000 scale (4,000 km^2). Several problems that occurred since 1922 prevented the last years of activity of the General Map Commission from getting along, and, in 1930, practically all the works were ceased (DSG, 2014).

Figure 1 – Map of the Empire of Brazil.



Source: Ponte Ribeiro, Duarte da Ponte Ribeiro, Baron of (1873).

Despite the lack of topographic mapping at large scales, with the Civil Code of 1916, it was possible to acquire a property through the transcription of titles in the Land Registration Office. In 1922, the Brazilian territory was completed mapped, with the Brazilian Map's publication to the Millionth, comprising 50 sheets at a 1:1,000,000 scale (ARCHELA; ARCHELA, 2008). The 1939 Code of Civil Procedure introduced the Torrens system of land title registration and enabled the acquisition and loss of land.

The Federal Constitution of 1946 defined the basis for the new agrarian legislation, establishing the use of the property for social welfare. The Land Statute (Law 4504/1964) created the Brazilian Institute of Agrarian Reform (IBRA) and the National Institute for Agrarian Development (INDA), and, in 1966, the National Agrarian Reform Program (PNRA) was established. In 1967, the decree-law n° 243 set the guidelines and bases for Brazilian cartography and created the Cartography Commission (COCAR). The creation of the National Institute of Colonization and Agrarian Reform (INCRA) was in 1970. In 1972, decree n° 5868 determined the creation of the National System of Rural Cadastre (SNCR), whose main goal was to promote

integration and systematization of the collection, search, and processing of data and information about land use and possession. Decree 72106 regulated the SNCR in 1973, and, in the same year, the Law of Public Records (Law 6015) was approved.

However, in 1978, the Brazilian government approved the National Mapping Program to perform the systematic mapping at 1: 100,000 and 1: 250,000 scales, which should be completed by 1985 (ARCHELA; ARCHELA, 2008). Decree n° 89817 of 1984 established the Regulatory Instructions for the Technical Standards of National Cartography to define procedures and minimum standards for cartographic activities. In 1985, decree n° 91766 approved the new National Agrarian Reform Program (PNRA), whose execution was under the responsibility of INCRA.

Besides facing the land issue by establishing "the social function of property," the 1988 Federal Constitution determines that it is a matter of federal power (at the Union level) organizing and maintaining the official cartographic services (Art. 21) and the legislation on the national cartographic system (Art. 22).

COCAR was deactivated in 1990 and reactivated in 1994 as National Cartography Commission (CONCAR), with the duties of advising the Minister of State in the National Cartographic System (SCN) and coordinating the execution of the National Cartographic Policy. A decree designated the Minister of State for Land Policy in 1996, and Provisional Measure 1999-1 created the Ministry of Land Policy and Agrarian Development in 1999. Decree 6.666 of 2008 (CONCAR, 2010) set up the Brazilian Spatial Data Infrastructure (INDE) to facilitate and order the generation, storage, access, sharing, dissemination, and use of geospatial data.

We note from the Colony to the Republic, the chronological mismatch between the legislation (the occupation of the territory) and mapping (the territory knowledge). Table 1 presents the timeline with the essential landmarks related to topographic mapping and land demarcation in Brazil.

Table 1 – Brazilian legal-cartographic chronological relationship.

(to continue next page)

COLONY	**CARTOGRAPHY**	**LAW**
16th, 17th, and 18th centuries		*Capitanias hereditárias* and *sesmarias*
1695		Royal Charter: attempt to control the Colony's territorial situation
1781 to 1795	First astronomical observations (Rio de Janeiro and São Paulo)	
EMPIRE		
1822		Constitution of the Empire, end of the *sesmarial* system, and establishment of the right to property by recognizing the land ownership
1824		Establishment of the right to property
1850		Law 601 – Land Law: access to the property through the purchase and sale system, and redefining the concept of vacant lands
1854		Decree 1318: Land Law regulation, and creation of the General Office of Public Lands
1864	Establishment of the General Map of the Empire Commission	
1871	Publication of the Map of the Empire of Brazil (1:3,710,220 scale)	
1875	Vienna National Exhibition the Map of the Empire of Brazil	
1876	Philadelphia Universal Exhibition of the Map of the Empire of Brazil	
REPUBLIC		
1891		Constitution of 1891: transfers the vacant lands to the states
1903	Settlement of the General Map of Brazil Commission	
1916		Civil Code: allows the acquisition of real estate through the transcription of titles in the Land Registration Office

