

# VIRUS

26

## THE DECOLONIAL DEBATE TERRITORIES

PORTUGUÊS-ESPAÑOL | ENGLISH

REVISTA . JOURNAL

ISSN 2175-974X

CC-BY-NC-AS

UNIVERSITY OF SAO PAULO

INSTITUT OF ARCHITECTURE AND URBANISM

NOMADS.USP

[WWW.NOMADS.USP.BR/VIRUS](http://WWW.NOMADS.USP.BR/VIRUS)

DECEMBER 2023

NOMADS  
USP

FAU

USP

# WI26

## THE DECOLONIAL DEBATE: TERRITORIES O DEBATE DECOLONIAL: TERRITÓRIOS

### EDITORIAL

- 001 THE DECOLONIAL DEBATE: TERRITORIES  
O DEBATE DECOLONIAL: TERRITÓRIOS  
MARCELO TRAMONTANO, JULIANO PITA, PEDRO TEIXEIRA, THAMYRES REIS, ISABELLA CAVALCANTI, CAIO MUNIZ

### INTERVIEW

- 004 A DECOLONIAL PERSPECTIVE TO OVERCOME INSUFFICIENCIES  
UMA PERSPECTIVA DECOLONIAL PARA SUPERAR INSUFICIÊNCIAS  
UNA PERSPECTIVA DECOLONIAL PARA SUPERAR LAS INSUFICIENCIAS  
FERNANDO LUIZ LARA

### AGORA

- 012 THE SPATIAL DIMENSION OF COLONIALITY: AN INTERPRETATIVE PROPOSAL AND OTHER IGNORED VOICES  
LA DIMENSIÓN ESPACIAL DE LA COLONIALIDAD: UNA PROPUESTA INTERPRETATIVA Y OTRAS VOCES IGNORADAS  
YASSER FARRÉS
- 028 SOMETIMES IT'S UGLY, BUT FASHIONABLE! DECOLONIAL POWERS, ADDITIONS, AND LIMITS  
ÀS VEZES É FEIO, MAS TÁ NA MODA! POTÊNCIAS, ADIÇÕES E LIMITES DECOLONIAIS  
LEO NAME, TEREZA SPYER
- 040 TOWARD A POLITICAL ONTOLOGY OF URBAN BUEN VIVIR  
HACIA UNA ONTOLOGÍA POLÍTICA DEL BUEN VIVIR URBANO  
PILAR MARIN, ALDO ALOR, ISRAEL ORREGO-ECHEVERRÍA
- 049 THE POETICS OF RELATION AND CITIES: PERSPECTIVE FOR A DECOLONIAL URBANISM  
A POÉTICA DA RELAÇÃO E AS CIDADES: PERSPECTIVA PARA UMA URBANÍSTICA DECOLONIAL  
CARLOS HENRIQUE MAGALHÃES DE LIMA
- 058 FOSS, CARTOGRAPHY, COLONIALISM AND SOVEREIGNTY IN PARAGUAY AND THE GLOBAL SOUTH  
FOSS, CARTOGRAFÍA, COLONIALISMO Y SOBERANÍA EN PARAGUAY Y EL SUR GLOBAL  
JUAN CRISTALDO, GUILLERMO BRITZ, SILVIA ARÉVALOS, LISSANDRY RODRIGUEZ
- 086 THE LANDSCAPE IN THE CONSTRUCTION OF GOOD LIVING: THE NHANDEREKO IN SAO PAULO STATE CAPITAL  
A PAISAGEM NA CONSTRUÇÃO DO BEM VIVER: O NHANDEREKO NA CAPITAL PAULISTA  
LUCAS BUENO, FÁBIO GONÇALVES

- 101 DECOLONIAL APPROACHES TO RESEARCH IN URBAN PLANNING  
ABORDAGENS DECOLONIAIS PARA PESQUISA EM PLANEJAMENTO URBANO  
FABIANA SILVA, CINTIA ALVES, ISABELA SANTOS
- 117 EXPERIENCE ON THE ALTIPLANO: FLÁVIO DE CARVALHO AND THE SOUTH AMERICAN NAKED CIVILIZATION  
EXPERIÊNCIA NO ALTIPLANO: FLÁVIO DE CARVALHO E A CIVILIZAÇÃO NUA DA AMÉRICA DO SUL  
LEONARDO NOVO, LEONARDO SOUZA
- 126 1984: COLONIALISM AND DYSTOPIA  
1984: COLONIALISMO E DISTOPIA  
PAULA ALBUQUERQUE
- 135 PROSPECTING ANTI-COLONIAL QUALITIES IN DESIGN EDUCATION  
PROSPECTANDO QUALIDADES RELACIONAIS ANTICOLONIAIS NA EDUCAÇÃO EM DESIGN  
MARCO MAZZAROTTO, FREDERICK VAN AMSTEL, BIBIANA SERPA, SÂMIA SILVA

## PROJECT

- 144 TOWARDS A LATIN-BASED URBAN DESIGN  
RUMO A UM DESENHO URBANO GENUINAMENTE LATINO  
CARLOS COSTA, CARLOS NOME

## FOSS, CARTOGRAPHY, COLONIALISM AND SOVEREIGNTY IN PARAGUAY AND THE GLOBAL SOUTH

### FOSS, CARTOGRAFÍA, COLONIALISMO Y SOBERANÍA EN PARAGUAY Y EL SUR GLOBAL

JUAN CARLOS CRISTALDO, GUILLERMO BRITZ, SILVIA ARÉVALOS, LISSANDRY RODRIGUEZ

**Juan Carlos Cristaldo** is an Architect and holds a Master's degree in Sustainable Development and Architecture and Urbanism. He is a Researcher Professor at the Faculty of Architecture, Design and Arts of the National University of Asunción, Paraguay, and the Director of its Center of Research Development and Innovation. He works on Architectural Design, Urban Studies, Urbanism, and Territorial Studies. [juan.cristaldo@cidi.fada.una.py](mailto:juan.cristaldo@cidi.fada.una.py) <https://orcid.org/0000-0001-6966-8787>

**Guillermo Britz** is an Architect and researcher. He works on Urban Environmental and Architecture issues at the Center of Research Development and Innovation at Faculty of Architecture, Design and Arts of the National University of Asunción, Paraguay. [guillermo.britz@cidi.fada.una.py](mailto:guillermo.britz@cidi.fada.una.py) <https://orcid.org/0000-0003-2134-2619>

**Silvia Arévalos** is an Architect and a Teaching Assistant at the Center of Research Development and Innovation at Faculty of Architecture, Design and Arts of the National University of Asunción, Paraguay. She studies the application of Geographic Information Systems on urban and territorial research. [silvia.arevalos@cidi.fada.una.py](mailto:silvia.arevalos@cidi.fada.una.py) <https://orcid.org/0000-0002-2757-7876>

**Lissandry Rodriguez** is an Environmental Engineer and a Researcher Assistant at the Center of Research Development and Innovation at Faculty of Architecture, Design and Arts of the National University of Asunción, Paraguay. [lissandry.rodriguez@cidi.fada.una.py](mailto:lissandry.rodriguez@cidi.fada.una.py) <https://orcid.org/0000-0003-0634-9206>

ARTICLE SUBMITTED ON AUGUST 6, 2023

How to quote this text: Cristaldo, J. C., Britz, G., Arévalos, S., Rodriguez, L.(2023). FOSS, Cartography, Colonialism and Sovereignty in Paraguay and the Global South. *VIRUS Journal*, 26, 58-85. <http://vnomads.eastus.cloudapp.azure.com/ojs/index.php/virus/article/view/780>

## Abstract

This article contributes to the decolonial debate by means of a critical analysis of the historical evolution of Paraguay through its cartographic representations, discussing the connections between maps, colonialism, rights, and citizenship. Exploratory in scope, the article employs a qualitative methodology supported by a triangulation of data sources and methods. It proposes that in Paraguay and Latin America, cartography was linked to colonial processes of territorial domination, military control and exploitation of natural resources, influencing the dynamics of territorial conformation. Based on interviews with key actors and the analysis of contemporary cartographic pieces, we demonstrate that Paraguay has, even today, a low capacity to represent its territory, resulting in limited sovereignty. Finally, we propose that cartography developed from Free and Open Source Software (FOSS) allows for collective, collaborative and cumulative mapping. Such processes make it viable to produce cartographic data for civil multipurpose use with high accuracy and low cost, expanding the conditions of sovereignty. Lacking cost barriers, FOSS tools can empower communities. Consequently, they have an increased potential to subvert historical asymmetries: the more people can produce maps "from the inside", the less forced Paraguay will be to assume narratives and representations made "from the outside".

**Keywords:** Cartography, Colonialism, Sovereignty, FOSS

## 1 Introduction

This article proposes a contribution to the decolonial debate by means of a critical reflection on the relationship between data, cartography, the formation of national states, territorial management, dynamics of socio-economic exclusion and processes of wealth concentration. The text focuses, first, on the analysis of historical cartographies of Paraguay to reflect on how they have described and conditioned the territorial development of the country. The paper then moves on to a series of interviews with key actors to delve into the conditions and capacities related to cartography in the present. Finally, the article reflects on cartographic processes based on free software as ways to expand and enhance effective sovereignty.

On the historical matter, Cristaldo (2013) has described Paraguay as a late-articulated territory with boundaries that were defined after centuries of uncertainty and friction, which resulted in two international wars in the years 1864-1870 and 1932-1935. After these conflicts ended, relevant details of the border definition remained in dispute, being defined only in the second half of the 20th century in the context of the treaties related to the construction of the binational dams of Itaipú and Yacyretá (Costantini, 2007).

The imprecision in the boundaries of the Province of Paraguay and its neighboring provinces was related to the political tensions between Portugal and Spain and, in addition, to the complex colonial administrative structures whose religious and civil jurisdictions were often not harmonized (Caballero Campos, 2017). Historical vicissitudes such as the Iberian Union between 1580 and 1640 added even more complexity to these controversies (Costa, 2009).

The cartographies produced in this period failed to clarify these inaccuracies and contradictions. The "cartographies from outside" produced by European countries suffered from a lack of basic information, technical limitations and also a narrow conceptual view (Pensa, 2021). In general, they were oriented to claim political and military control of the territories, or to locate exploitable natural resources. It is emphasized that these representations ignored any territorial rights of native peoples (CELADE and ECLAC, 2014). This cartographic invisibilization is part of the first process of exclusion and dehumanization of native peoples, with consequences that extend to the present.

In terms of natural resources, Paraguay is a country that has historically lacked mineral wealth. Consequently, territories were mapped that contained products that could be exploited for extractive economic purposes, such as yerba mate. The native peoples were also mapped due to the interests of the colonial powers, such as the religious conversion to Catholicism in the framework of the Jesuit Reductions, or the brutal exploitation of their labor force in slavery or quasi-slavery regimes (Whigham, 1991; Pensa, 2021).

The independent period in Latin America began in the early 18th century after the debacle of the imperial powers under Napoleon's armies. In the period, Brazil was consolidated as the new seat of the Portuguese Empire and as a single state, while the Spanish colonies were disintegrated into national states whose boundaries were loosely related to the viceroyalties and provinces of the colonial period. In this regard Craib (2017) states "(...) while the boundaries of many of the fledgling republics of Latin America born of independence movements in the early nineteenth century would change over the course of that century, leaders of those movements initially applied the legal principle of *uti possidetis juris* (Latin for "as you possess under law")" (p. 17). Paraguay, as an independent nation from 1811 onwards, had permanent tensions regarding its boundaries and the navigability of the rivers that constituted its main logistical link with the world (Mendible-Zurita, 2010; Echeverría, 2013).