(conclusion)

REPUBLIC		
1922	Replacement of the General Map of Brazil Commission by the Geographic Service of the Brazilian Army and publication of the Brazilian Map to the Millionth	
1934		Constitution of 1934: establishes land expropriation for public utility purposes
1936	Creation of the Brazilian Institute of Geography and Statistics (IBGE)	
1937	First IBGE project: determining the coordinates of cities and towns	
1939		Code of Civil Procedure: admits the acquisition and loss of land and introduces the Torrens Registry
1946	Beginning of the São Francisco Valley and the State of Bahia mapping (1:250,000 scale)	Decree-law 9760: administration of public lands and public assets in charge of the Brazilian Public Patrimony Service
		Constitution of 1946: defines the bases for the new agrarian legislation – Art. 147: use of the property for social welfare
1964		Law 4504: edits the Land Statute and creates the Brazilian Institute of Agrarian Reform (IBRA) and the National Institute for Agrarian Development (INDA)
1966		Decree 59456: establishes the National Agrarian Reform Program (PNRA)
1967	Decree-law 243 - Guidelines and Bases for Brazilian Cartography: the creation of the Cartography Commission (COCAR)	
1970	Creation of National Institute of Colonization and Agrarian Reform (INCRA)	
1972		Decree 5868: determines the creation of the National System of Rural Cadastre (SNCR)
1973		Decree 72106: regulates the SNCR Law 6015: Law of Public Records
1978	National Mapping Program approval	
1984	Decree 89817: Regulatory Instructions for the Technical Standards of National Cartography	
1985		Decree 91766: approves the new PNRA
1988	Federal Constitution of 1988: Cartography is a matter of federal power	Federal Constitution of 1988: establishes the social function of the property
1990	COCAR deactivation	
1994	National Cartography Commission (CONCAR) reactivation	
1996		Designation of the Minister of State for Land Policy
2000		Creation of the Ministry of Land Policy and Agrarian Development
2008	Decree 6666: the establishment of the Brazilian Spatial Data Infrastructure (INDE)	

Source: The authors (2020).

5 DIAGNOSIS OF THE CURRENT SITUATION OF THE CADASTRE AND ITS RELATIONSHIP WITH SYSTEMATIC TOPOGRAPHIC MAPPING

The Cadastre's function is to collect and make available graphic and descriptive information about the parcels of territory, based on the survey of its limits (UNECE, 2005). In Brazil, the absence of national registration law and an institution whose primary competence is to establish guidelines for its elaboration has meant that it has developed without integration between rural and urban cadastres. Law nº 5868/72 established the rural cadastre (National Rural Cadastre System) under the federal administrations' responsibility. On the other hand, there is no specific legislation for urban cadastre. Its implementation is done by the municipality,

generally for tax purposes. Over time, rural cadastres were based exclusively on descriptive information since there is no systematic mapping on an adequate scale. Also, topographic mapping is not an essential element of rural cadastre. Table 2 summarizes the current constitution of the leading rural cadastres. In addition to these, there are also environmental, indigenous land, and federal land cadastres (which include urban properties).

Most municipalities follow the CIATA (Incentive Agreement for Technical) Project's methodology for urban cadastre. This project was implemented as an experiment (1973/74), by the Secretariat of Economy and Finance of the Ministry of Treasury of Brazil, with resources from the Technical Assistance Program – PRAT (*Programa de Assistência Técnica*), through the Federal Data Processing Service – SERPRO (*Serviço Federal de Processamento de Dados*). According to Cunha et al. (2019), in general, the methodology used by the CIATA Project for the urban properties cadastre was composed of two phases: Execution and Implementation. The execution phase consisted of 6 stages: Sectorization of Inspection, Cadastral Survey, Property Valuation, Information Treatment, Launch and Final Art (block/street plan), with the first four stages being performed directly by SERPRO and the last two by the city hall, with guidance from SERPRO.