This period of Paraguay's formation as an independent nation meant the replacement of international elites by local criollo elites and the establishment of wealth accumulation processes, concentrated in the State, during the dictatorship of Dr. Francia and the government of Carlos Antonio López. A key moment in this process was the decree of 1848, which provided citizenship to indigenous peoples, while declaring "(...) properties of the State the goods, rights and interests of the (...) peoples of natives of the Republic" (Melià, 2011, our translation). Thus, the nascent Paraguayan state assumes, without compensation, the ownership of all the territories of native peoples, in a second structural moment of invisibilization and exclusion.

When, after the War of the Triple Alliance (1864-1870), Paraguay was reduced to a buffer state between Brazil and Argentina, the vastness of previously usurped properties of the Paraguayan State was sold under the new laws for the commercialization of public lands established in 1883, 1885 and 1886 (Flecha, 2011).

Based on these laws, the large latifundios of the Western and Eastern regions were formed. The latifundios of the western region were linked to the exploitation of tannin and quebracho, while those of the eastern region were linked to the extraction of yerba mate. The brutality of the working conditions in both types of enclaves has been recorded in the social sciences and in Paraguayan culture, being reflected, for example, in the literature of Roa Bastos (Roa Bastos, 1974).

It should be noted, then, that the cartographies of the independent period continued to be instruments of extractivist exploitation and privatization of territories at the expense of native peoples and peasant criollo populations. This historical legacy had consequences on territorial management and on the very structure of society, through the systematic exclusion of ethnic and cultural groups and the invisibility of their rights. Paraguay is still today one of the countries with the highest levels of concentration of land ownership in the world. Studies indicate that the Gini Index of land distribution in Paraguay points to an almost perfect inequity. Guereña and Rojas Villagra (2016), indicate in a report by the NGO Oxfam, that the Gini index of land concentration was 0.93 based on data from 2008.

This legacy of "cartographies from the outside" is also materialized in a systemic weakness of the state and the current Paraguayan society to portray itself "from the inside". The analysis of contemporary cartographic pieces, and interviews with key actors of Paraguayan institutions working in the area of cartography, reveal a chronic lack of cartographic representation competencies at all levels of the State.

This lack of capacity to produce "cartography from within" affects all aspects of national life such as urban taxation, national defense, transparency and security of land tenure, the ability to implement infrastructure projects, or the recognition of the rights of indigenous peoples and landless peasant populations.

At the time of writing, the Direction of the National Cadastre Service (SNC) only has, in Paraguay, spatial information with nationwide coverage for the country's parcel system, and even this information is incomplete and inaccurate. There is no detailed cartography of the buildings constructed on the parcels, nor is there a characterization of their heights or uses. This gap in cartographic information prevents transparent and fair municipal taxation processes, and constitutes an obstacle to evidence-based urban planning in the vast majority of the country's cities.

Additionally, the lack of geospatial data and methodologies to produce "cartographies from within" affect local populations living in slums, and their possibility of urban consolidation or improvement. Only recently, through pioneering studies (DAPSAN, TECHO

Paraguay and CIDI FADA-UNA, 2023) has it been possible to have a more precise quantification and location of slums in the Metropolitan Area of Asunción (AMA).

In contrast, in contemporary Paraguay, there are socio-economic processes of transformation and management of the territories that are systematically and accurately mapped. For example, the planting and harvesting cycles of agro-industrial production, mostly related to oilseeds, are monitored with high precision (INBIO, 2019 and 2023 b). This indicates, then, that the issue is not determined by the absence of technology or economic resources, but by a prioritization of interests and policies. The evidence suggests that in contemporary Paraguay, as in colonial times, that which is of economic interest is known, described, mapped and registered, while that which is not, continues in general, as an invisible reality.

Given this historical picture, the article concludes by exploring how it is possible to contribute to the issue of mapping from academic institutions using FOSS tools. To this end, experiences of mapping "from within" developed from academia are presented, discussing their characteristics, products and methods, while advancing a reflection on the social and political implications of this type of tools.

## 2 Methods

This paper presents an exploratory, non-experimental and qualitative methodology whose main aspiration is to advance in new interpretations that allow us to re-discuss the relationships between cartography, colonialism and sovereignty in Paraguay, linking these notions to reflections on processes of exclusion and invisibilization and their correlate in processes of wealth accumulation.

Methodologically, this work is based on a triangulation (Denzin, 1970) characterized by the following aspects:

(i) Triangulation of data sources: In the first section, the paper relies on secondary data, such as historical (Rivarola, 2021; Rumsey & Cartography Associates, 2022) and contemporary (DISERGEMIL and US DOD, 1970; INBIO, 2019 and 2023 b) cartographies, in addition to academic texts discussing the historical evolution of contemporary Paraguay in the context of Latin America. In the second section, on the cartographic capacities of contemporary Paraguay, the text relies on primary data obtained through four semi-structured interviews with five key actors, belonging to academic and governmental spheres, conducted in 2020 and 2021. The third section includes cartographic practices and documents produced by the Center for Research, Development and Innovation (CIDi) of the Faculty of Architecture, Design and Art of the National University of Asuncion (FADA UNA).

(ii) Methodological triangulation: In the first section, the materials studied are analyzed based on a critical review of the bibliography, in combination with the iconographic and iconological analysis of the cartographic pieces (Harley, 2005 as cited in Pensa, 2020). In the second section, we proceed to systematize the results of the interviews, extracting key concepts that provide clues about the challenges of contemporary cartography in Paraguay. The third section is based on a descriptive and qualitative analysis of the experiences with FOSS Geographic Information Systems (GIS) at CIDI FADA, together with a reflection on their social and political implications.

## 3 Results

This section will present the results obtained in the development of this work. They will be presented in three parts, the first one referring to the iconographic and iconological analysis of cartographic pieces, from a perspective of critical analysis of colonialism; while the second part focuses on the results of interviews with key actors, and serves to provide indications of cartographic and governance capacities in contemporary Paraguay. The third part will analyze the use of FOSS GIS tools in Paraguay and discuss their political and social implications.

### 3.1 Part One: Iconographic and iconological analysis of cartographic pieces

The maps<sup>1</sup> are organized according to four historical periods: (i) the Colonial Period (1524-1811), (ii) the Independent Period until the War of the Triple Alliance (1811-1870), (iii) the Independent Period after the War of the Triple Alliance (1870-1954) and (iv) the Contemporary Period (1954-2023) (see Table 1). A total of 7 maps are presented, illustrating the four defined historical periods.

Nº	Period	Title	Main Author	Year	Publicación
1	Colonial (1524 - 1811)	<i>Carte générale du Paraguay et de la province de Buenos-Ayres.</i>	Félix de Azara	1809	<i>Voyages dans l'Amerique meridionale, par Don Felix de Azara. Paris, Dentu, Imprimeur-Libraire, Rue du Pont-de-Lodi, No. 3.</i>
2	Independent Period Prior to the War of the Triple Alliance (1870-1954)	<i>Carte de la République du Paraguay (Cours du Parana et du Paraguay) (Amérique Méridionale)</i>	Ernest Mouchez	1862	<i>Dépôt des Cartes et Plans de la Marine</i>
3	Independent Period After the War of the Triple Alliance (1870-1954)	Siege of Humaitá	1st Lt. E. C. Jourdan	1871. 1893 (publication)	History of the Uruguay, Matto Grosso and Paraguay Campaigns. Rio de Janeiro, Imp. Nacional
4	Independent Period After the War of the Triple Alliance (1870-1954)	Sketch of the Paraguayan Chaco. Reproduced from the Fontana Map, drawn by order of the Superior Government of Paraguay.	Luis Jorge Fontana	1885. 1910 (publication)	Paraguay, Government: Property in the Paraguayan Chaco. Asunción. Graphic Workshop H. Krafuss.
5	Independent Period After the War of the Triple Alliance (1870-1954)	Yerbales de Domingo Barthe	Arsenio López Decoud	1868. 1911 (publication)	Published in Buenos Aires, <i>Talleres Gráficos de la Compañía General de Fósforos</i> . Included in the Graphic Album of the Republic of Paraguay.
6	Contemporary period - Stroessner Dictatorship and Democratic Period (1954-2023)	Map of Asunción	United States Department of Defense (US DOD)	1970	Published by the U.S. Army Topographic Command, Washington, D.C.
7	Contemporary period - Stroessner Dictatorship and Democratic Period (1954-2023)	Maps of Geospatial Distribution of Soybean Production in the years 2018 to 2019 and 2022 to 2023.	Instituto de Biotecnología Agrícola	2019, 2023	Instituto de Biotecnología Agrícola

**Table 1:** Analyzed cartographic pieces. Source: Authors, 2023.

<sup>1</sup> A large part of the cartographic pieces analyzed here are related to the pioneering work of historian Milda Rivarola, who together with Carlo Spatuzza organized an exhibition of great relevance called "Cartographic Memory of Paraguay", in the context of the bicentennial celebrations of Paraguay's independence, in 2011. These and other pieces were later consolidated in a book of the same name (Rivarola and Spatuzza, 2011) and in a repository of enormous value for researchers called "Imagoteca Paraguay" <https://imagoteca.com.py/>. Historical maps were also obtained from the David Rumsey Historical Map Collection <https://www.davidrumsey.com/>. Contemporary official maps of Paraguay were obtained from the Dirección del Servicio Geográfico Militar (DISERGEMIL).



### 3.1.1 Colonial Period (1537-1811)

#### “Carte Générale du Paraguay et de la Province de Buenos-Ayres” by Félix de Azara (1809)

Felix de Azara, the first author of cartographies of Paraguay and much of the South American continent, was an important intellectual figure, later cited in Darwin's work (Beddall, 1975). He recorded territories acting as an envoy of the Spanish Crown to define the borders between the Spanish and Portuguese empires. The first cartographies of Paraguayan territory - including the first map of the capital, Asunción - are part of an attempt to settle territorial disputes that are nearly 300 years old at the time of the beginning of Azara's work in 1784 (Beddall, 1975). Azara did extensive mapping of physical geography, including the course of various rivers and the location of cities and towns, taking latitudinal measurements in Montevideo, Buenos Aires, Corrientes and Asunción. The map in Fig. 1 is characterized by the fact that, in general, the basic elements of the territory are defined, but with important distortions, especially in the Chaco territory.

The long years of work in America - 20 in total - weighed heavily on Azara's mind, who stated, "I have written overwhelmed by loneliness and melancholy, in despair of ever being able to tear myself away from these bleak solitudes and the society of animals" (Beddall, 1975, p. 20, our translation). That this solitude was more real than perceived has been discussed by Glick and Quinlan (1975), who state that: "Azara communicated intermittently but consistently with a group of two dozen naturalists and intellectuals" (p. 70). Azara's lines can be interpreted as the expressions of an isolated and depressed intellectual, but they can also be read as a bias in the gaze. It is postulated that Azara's statements underlie the concept that the absence of contact with western cultures is equal to the absence of contact with humans, providing indications of the existing bias in the valuations made from Europe towards the native peoples. In purely cartographic terms, the Eurocentrism of the piece is also evident in the sense that both the motivations (defining borders) and the geographical references themselves (the Paris meridian) obey European reasons and motives.

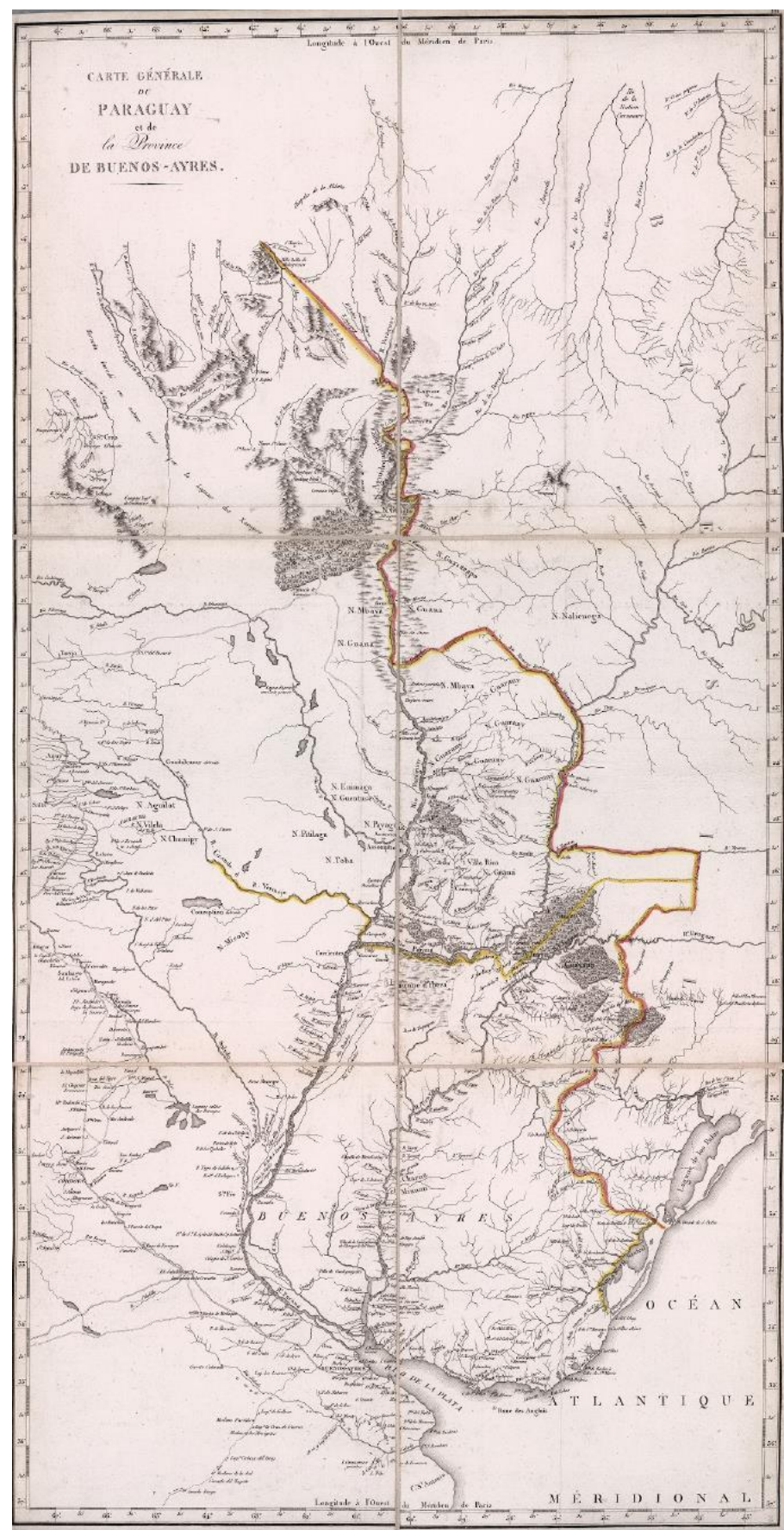
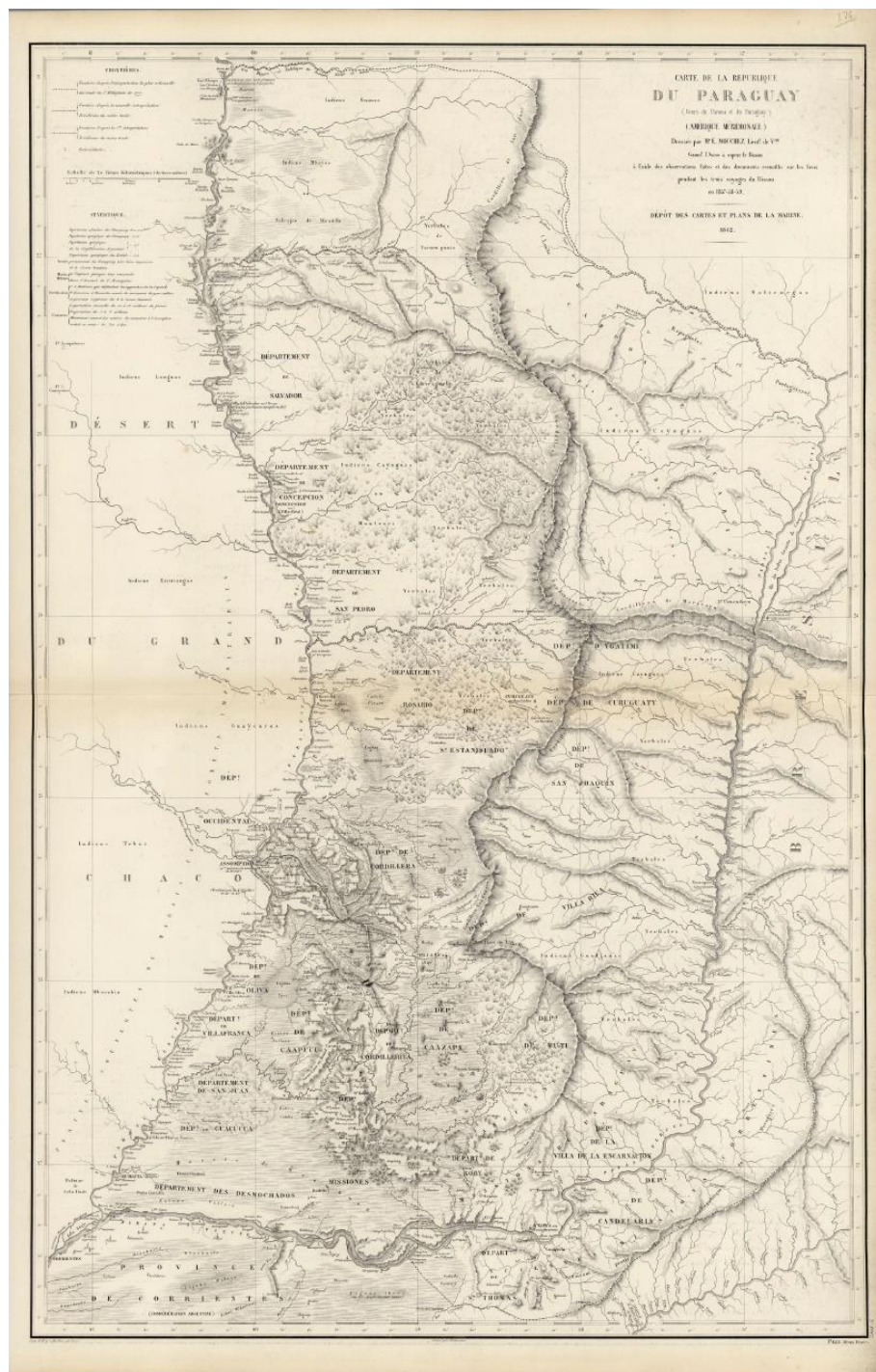


Fig. 1: *Carte Générale du Paraguay et de la Province de Buenos-Ayres*, by Félix de Azara (1809). Source: Rivarola, 2021. Available at: <https://imagoteca.com.py/>. Access on: 08/04/2023.

### 3.1.2 Independent Period Prior to the War of the Triple Alliance (1811-1870)

#### “Carte de la République du Paraguay: cours du Parana et du Paraguay”, by Mouchez (1862)

Mouchez was a French naval officer who, in 1878, was appointed Director of the Paris Observatory (Ashworth, 2022). He explored the Uruguay, Paraguay and Paraná Rivers between 1857 and 1859. His voyage made possible a much more precise description of the territory than Azara's map: the main elements of the country's physical geography are perfectly recognizable and clearly defined (see Fig. 2). An implicit recognition of the rigor of his work is the fact that his map is cited in the treaty of "Limits between Argentina and Paraguay" of 1876 (Bobrik, 2007). The map in Fig. 2 records several possible border lines with Brazil, based on interpretations of the Treaty of San Ildefonso of 1777. The cartographic piece also provides statistical data on the country. It is important to note that the natural resources —with emphasis on the immense yerba mate plantations to the east of the Eastern Region— and the native peoples of the territory are meticulously recorded. The cartography allows to locate resources that will be intensely exploited at the end of the war of the Triple Alliance. Finally, the emptiness and lack of details that characterize the representation of the Chaco in contrast with the Eastern Region stand out. This situation of ignorance and emptiness in the representations in relation to the Chaco will not change until the 20th century.



**Fig. 2:** *Carte de la République du Paraguay: cours du Parana et du Paraguay*, by Mouchez (1862). Source: Rivarola, 2021. Available at: <https://imagoteca.com.py/> Access on: 08/04/2023.

### 3.1.3 Independent Period After the War of the Triple Alliance (1870-1954)

#### "Historical Atlas of the War of Paraguay - Siege of Humaitá", by Jourdan (1871)

The graphic pieces of the "Historical Atlas of the Paraguayan War" stand out for the detail of the information. The physical geography and the fortifications are described meticulously and with high aesthetic quality. At the same time, the map of Fig. 3, "Siege of Humaitá" and others that compose the Atlas (Rumsey, 2022), reaffirm that the fundamental motivations that guide the production of cartography in Paraguay are related —historically— to military and territorial control, as well as to economic extractivism. With rare

exceptions, such as the works of Cleto Romero, Moises Bertoni, De Gásperi and Bordón, there are no civilian maps of comparable quality in the history of Paraguayan cartography (Rivarola, 2021).



**Fig. 3:** *Siege of Humaitá - Historical Atlas of the War of Paraguay*, by Jourdan (1871). Source: Rumsey & Cartography Associates, 2021. Available at: <https://www.davidrumsey.com/> Access on: 08/04/2023.

### “Sketch of the Paraguayan Chaco” (Fontana, 1885)

The map in Fig. 4 illustrates the massive processes of sale and subsequent concentration of land ownership in the Paraguayan Chaco after the conclusion of the War of the Triple Alliance.

The prices of the plots change in relation to their economic exploitation potential, which is measured in relation to the distance to the Paraguay River and Asunción. The farther away from Asunción or the river, the lower the prices. The properties of tannin companies, such as the Carlos Casado Company, are formed from these instruments. They follow a cartographic matrix and a structure of parceling and ownership that is defined from Asunción, Buenos Aires and other centers of economic decision making.

The plots of groups I, II and III have 1 league of frontage by 10 in depth. Considering the Argentinian League of 1878, this is equivalent to 5 kilometers of river frontage by 50 kilometers of depth. Therefore, each plot has an area of 25,000 hectares. Group IV lots measure

10 leagues by 10 leagues, that is to say 2,500 km<sup>2</sup> or 250,000 ha. As a reference of scale, it can be considered that only two plots constitute the entire territory reserved for the city of Villa Hayes.

As revealing as what the map shows is what it does not indicate. Except for some tributary rivers of the Paraguay on the right bank, the map is an almost perfect abstraction. The only references to the sovereignty of the National State are "the reserves of fiscal lots for roads, colonization, etc." .It does not present physical geography features, nor does it recognize the ecological distinction between the low Chaco and the boreal Chaco. Nor does it indicate the territories or the names of native peoples. It is a completely abstract map that reinforces the western notion that it is possible to exercise possession and establish legitimacy over a territory that one does not inhabit and one does not know.

In fact, the native peoples never had a seat at the political decision-making table where this land was parceled and sold. As a magical legal act of Western culture, the combination of mapping and property rights, together with the privately owned police coercive force of the tannin companies, suddenly transformed the native peoples into illegal occupants of their ancestral lands, or, in the best of cases, into a reserve of labor force in debt bondage, known as the Mensúes system.