Table 2 – Current constitution of the main rural cadastres - SNCR – Sistema Nacional de Imóveis Rurais [National System of Rural Properties]; **CAFIR – Cadastro de Imóveis Rurais [Cadastre of Rural Properties] and ***CNIR – Cadastro Nacional de Imóveis Urbanos [National Cadastre of Urban Properties].

	SNCR	**CAFIR**	**CNIR**
Administration	INCRA	Internal Revenue Service (IRS)	INCRA + IRS
Descriptive data	Yes	Yes	Yes (in a phase of compatibility between the SNCR and CAFIR)
Topographic mapping	No	No	No
Geometric base (the measurement of parcels)	No	No	Possibility of using georeferenced surveys in response to Law 10.267/2001

Source: The authors (2020).

With a methodology consistent with the technology available at the time, the CIATA Project envisaged the development of isolated block plans, whose location in the municipal urban perimeter was identified through a Cadastral Reference Plan. The municipalities could not elaborate the expected topographic mapping, so many had an exclusively descriptive registration, based on information obtained from the cadastral information bulletins. The municipalities with better technical and economic conditions developed cadastres based on the photogrammetric mapping. The social inequalities of a vast territorial country are reflected in the current cadastres. Few structured cadastres are available to serve multiple purposes. Some seek to apply new technologies to implement simpler cartographic bases, which meet fiscal objectives, and others do not yet have graphic information to support their cadastral systems. Once again, the lack of topographic mapping on a scale compatible with the urban cadastre makes it challenging to implement a cadastre that serves as a basis for the development of integrated public policies.

As planned and performed in France by Colbert and Cassini, the topographic mapping must be carried out with a Geodetic Reference System, such as the Brazilian Geodetic System (SGB) materialized in geodetic benchmarks. The set of geodetic landmarks must be connected to a network. The network conformation and, consequently, the mathematical connection between all geodetic landmarks guarantees the uniformity of the positional quality in the whole mapped territory. The uniformity and homogeneity of the geodesic network make it possible to carry out the mapping on large scales with high accuracy and precision. This fact is one of the significant advances that Cassini's Map of France provided for topographic mappings, allowing the territorial Cadastre to be built with uniform positional quality throughout the national territory.

When the land cadastre is carried out with local surveys, even when linked to the BGS, with independent results particular to those determined locations, there is a set of surveys throughout the country geometrically independent cadastral representations. By allowing colloquial language, one can imagine the various cadastres in different regions as a "patchwork quilt." These "patches" are represented at different levels of detail and positional quality. There must be interdependence between the cadastre and topographic mapping. It is

intended that the homogeneity in the standards that determine the characteristics expected for the results is accomplished throughout the national territory.

6 FINAL CONSIDERATIONS AND FUTURE RESEARCHES

With the questions raised in this article, we intended to establish a research project that explores Topographic Mapping and Cadastre's current situation and its relations with the legislation that defines territorial order in Brazil. The interdisciplinary work herein developed sought to visualize the foundations and paths in the narrative told by Cartography and Law, especially when the two disciplines meet to finding a model of land structuring. Dialogue between knowledge areas can provide answers and support for interpreting what exists and constructing new realities. Most importantly, it is aimed at understanding what has happened in recent centuries to allow the system to manifest its current characteristics, with its advances and limits that, when identified and analyzed, may offer new answers to old and new questions. In this sense, we highlight successes and failures, decisions and silences about the foundations of the decision-making system for territorial issues, concerning the construction of public policies and the most wide-ranging responses to groups, communities, and individuals that are related to urban, rural, traditional, and environmental territories.