The implications of this notion are far from being purely a matter of intellectual speculation. Unfortunately, they are not a matter of the past either. Native peoples and criollo populations have been "sold with their lands" on more than one occasion. These sale cycles, following Western society standards and processes, have led to the sale of Carlos Casado's tannin estates to the Unification Church, also known as the "Moon Sect", at the beginning of the 21st century (Dalla-Corte, 2012).

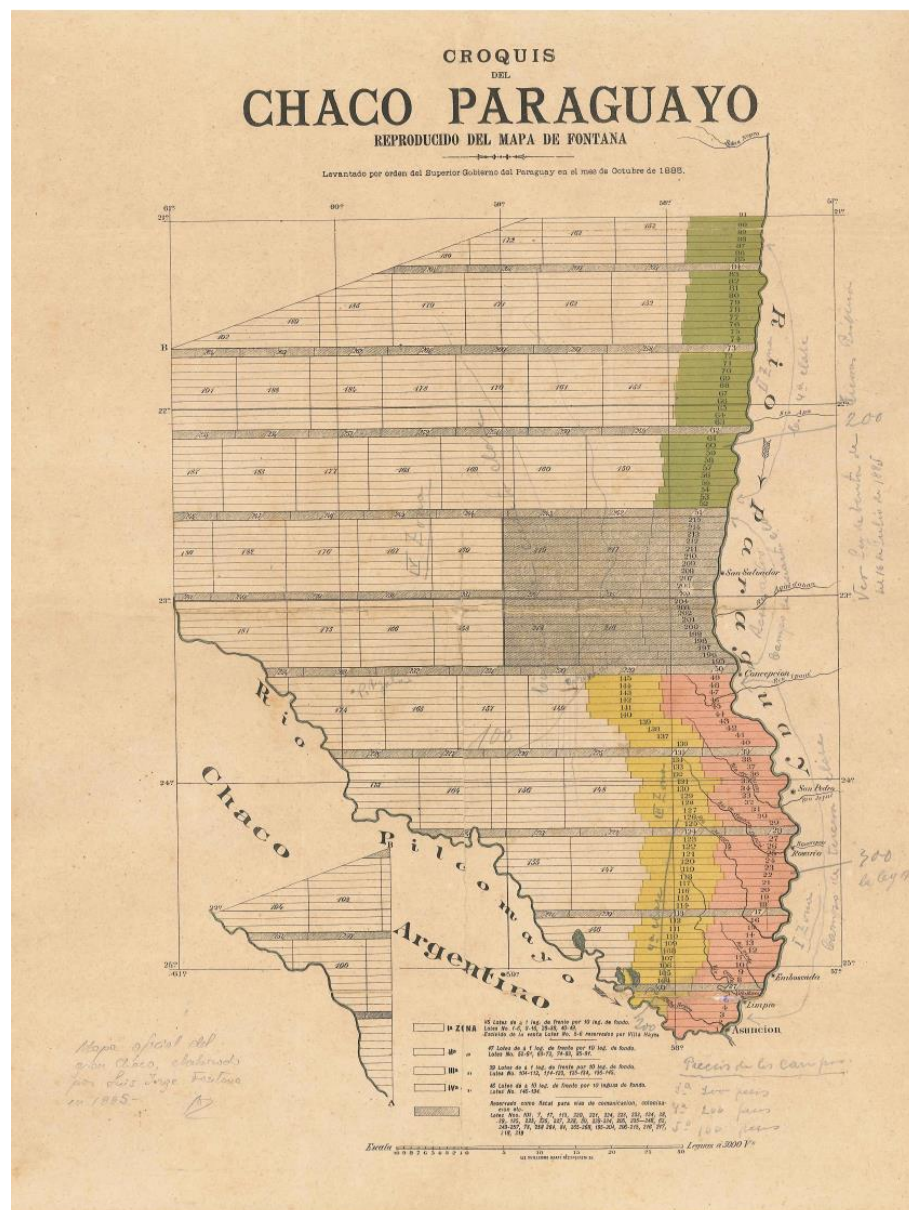


Fig. 4: Sketch of the Paraguayan Chaco, by Fontana (1885). Source: Rivarola, 2021. Available at: <https://imago-teca.com.py/> Accessed on: 08/04/2023

#### "Yerbales of Domingo Barthe", by López Decoud (1911)

The map in Fig. 5 describes Domingo Barthe's properties in Paraguay. It is possible to appreciate that these are timber and yerba mate exploitations in territories of Itapúa, Paraguay. The text accompanying the map is part of the "Graphic Album" published by Decoud to celebrate the hundredth anniversary of the Republic in 1911 (López Decoud, 1911). It emphasizes that Barthe owns 412 square leagues "in the area of Encarnación", which is equivalent to 1,030,000 ha, considering the Argentinian league of 1878. As a reference, with that surface, Barthe's lands were four times larger than the Central Department of Paraguay, whose extension reaches 246,500 ha (INE, 2012). Thus, Barthe is consolidated as one of the large landowners in the region, along with *La Industrial Paraguaya* and the *Compañía Matte Larangeira* (Alcaráz, 2019). The text accompanying the cartography is hyperbolically flattering, following the narrative lines of the romanticization of the European migrant who modernizes the void:

Mr. Barthe also dedicates his powerful and intelligent activity to the exploitation of Paraguayan timber and yerba, and to the tobacco trade of the country (...) Mr. Domingo Barthe, so highly and advantageously known in the Paraguayan and Argentinean high commerce, is a native of Mauléon, France (López Decoud, 1911, p. 50, our translation).

The image and the text reinforce each other by establishing his social legitimacy (by making Barthe's European ancestry visible), his economic power (by highlighting the extension and diversity of economic activities) and his role as an actor of Western progress (by making "the strength and intelligence of his work" visible). The native peoples and rural communities, in contrast, have been stripped of these three attributes: the value of their origin, their value as economic actors and their value as agents of history.

# DOMINGO BARTHE

## ASUNCIÓN

La línea de Posadas al extremo del Alto Paraná hasta Iguazú y Puerto Adela, con los siguientes vapores: «Adela», «Brasil», «Tembey», «Edelina» y «Elisa Esperanza».

Los remolcadores «Elena» y «Aníbal B.» con varias embarcaciones completan la flotilla.

El señor Barthe dedica también su poderosa e inteligente actividad a la explotación de maderas y yerba paraguayas y al comercio de tabaco del país.

La casa matriz se halla en Posadas, con sucursales en Buenos Aires, calle Reconquista N. 446, en Encarnación, Rosario, Apóstoles, (Misiones Argentina) e Iguazú (Brasil).

El molino de la empresa se halla en Buenos Aires, Calle Salta 1720.

El señor Barthe es propietario de 412 leguas cuadradas en la zona de Encarnación, y de extensas zonas en las Misiones Argentina y el Brasil. Se dedica así mismo a la ganadería con establecimientos montados a la moderna, en el Paraguay y en las citadas Misiones.

El Sr. Domingo Barthe, tan alta y ventajosamente es conocido en el alto comercio paraguayo y argentino, es oriundo de Mauléon, Francia. Llegó al Paraguay en 1871 estableciéndose en Concepción, donde dedicó su actividad al comercio.

A los seis años se trasladó a Encarnación con su familia, y desde entonces la casa comercial adquirió la considerable importancia que hoy tiene.

Fig. 5: Yerbales of the brands "La Florida", "Pirapitay" and "Guavirami" of the owner and importer Domingo Barthe. Source: López Decoud, 1911. Available at: <https://archive.org/details/albumgraficodela00lope/page/n445/mode/2up> Accessed on: 08/04/2023.



### 3.1.4 Contemporary Period. Stroessner Dictatorship and Democratic Period (1954-2023)

#### "Map of Asunción", prepared by the Direction of the Military Geographic Service of Paraguay (DISERGEMIL) and the United States Department of Defense (US DOD), 1970

The map of Asunción, available in Fig. 6, is a cartographic piece of high quality and accuracy, although it is outdated. It is still marketed on paper by the *Dirección del Servicio Geográfico Militar* (DISERGEMIL), the institution legally responsible for cartographic production in Paraguay. The interview with Acuña (Arévalos et al., 2020) revealed that, beyond the legal responsibility of DISERGEMIL, other institutions such as the National Institute of Statistics (INE), produce better and more updated geospatial data in the Paraguayan public sector.

It is important to note that DISERGEMIL was created in the context of the Chaco War between Paraguay and Bolivia (1932-1935) (DISERGEMIL, n.d.), reinforcing the historical link between cartography, extractivism and militarism in the Paraguayan context.

Perhaps the most revealing part of the map is the technical label indicating that the official cartography of Paraguay is produced in the United States.

It is implicit that DISERGEMIL, an institution created in the context of the Chaco War in order to help the army in combat to guarantee sovereignty, lacks, at the present historical moment, sufficient technical skills to describe the entire national territory in a way that serves the tasks of national defense, and that also results in useful inputs to multiple civilian processes of urban, territorial and environmental planning.

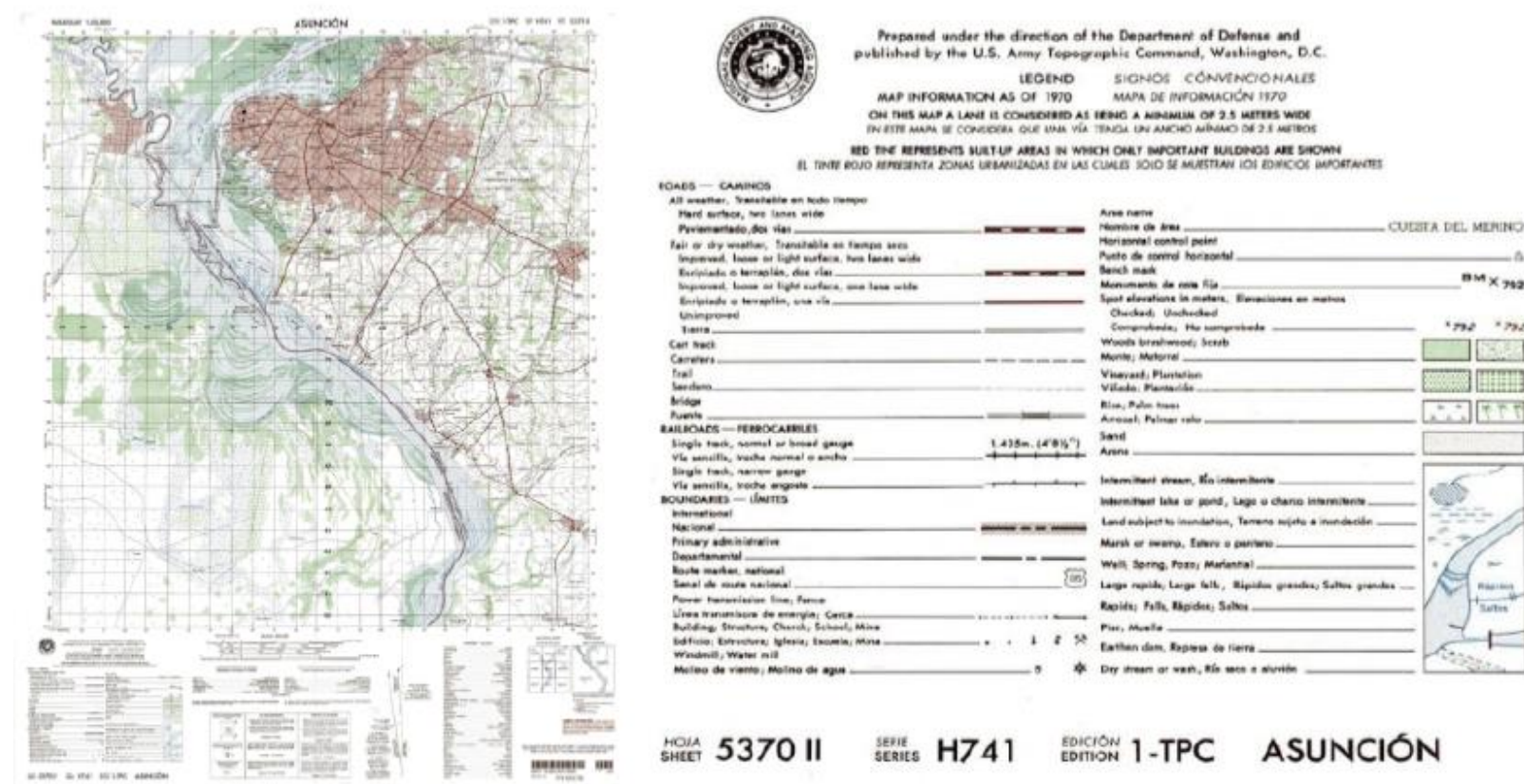


Fig. 6: Map of Asunción prepared under the Direction of the U.S. Department of Defense and Published by the U.S. Army Topographic Command, Washington, D.C. Source: DISERGEMIL and US DOD, 1970. Available at: <https://www.disergemil.mil.py/index.php/productos> Accessed on: 04/08/2023.

### **"Maps of Geospatial Distribution of Soybean Production in the Years 2018 to 2019 and 2022 to 2023" by the Institute of Agricultural Biotechnology (2019 and 2023)**

The Instituto de Biotecnología Agrícola (INBIO) is a non-profit civil association formed by several guilds related to agricultural production (INBIO, 2023a). For several years, it has been systematically mapping key variables for agribusiness, among which the mapping of sown areas according to the main agribusiness items stands out.

Fig. 7 provides a comparison between two mapping pieces corresponding to the soybean planted area in the years 2018-2019 (INBIO, 2019) and 2022-2023 (INBIO, 2023b).

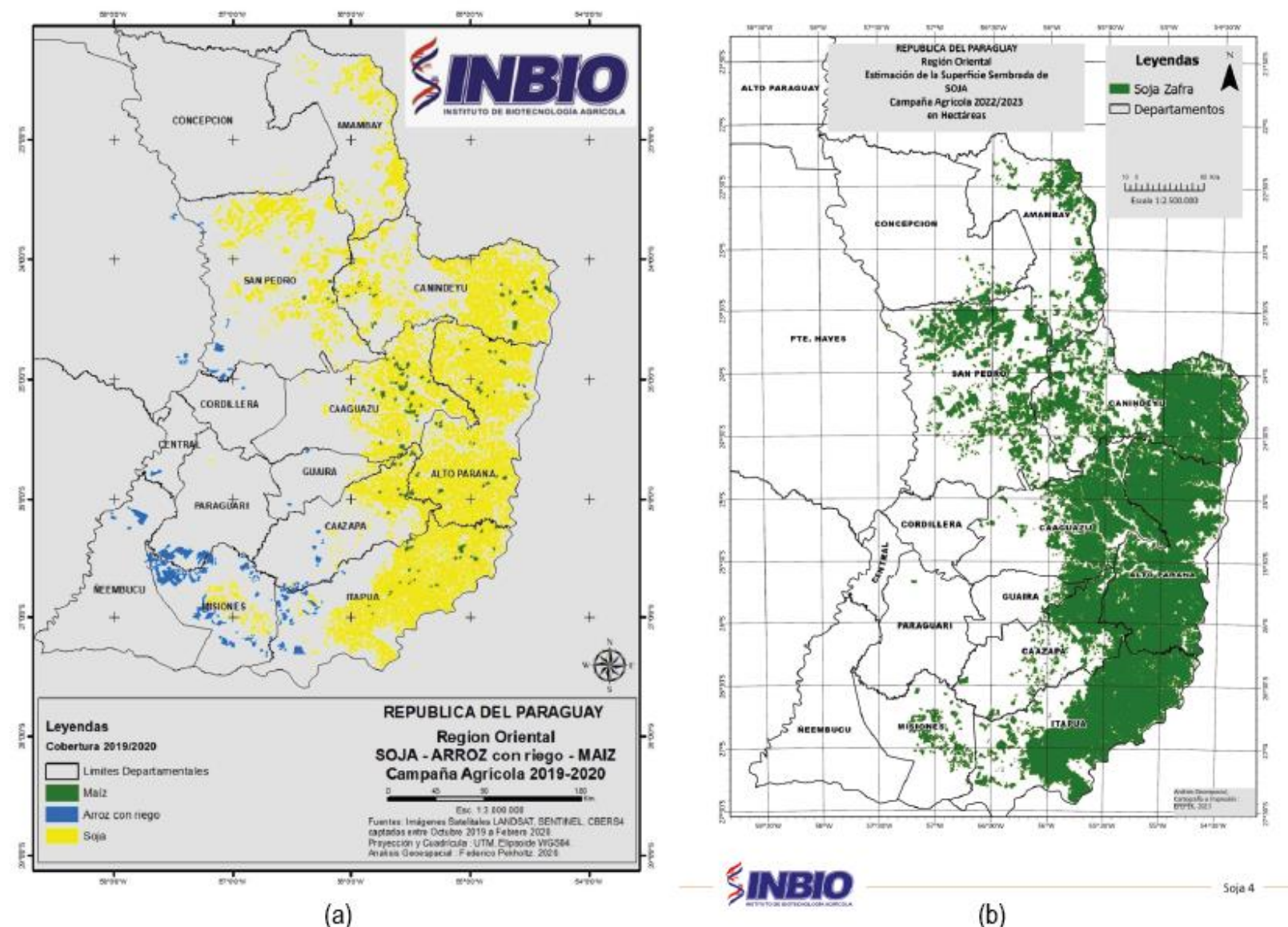
The large spatial overlap between the yerbales of the past and the soybean fields of the present is noted. The planting maps portray one of the drivers of contemporary Paraguayan productivity and, at the same time, indicate a dramatic change in land use that has resulted in the deforestation of vast portions of the Upper Paraná Atlantic Forest.

In addition, the technical quality of the mapping demonstrates mastery and competence in the use of contemporary GIS software techniques. In the Paraguayan context, it is often argued that information gaps are due to lack of human or financial resources. Consequently, it is argued that Paraguay suffers from chronic deficiencies in its cadastral systems and in the mapping of key urban variables, such as service networks, risk sites or precarious settlements.

INBIO's mapping and cartographic products, made with technical rigor and quality, demonstrate, however, that in reality it is not a question of the country lacking resources or technical capabilities, it is a question of a definition of priorities.

This article has documented that one of the aspects of Paraguayan cartography has always been linked to the economic exploitation of the territory. The INBIO maps reaffirm that what is considered economically valuable is mapped and thoroughly recorded.

The technical merits of INBIO's cartography indirectly illustrate the systematic absence of a State that acts to represent the interests of all citizens. Only in the face of this systematic absence or weakness of the State can it be explained that the mapping of Paraguay continues even today, describing only certain economic variables, and ignoring many other aspects of social or environmental relevance, which are not analyzed because they do not produce economic benefits in the short term.



73

Fig. 7: Maps of Geospatial Distribution of Soybean Production in the years 2018 to 2019 (a) and 2022 to 2023 (b). Source: INBIO, 2019 and 2023. Available at: <https://www.inbio.org.py> Access on: 08/04/2023.

### 3.2 Part Two: Discussion of the contemporary situation of Paraguayan cartography based on interviews with key actors

Nº	Date	Interviewee	Institution
1	10/24/2020 10/31/2020	Jorge Acuña	Coordinator of the Geographic Information Innovation Center at <i>Parque Tecnológico Itaipú - Paraguay</i>
2	10/24/2020	Lucía Fariña	Specialist in Geographic Information Systems, Professor at UNIGIS and Universidad del Pacífico.
3	07/02/2021	Lorenzo Alfonso* and Fátima Giménez**	*Technical staff member of the <i>Servicio Nacional de Catastro</i> of Paraguay. **Lawyer, staff member of the <i>Servicio Nacional de Catastro</i> of Paraguay.
4	10/07/2021	Andrés Ramírez Insfrán	Director of Statistical Geoinformation and Data Infrastructure of the <i>Instituto Nacional de Estadísticas</i> of Paraguay.

Table 2: List of key actors interviewed. Source: Authors, 2023.

In this paper we analyze four interviews with key actors from the academic and governmental spheres (see Table 2). These interviews were originally carried out in the context of undergraduate final projects and research projects promoted at CIDi. Some of the fundamental aspects highlighted in the interviews are summarized below:

### 3.2.1 Deficiencies in the national geospatial data infrastructure

The interviewees agree that the geospatial data infrastructure currently faces major weaknesses that include: (i) the lack of an active geodetic network, (ii) the absence of a spatial data infrastructure and (iii) the lack of a national metadata standard.

(i) Paraguay has only a passive geodetic network, composed of physical landmarks in the territory. An active geodetic network is a set of reference points that allow triangulating the territory and are also linked to GNSS (Global Navigation Satellite System) satellites (INEGI, 2017). Thus, an active geodetic network makes it possible to provide high-precision data, even when there are ground movements, maintaining an effective description of the territory at all times. The lack of an active geodetic network that covers the entire national territory prevents having solid technical criteria to strengthen the SNC and settle conflicts over dimensions or location of disputed property titles. Acuña (Arévalos et al., 2020) mentioned that large-scale infrastructural works, which need to be implemented with great precision, suffer from the lack of a primary framework of coordinate references in the national territory. The interviewee also mentioned that projects for an Active Geodetic Network have been developed in Paraguay but were not implemented.

(ii) The absence of a spatial data infrastructure (SDI) in Paraguay is related to the challenge of systematically accumulating and refining information about the territory and making it accessible for multiple purposes. A SDI is defined as "(...) the basic set of technologies, policies and institutional arrangements aimed at facilitating the availability and access to spatial information" (Capdevila Subirana, 2004, our translation). Accumulating information is a key aspect of the process of building "cartographies from within", since having an ecosystem rich in geospatial data can only be the result of articulated work processes that are sustained over time.

It is equally important to disseminate the information so that citizens, academics and civil society organizations can analyze the present reality, plan scenarios and discuss future alternatives. This process of socialization of information is also vitally necessary for the coordinated action of public institutions.

(iii) The absence of a national metadata standard is linked to the previous issue. Paraguay faces the challenge of not having an approved national metadata standard. According to Fariña, this prevents the standardization of metadata assigned to geospatial data and constitutes an obstacle to the interoperability of information (Arévalos et al., 2020).

### 3.2.2 The lack of sufficiently trained human resources in public institutions

Interviewees Acuña, Fariña and Ramírez (Arévalos et al., 2020; Oporto, 2023) indicate that institutions such as DISERGEMIL still do not implement GIS technologies in their cartographic processes despite having received training on numerous occasions. In other interviews, Alfonso and Giménez (Cristaldo et al., 2021) also mentioned that institutions such as the SNC need more properly trained human resources.

### 3.2.3 Inter-institutional disarticulations

The Paraguayan Government Institutions that act in the areas of cadastre and cartography include DISERGEMIL, the SNC — depending on the Ministry of Finance—, the *Dirección Nacional de los Registros Públicos* —depending on the Judiciary and INE—. It is necessary to promote the articulated work between these institutions, and additionally link them to the municipalities considering that, within the terms of the Municipal Organic Law, local governments have the mandate to establish urban planning processes, being geospatial data and cadastres, a key input for this. In such context, the interviewees agree that inter-institutional articulation constitutes an enormous challenge that prevents progress in new projects or even disrupts the efforts implemented in the area of geospatial data (Arévalos et al., 2020; Cristaldo et al., 2021; Oporto, 2023).