Our understanding of these scenarios was not intended to indicate valuative interpretations of the findings and, precisely because of the intention established from the beginning, neither did we seek to reiterate traditional arguments. We have shown the evident contradictions in the foundations and development processes through which Brazil designed its territorial structure. It is necessary to critically analyze this territorial structure design and its implementation process to understand this problem.

Cartography and Law can identify contradictions and gaps that have increased inequality and territorial injustice by critically reviewing such a process. We understand that knowledge about the territory means power over the definition of the population's life and the structuring of spaces. Moreover, advancing the reading of territorial issues also allows contemporary instruments, such as territorial cadastres, to consign the diversity of themes that make up the representation, the analytical understanding of the land, and the plurality of public policies impact new territorial realities. However, the analyses of these issues were passed on to the continuity of these studies.

For the time being, our intention here is to retrace the historical path. In Brazil, colonization created the founding elements of tensions that would lead to an immense territory dispute. The invasion by new notions of society is perfected in each concrete struggle for preservation, survival, resistance, and life of and on the land.

The quarrels that have crossed time find deep marks in the colonization project, as such, in the more concrete situation that characterizes the various instances of land occupation, as well as in the descriptive, narrative, illustrative, and representative constructions that have appeared in the popular imaginary, in the discourses of naturalization of asymmetries, and every order of constitution of new powers that to this day justify territorial injustice, sustained mainly by the legitimizing apparatuses of Law and Cartography.

In effect, knowledge about the land, territories, environments, and peoples is meaningful in the constitution of powers, in the construction of policies, in interpreting society, and the intervention of reality. In Brazil, the bases for the constitution of systems, often imprecise and unrealistic, were forged into legitimacy. Nevertheless, in the investigation of inconsistencies or injustices, it was not our intention to deny the importance and advancement of the technical-social and political-technological constructions of these two disciplines.

We found that somehow, given the general situation since colonization, it was urgent to establish the general system of land administration and, given the need to produce official documents, a registration system was prescribed, featuring topographic mapping and surveying. However, it was only in the 20th century that attempts at territorial planning and the structuring of systems and cadastres took place, along with the legal formulation of territorial ordering that went beyond the mere protection of private territorial interests. To unravel the contemporary aspects of the Brazilian territorial system, we retraced the path of Cartography and Law in Brazil, which meant to verify, among other issues: The premises of this conjoined system; the history, bases, paths, and context in which Cartography and Law were presented as a model of thought; the

inconsistencies, absences, and impossibilities in the face of the conditions for the realization of a legal cartographic system; the organization of the State and public land policy; the institutional arrangements made to conduct Brazilian territorial studies and surveys; the rules of the systems; and the results, the consequences of what was produced up to the 21st century.

Given the historical legal-cartographic-cadastral panorama established on the first analyzes set out in this article, we glimpse the reading on contemporaneity. Therefore, the continuity of the research project will take place in three axes of analysis. Thus, we list the following future research challenges:

a) The incorporation of complexities and absences in legal-cartographic-cadastral issues. This axis encompasses those issues related to some overlap between cartography and Law, and they concern to environmental aspects of urban and rural regions. Here our goal is to propose suitable solutions for:

(i) What are the consequences of the absence of the topographic and cadastral mapping for Brazilian society?

(ii) Does the Cadastre in Brazil assure the rights, restrictions, and responsibilities towards people and land?

(iii) How to make it possible to build a cadastre system that can assure the rights, restrictions, and responsibilities of the relationship between people and land?

b) Understanding the meanings of mapping, registering, planning, and regulating the land occupation from reading about the structuring of these activities within the State and its institutions. This issue means a need to understand territorial planning, data and information infrastructure, and territorial data management, including the proposals already done, such as the National System of Territorial Information Management (SINTER). We also aim to comprehend the tax issue, the publication (public ownership) of data, among other issues concerning the contemporary organization of territorial information.

c) "With your back to Brazil: between absences and leftovers" concerns the third axis of analysis. It aims to understand the import of legal-cadastral-cartographic models and solutions meant and mean, and the consequences of these assimilations in the Brazilian land management structure history. We will look for the possibility of other proposals, with a decolonial bias, that more concretely represent the possibilities of planning, management, and instruments that correspond to the Brazilian reality and its complexities. In this sense, we intend to carry out comparative analyzes of Latin American models and read about models that have also been exported.