### 3.3 Part Three: Experiences applying GIS - FOSS tools in Paraguay and their implications

#### 3.3.1 Experiences with FOSS GIS at CIDI FADA

CIDI FADA UNA is the academic space from which the authors develop their daily work. One of the most important academic objectives of the institution is to explore how FOSS GIS tools can be applied to overcome the cartographic gaps of the Global South. This is a response to the historical and current limitations of Paraguayan cartography, described in this article.

In such context, CIDI develops —together with national and international partners— a repertoire of methodologies, academic research and training (see fig. 8) linked to the use of FOSS GIS tools, for the study of cities and territories of Paraguay and the Global South. Since 2017, these efforts have been developed within a research line called "Mapping with Free Software".

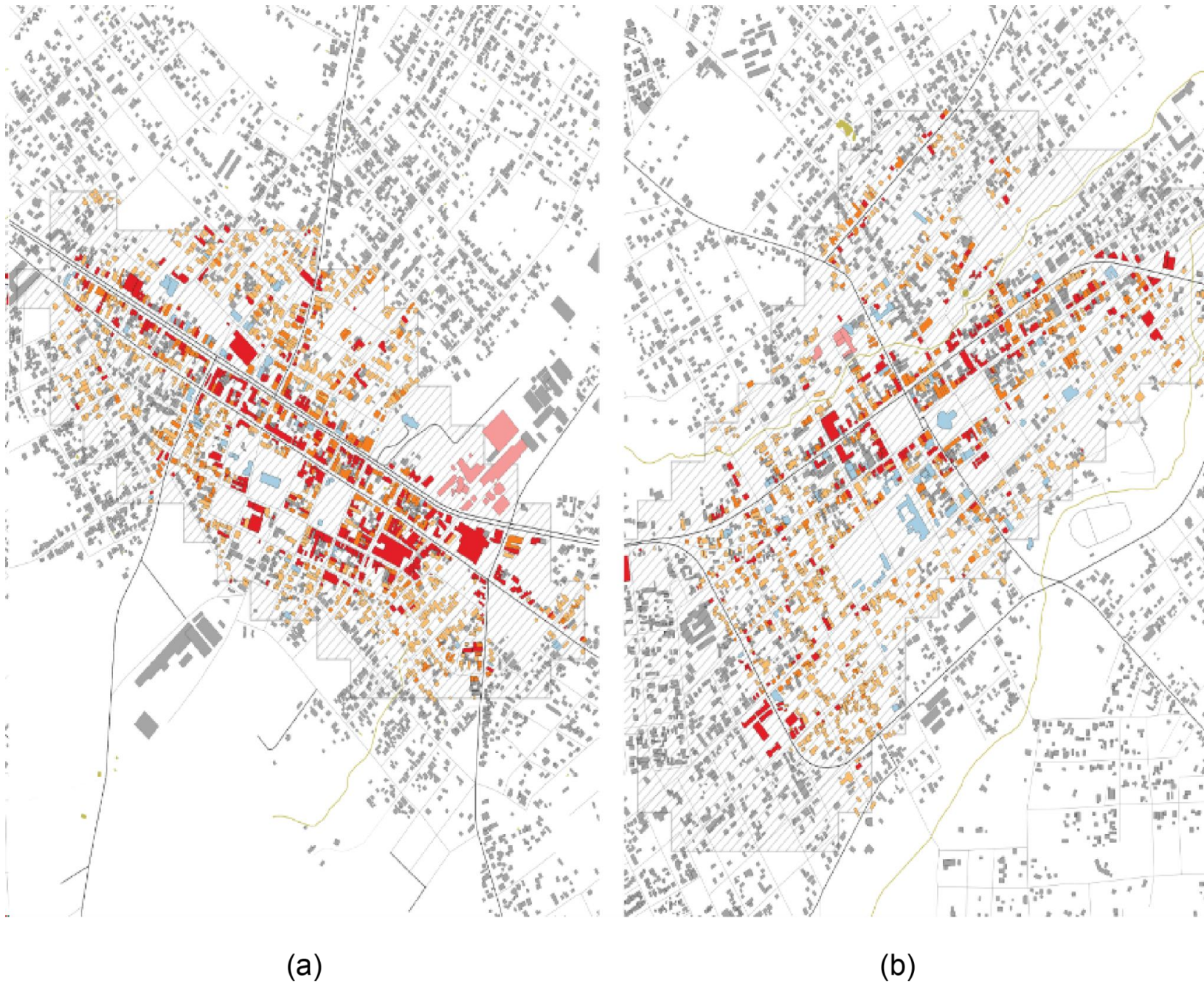


**Fig. 8:** Territorial Mapping Techniques with Free Software course. Source: prepared by the authors, 2023.

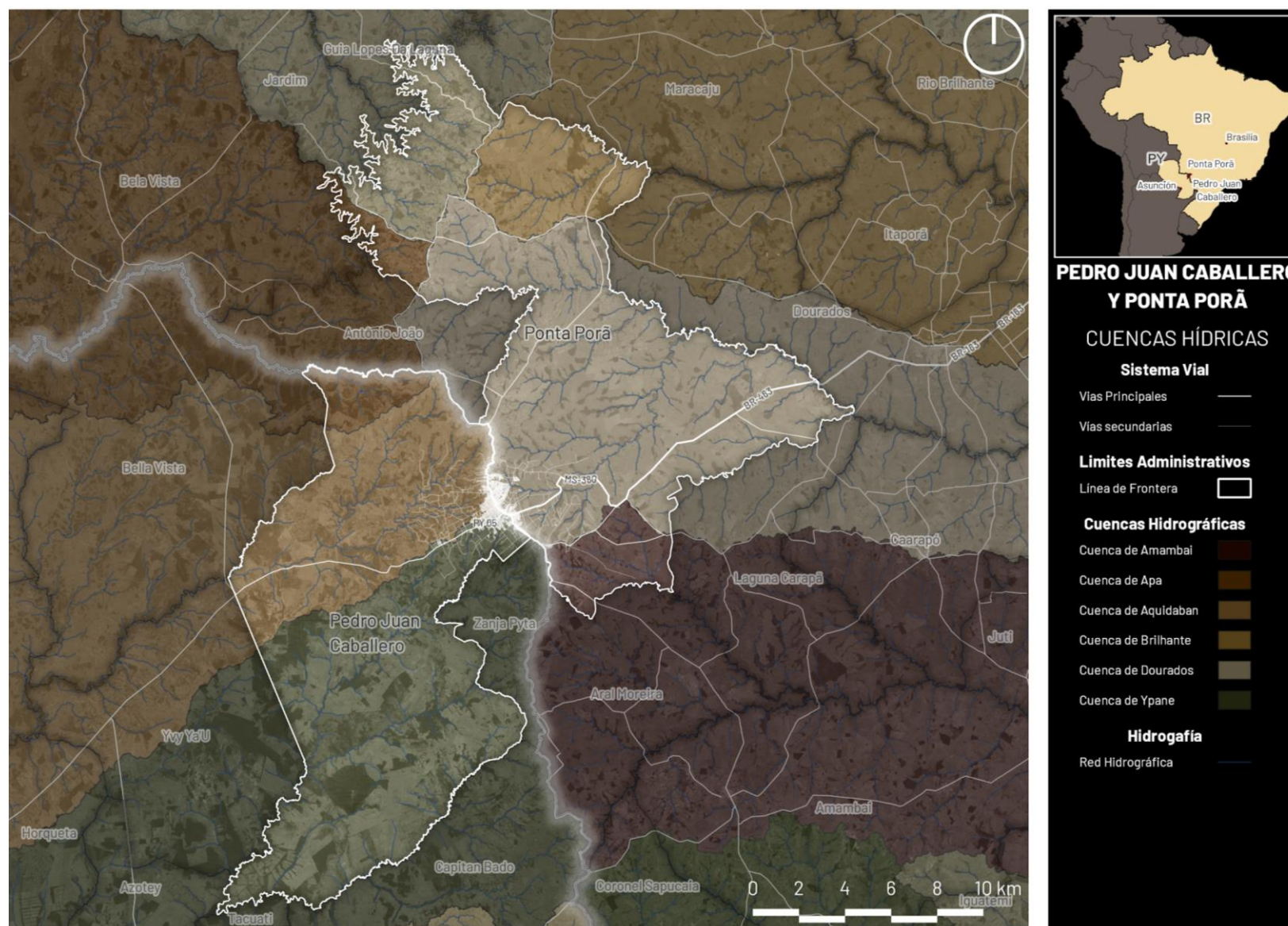
As a result, projects such as Mapping Paraguay with OpenStreetMap (Map Py OSM) and Urban Atlas of Paraguay (AUPy) have been developed (Cristaldo, 2022). The first one produces basic geospatial information on buildings, vegetation and artificial bodies of water for the whole of Paraguay (see Fig. 9). The second has developed analytical cartography of 15 cities in the country, in the Route No. 2 corridor, and in border cities between Paraguay and Brazil (see Fig. 10 and 11).



**Fig. 9:** Mapping of buildings in the Triple Frontier region, Map Py OSM Project (a) 2018, (b) 2019. Source: prepared by the authors, 2019.



**Fig. 10:** Mapping of building uses in Itauguá (a) and Caacupé (b). Urban Atlas of Paraguay Project. Source: prepared by the authors, 2020.

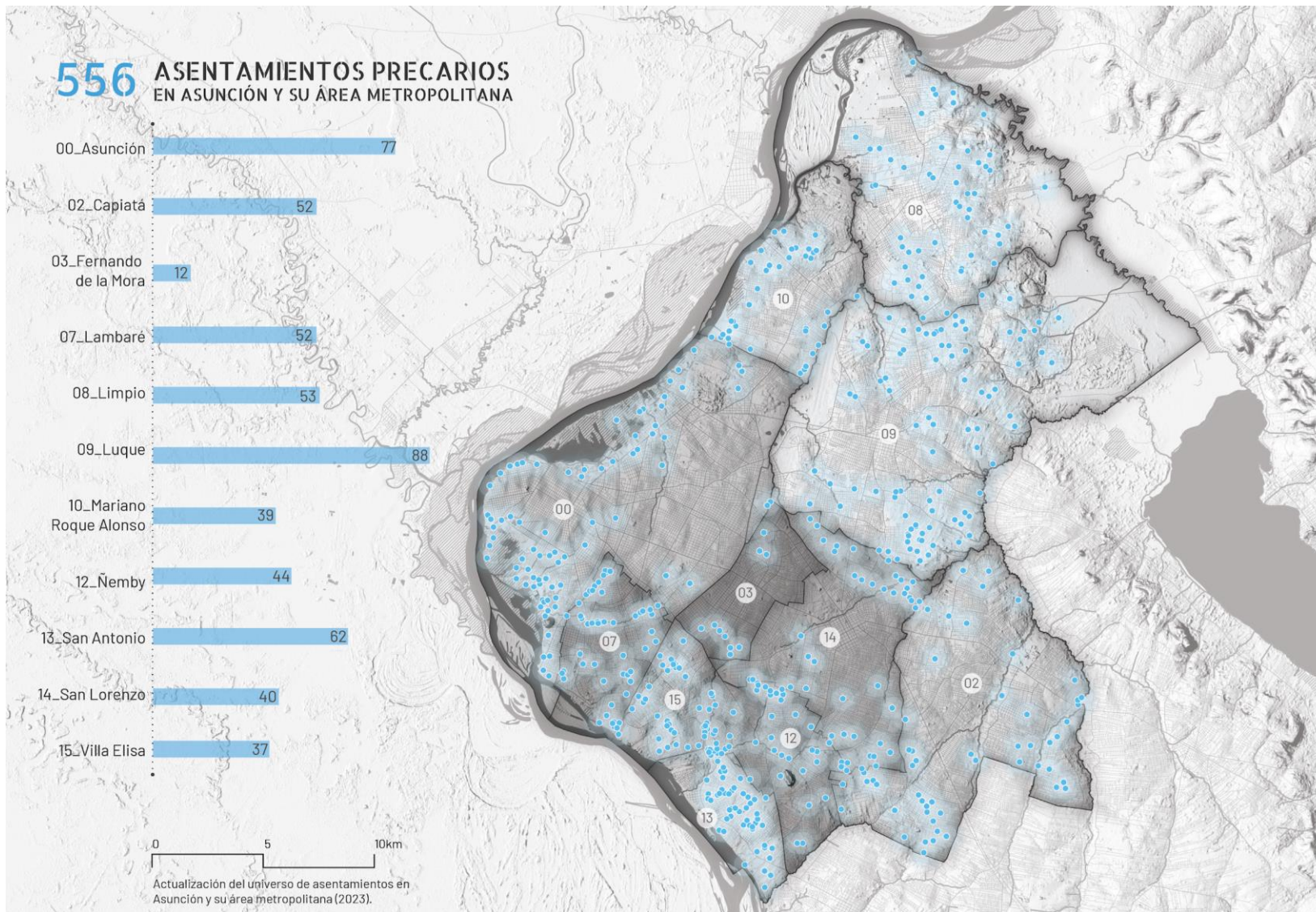


**Fig. 11:** Urban Atlas of Paraguay Project - Border cities. Map of watersheds in Pedro Juan Caballero (Py) and Ponta Pora (Br). Source: prepared by the authors, 2022.