These are the general lines of future research to continue the matrix already established in this text, resulting from the first analyzes of the meetings in Cartography, Law and Cadastre.

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Authors' contribution

The authors contributed equally in all stages of this article, from its conception and investigation to the final text's writing.

Conflicts of interest

There are no conflicts of interest.

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Authors' biography

Claudia Robbi Sluter, Curitiba - P.R. – Brasil/1960. She received her B.E. degree in Cartographic Engineering and M.Sc.E. degree in Geodetic Sciences from the Federal University of Paraná (UFPR) and a Ph.D. degree in Applied Computing from the National Institute for Space Research (INPE). She is a Professor at the Federal University of Rio Grande do Sul (UFRGS), Department of Geodesy, Institute of Geoscience, in Porto Alegre – R.S., Brazil. She teaches and develops research in geoscience with a focus on Cartography and GIScience. Her current research focuses on geovisualization, geoinformation solutions' design, and topographic mapping.

Andrea Flávia Tenorio Carneiro, Arcoverde-PE-Brazil, 1966. Cartographic Engineer from the Federal University of Pernambuco – UFPE in 1989. Master in geodetic sciences from the Federal University of Paraná - UFPR in 1993 and Ph.D. in production engineering from the Federal University of Santa Catarina - UFSC in 2000. She did postdoctoral training at Universidade Nova de Lisboa - UNL in 2018. Teacher of the Department of Cartographic Engineering at UFPE since 1994, in Recife-PE. Works in teaching and research in cadastre and land management in the courses of cartographic engineering and surveying and post-graduation in geodetic sciences and geoinformation technologies.

Andrea Lopes Iescheck, Curitiba - P.R. – Brazil/1965. She received her B.E. degree in Cartographic Engineering, M.Sc.E. degree in Geodetic Sciences, and a Ph.D. degree in Geodetic Sciences from the Federal University of Paraná (UFPR). She is a Professor at the Federal University of Rio Grande do Sul (UFRGS), Department of Geodesy, Institute of Geoscience, in Porto Alegre – R.S., Brazil. She teaches and develops research in geoscience with a focus on Cartography and GIScience. Her current research focuses on volume visualization, 3D modeling, geospatial data quality, spatial data infrastructure, and topographic mapping.

Daniele Regina Pontes, Porto Alegre/1976. She received her B.E. degree in Law. Professor of Law at the Federal University of Paraná. Ph.D. in Law from UFPR (2012). She was the coordinator (2018-2020) and Professor of the Graduate Program in Urban Planning at UFPR. Researcher at the Research Group on Urban and Regional Planning and Policies - CEPPUR and coordinator of the research line in Law, Land, and City - DICIT at the Federal University of Paraná. Researcher at the PRO POLIS / CCONS Research Group at the Federal University of Paraná. Researcher at the UFPR Constitutional Civil Research Group. She was a researcher at the Center for Cooperative Law and Citizenship at UFPR.

José Antônio Peres Gediel was born on September 15th, 1953, in Quaraí, the Rio Grande do Sul, Brazil. Bachelor of Law at the Federal University of Rio Grande do Sul (UFRGS), Master of Laws, and Ph.D. in Law at Federal University of Paraná (UFPR). Visiting Researcher at the University of Montreal, Canada. Visiting Professor at University of Buenos Aires, Argentina, and at Columbia University, New York, USA (Grantee of Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, Capes). He is a Law School Full Professor at the Federal University of Paraná. He teaches and develops research in Law with a focus on civil law, personality rights, bodily autonomy, biotechnology, right to property, public policies, and human rights.