These initiatives are conceptually grouped into two categories. On the one hand, basic science studies: these are descriptive urban-spatial analyses that involve the elaboration of an important contingent of new data through remote and field work. They provide inputs to communities, academic actors and local governments, helping to decode the "urban genome" of Paraguayan cities. On the other hand, there are applied science studies: usually commissioned by partner institutions, they focus on key aspects such as the detailed description of low-income communities, the study of metropolitan territories or urban risks, among others (see fig. 12).

In terms of tools, these works are based on the contribution to open projects such as OpenStreetMap, OpenAerialMap and Mapillary; the use of free software such as QGIS and of low-cost tools such as 360° cameras and drones for data capture in the field (see fig. 13). Acting in a context in which resources are chronically limited, these methodologies are based on the idea of promoting collective, collaborative and cumulative work. All data produced by CIDi are publicly available. In addition, the methods and sources used to produce data and analysis are also publicly accessible, allowing the empowerment of communities and transparent processes of continuous improvement





**Fig. 12:** Consultancy for the diagnosis of the water, sanitation and hygiene situation in informal settlements in the metropolitan area of Asunción (2022). Source: DAPSAN, TECHO Paraguay and CIDI FADA-UNA, 2023.

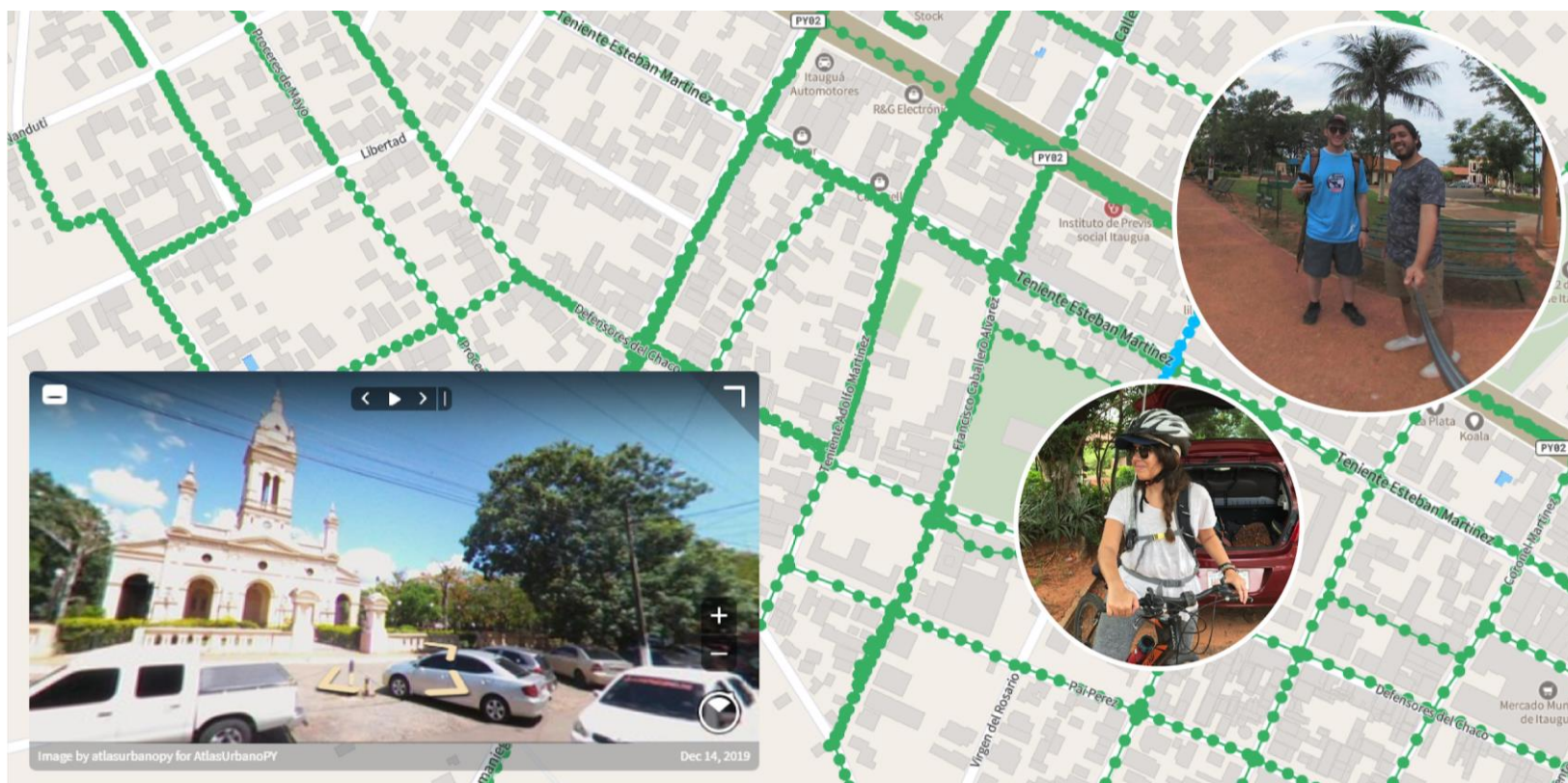


Fig. 13: Campaigns of photomapping for the survey of urban areas. Source: prepared by the authors, 2023.

### 3.3.2 Implications

The social and political implications of mass-producing geospatial data through collaborative work and using FOSS tools are multiple:

(i) It transforms a radically opaque society into one that has a relatively richer information ecosystem, enabling greater transparency. This in turn provides the opportunity to reduce corruption and make rational, evidence-based decisions. The accumulation of data also makes it possible to move from processes of register and description to processes of analysis, critical reflection and prospective-projective studies.

(ii) Collaborative work and FOSS tools imply that mapping priorities are not defined from any single political-institutional panopticon, but rather that communities, academics and local governments have the capacity to promote their own mapping agendas and share their data and methods.

(iii) The use of FOSS tools makes it possible to reduce the digital and technological gap between the countries of the Global North and those of the Global South. In addition, by designing methodologies that are based exclusively on free software and open source tools, the cost barrier practically disappears, and is replaced by a technical capacity barrier that can be overcome with training processes.

(iv) Finally, there is the issue of building a society that progressively has more people with the capacity to produce and use data for their own purposes. Ultimately, this is the aspect that has the greatest potential to subvert historical asymmetries: the more people are able to produce maps "from the inside", the less obliged Paraguay will be to assume the narratives and descriptions that have been made "from the outside". A society that has the capacity to represent itself is exercising its capacity to imagine and understand itself in space, without depending on other actors.

## 4 Conclusions

This work has provided a contribution to the decolonial debate through (i) an analysis of the historical territorial evolution of Paraguay through its cartographies, (ii) the discussion of the contemporary cartographic capacities of the country and (iii) the reflection on cartographic practices developed by the authors in Paraguay, practices based on the use of FOSS GIS tools, discussing their political and social implications.

In this sense, the text seeks to establish a dialogue with the work of authors such as Maluly, Gil and Grava (2023) who state: "(...) we aspire to rescue the existing relationship between geography and history, not in the form of a regression, but of an enrichment in the use of techniques" (p. 62). In this sense, the present work provides a contribution to the scientific literature that discusses the links between cartography, colonialism and decolonization (Craib, 2017; Dym, 2017; Moraes et al., 2021; Maluly, Gil & Grava, 2023) by emphasizing the role of FOSS GIS tools, as a potential means of contributing positively to the inclusion of excluded social sectors and to the democratic management of the territory.

In the first section of the paper we have deepened our reflection on the historical evolution of the Paraguayan territory through the iconographic and iconological analysis of seven pieces produced between 1809 and 2023. This analysis has elucidated that the production of a relevant part of the cartography on Paraguay is related to the geopolitical-military control of the territories and economic extractivism, whilst favoring the exclusion of native peoples and peasant communities.

It has been documented that in the case of Paraguay, "cartographies from outside" historically predominate, conceived and executed by imperial powers, military forces or technicians acting at the service of external economic interests. It has also been determined that "cartographies from outside" do not only characterize the colonial period, but continued to be produced in the independent period. In fact, the maps that were used for the massive privatization of the Chaco territories and the yerbales of the Alto Paraná, after the end of the War of the Triple Alliance, were produced in the independent period of Paraguay as a Republic (i.e., after 1811). In spite of this, they were made as instruments that made possible the action of international interests, guiding ways of occupying the territory and exploiting natural resources. The social and economic implications of these cartographies continue to be felt by peasant and indigenous communities in contemporary Paraguay.

It is postulated that "cartographies from outside" share some characteristics: (i) they distort what is portrayed by the distance (geographical and cultural) between the map producer and the mapped territory and its inhabitants; and (ii) they produce abstractions of the territory that simplify, reduce or directly eliminate ecological-geographical features and the original inhabitants in order to make way for new rights and new occupants who derive their legitimacy from metanarratives such as imperial power, the Christian need to evangelize, the notion of private property, or the social value of modernizing the barbaric void of the jungle and nature.

The work has not stopped at historical reflection. In the second section, based on interviews with key actors, progress has been made in understanding the challenges faced by contemporary Paraguayan society in order to produce "cartographies from within". Cartographies from within" are defined in this work as those that help citizens and institutions that inhabit a territory to make rational, sustainable and democratic decisions about it.

The four key actors interviewed are technicians of institutions working in the area of geospatial data. Through their statements, we have obtained indications that Paraguay, even today, has a precarious capacity to represent itself in geospatial data. These limitations refer to the difficulty of producing data but, even more, to the inability to articulate efforts between institutions. The interviews also indicate that basic pillars of a contemporary and accurate cartographic infrastructure are absent (the active geodetic network, the SDI and the national metadata standard). Finally, the interviewees pointed out that more human resources trained in the use of GIS tools are needed in the public sector.

From the analysis of the cartographic pieces and the results of the interviews carried out in the first and second sections, another indirectly revealed absence can be glimpsed: that of a State that works systematically and in an organized manner to know its territory, with a view to increasing its management capacity.

The third section discusses experiences on GIS - FOSS in Paraguay and their social and political implications. The intention is to reflect on cartographic practices promoted from CIDI, and to evaluate how they can contribute to bridge the historical gaps presented in the first two sections. It is postulated here that from the academy it is possible to promote new pedagogical, research and methodological development processes that make possible the production of "cartographies from within". It is proposed that these methods are to be based on FOSS tools, to enable a collective, collaborative and cumulative work of data production and cartography, suitable for contexts of limited resources.

It is proposed that under these parameters of free use of technological tools and collaborative work it is possible to produce high quality cartography at low cost, oriented to civil multipurpose use. These expanded capacities to represent the territory constitute a condition that, although not sufficient, is necessary to improve the sustainable and democratic governance of the territories.

Finally, the paper concludes that FOSS GIS tools result in potentially positive social and political implications, which are summarized here: (i) moving from a radically opaque society to a society that has a relatively richer information ecosystem and consequently, that allows for greater transparency (ii) the agenda of what is mapped, is not defined from any single political - institutional panopticon (iii) the use of FOSS tools, implies a strategic option of reducing the digital and technological gap between the countries of the Global North and those of the Global South (iv) to build a society that progressively, has more people with the ability to produce and use data for their own purposes.

### Acknowledgments

This article would not have been possible without the contribution of CIDI colleagues. Diego Bernal, Sol Cáceres, Eliana Gomez, Paloma Rodríguez and Tomás Lopez, who conducted the interviews with Jorge Acuña from PTI and Lucía Fariña from Universidad del Pacífico, in the context of their Final Degree Projects. Additionally, we would like to express our gratitude to Architect Julia Oporto, who conducted the interview with Andrés Ramírez, from INE. Finally, we would like to highlight that the interview with Lorenzo Alfonso and Fátima Giménez, from SNC was conducted within the framework of the Project "Transformations of the Riverfront of Asunción and the Metropolitan Area", which was financed by the National Council of Science and Technology (CONACYT) of Paraguay.

### References

Arévalos, S., Bernal, D., Cáceres, S., Gómez, E., Rodríguez, P., & López, T. (2020). Entrevista a profesionales de la cartografía: Jorge Acuña y Lucía Fariña. En *Modelo de Atlas Urbano replicable a partir del estudio en el municipio de San José de los Arroyos. Elaboración de un modelo de Atlas Urbano aplicable a distintos municipios del Paraguay, a partir del desarrollo de estudios específicos en municipios pertenecientes a la región funcional urbano territorial de la Ruta Nacional PY02* [Trabajo de fin de grado]. Facultad de Arquitectura, Diseño y Arte. Universidad Nacional de Asunción.

Alcaráz, A. (2019). El liderazgo carismático empresarial enfrentado al poder burocrático del Estado: el conflicto por los yerbales entre la empresa Domingo Barthe y el gobernador Juan José Lanusse (1896-1905). *Antíteses*, 12(23), 466-486.

Alfonso, L., & Giménez F. (02 de julio de 2021). *Entrevista a actores gubernamentales*. Servicio Nacional de Catastro. Universidad Nacional de Asunción.

Ashworth, W. (2022). *Scientist of the day: Ernest Mouchez*. Linda Hall Library. <https://www.lindahall.org/about/news/scientist-of-the-day/ernest-mouchez>.

Beddall, B. (1975). Un Naturalista Original: Don Félix de Azara, 1746-1821. *Journal of the History of Biology*, 8(1), 15–66. <http://www.jstor.org/stable/4330623>

Bobrik, G. (2007). Enclaves insulares en ríos internacionales. El caso de los ríos Uruguay, Paraná y Paraguay. *Aequitas*.

Caballero Campos, H. (2017). En los Confines del Paraguay: el último intento para fijar un límite definitivo entre España y Portugal en 1802. *Anais Do V Seminário "Leituras de Fronteiras,"* 01. <https://www.mre.gov.py/index.php/cndl/articulos-de-opinion-en-cuestion-los-limites>.

Capdevila Subirana, J. (2004). Infraestructura de datos espaciales (IDE). Definición y desarrollo actual en España. *Scripta Nova. Revista Electrónica de Geografía y Ciencias Sociales. Universidad de Barcelona, VIII(170)*, 61. <https://www.ub.edu/geocrit/sn/sn-170-61.htm>.

Centro Latinoamericano y Caribeño de Demografía (CELADE) y Comisión Económica para América Latina y el Caribe (CEPAL) (2014). *Los pueblos indígenas en América Latina. Avances en el último decenio y retos pendientes para la garantía de sus derechos*. CELADE. [https://repositorio.cepal.org/bitstream/handle/11362/37222/1/S1420521\\_es.pdf](https://repositorio.cepal.org/bitstream/handle/11362/37222/1/S1420521_es.pdf).

Costa, M. (2009). Viajes en la frontera colonial. Historias de una expedición de límites en la América Meridional (1753-1754). *Anales Del Museo de América*, 16.

Costantini, F. (2007). Itaipú y Yacyretá como entidades, sociedades o corporaciones públicas internacionales. *Revista Jurídica (CEDUC)*, 16. <https://py.lejister.com/pop.php?option=articulo&Hash=8ac127cdbe856b14f7cc9c663a56ab90>.

Craib, R. B. (2017). Chapter 1. Cartography and Decolonization. En J. R. Akerman (Ed.), *Decolonizing the Map*. University of Chicago Press.

Cristaldo, J. (2013). *Continental Hub: A Prospective Reflection Upon Infrastructure, Energy and Territorial Transformations at the Triple Frontier* [Tesis de maestría]. Harvard Graduate School of Design.

Cristaldo, J. C., Britez, G., Ganchozo, L., Peroni, M. B., Spitale, S., Bernal, N., Lezcano, A., León, G., Larroza, J., & Rodríguez, L. (2021). Entrevistas a la Secretaría Nacional de Catastro (SNC) - Actor Gubernamental. Lorenzo Alfonso y Fátima Giménez. En *Informe consolidado de la investigación PINV 18-1489. Transformaciones territoriales en el frente fluvial de Asunción y su Área Metropolitana* (p. 94).

Cristaldo, J. C. (2022). Hacia una cartografía postcolonial basada en software libre para Paraguay y países del Sur Global. Notas sobre cómo y por qué estamos mapeando un país entero con los proyectos MapPyOSM y Atlas Urbano Py. En C. Llop (Ed.), *Cuestiones impostergables para la agenda. Plan/Proyecto/Gestión de nuestros territorios Contemporáneos* (p. 127). <https://mdut.duot.upc.edu/publicacion-cuestiones-impostergables-para-la-agenda-plan-proyecto-gestion-territorios-contemporaneos/>.

Dalla-Corte, G. (2012). *Empresas y tierras de Carlos Casado en el Chaco Paraguayo. Historia, negocios y guerras (1860-1940)*.

Denzin, N. (2009). *The Research Act: A Theoretical Introduction to Sociological Methods*. Routledge. <https://doi.org/10.4324/9781315134543>.

Dirección de Agua Potable y Saneamiento (DAPSAN), TECHO Paraguay y Centro de Investigación, Desarrollo e Innovación de la Facultad de Arquitectura, Diseño y Arte de la Universidad Nacional de Asunción (CIDi FADA UNA). (2023). *Consultoría para la elaboración del diagnóstico de la situación de la prestación de los servicios de agua, saneamiento e higiene en los asentamientos informales del Área Metropolitana de Asunción*.

Dirección del Servicio Geográfico Militar (DISERGEMIL) (s.f.). *Reseña histórica*. DISERGEMIL. <https://www.disergemil.mil.py/>.

Dirección del Servicio Geográfico Militar (DISERGEMIL) y Departamento de Defensa de los Estados Unidos (USDOD) (1970). *Mapa de Asunción*. DISERGEMIL.

Dym, J. (2017). Chapter 4. Democratizing the Map: The Geo-body and National Cartography in Guatemala, 1821– 2010. En J. R. Akerman (Ed.), *Decolonizing the Map*. University of Chicago Press.

Echeverría, D. (2013). *La frontera argentino-paraguaya en la línea del Pilcomayo: cotidianeidad, coexistencia y conflictos durante la etapa territorialiana de Formosa (1884-1955)*. [Tesis doctoral]. Universidad del Salvador - Facultad de historia y letras. Ciudad Autónoma de Buenos Aires, Argentina. [https://racimo.usal.edu.ar/2633/1/P%C3%A1ginas\\_desde500017077\\_-\\_La\\_frontera\\_argentino-paraguaya.pdf](https://racimo.usal.edu.ar/2633/1/P%C3%A1ginas_desde500017077_-_La_frontera_argentino-paraguaya.pdf).

Flecha, J. (2011). Las ventas de las tierras públicas, 1883-1885|Tetã yvyeta jehepyme'ë, 1883-1885. Secretaría Nacional de Cultura. Archivo Nacional. <http://www.cultura.gov.py/2011/05/las-ventas-de-las-tierras-publicas-1883-1885/>.

Glick, T. F., & Quinlan, D. M. (1975). Félix de Azara: the Myth of the Isolated Genius in Spanish Science. *Journal of the History of Biology*, 8(1), 67–83. Recuperado de: <http://www.jstor.org/stable/4330624>.

Guereña, A., & Rojas Villagra, L. (2016). *Yvy Jára. Los dueños de la tierra en Paraguay*. OXFAM. <https://www.oxfam.org/es/informes/paraguay-informe-de-distribucion-de-la-tierra>.

Instituto Nacional de Estadística y Geografía del Gobierno Mexicano (INEGI) (2017). *Red Geodésica Nacional Activa*. INEGI. [http://www3.inegi.org.mx/contenidos/temas/mapas/geodesia/metadatos/red\\_geodesica\\_nacional\\_activa.pdf](http://www3.inegi.org.mx/contenidos/temas/mapas/geodesia/metadatos/red_geodesica_nacional_activa.pdf).

Instituto de Biotecnología Agrícola (INBIO) (2019). *Informe de zafra del 2018 al 2019. Soja, arroz y maíz*. <https://www.inbio.org.py/superficies-de-siembra/>.

Instituto de Biotecnología Agrícola (INBIO) (2023a). *Acerca de*. INBIO. <https://www.inbio.org.py>.

Instituto de Biotecnología Agrícola (INBIO) (2023b). *Informe de zafra del 2022 al 2023. Soja, arroz y maíz*. INBIO. <https://www.inbio.org.py/superficies-de-siembra/>.

Instituto Nacional de Estadística (INE) (2012). *Cartografía censal 2012*.

López Decoud, A. (1911). *Álbum gráfico de la República del Paraguay (1811 - 1911)*. Archive.org. <https://archive.org/details/albumgraficodela00lope/page/n445/mode/2up>.

Maluly, V., Gil, T., & Grava, M. (2023). Do historical GIS and digital humanities walk hand in hand? *Cartographica: The International Journal for Geographic Information and Geovisualization*, 58(2), 59–63. <https://doi.org/10.3138/cart-2023-0005>.

Melià, B. (2011). *El Decreto del 7 de octubre de 1848 del Presidente Carlos Antonio López*. Secretaría Nacional de Cultura. <http://www.cultura.gov.py/2011/05/el-decreto-del-7-de-octubre-de-1848-del-presidente-carlos-antonio-lopez/>.

Mendibl-Zurita, A. (2010). El rey portugués en Brasil y el surgimiento del país del futuro. *Tiempo y Espacio*, 20(53), 047-059. [http://ve.scielo.org/scielo.php?script=sci\\_arttext&pid=S1315-94962010000100004&lng=es&tlng=es](http://ve.scielo.org/scielo.php?script=sci_arttext&pid=S1315-94962010000100004&lng=es&tlng=es).

Moraes, L., Carvalho, C., Rendeiro, M., & Gil, T. (2021). Eliminando manchas brancas. *História Da Historiografia*, 14(37), 17–61. <https://doi.org/10.15848/hh.v14i37.1686>.

Pensa, L. (2021). El retorno a lo visual en el estudio de documentos cartográficos: análisis de un plano para la gobernación de Paraguay a mediados del siglo XVII. *Fronteras de La Historia*, 26(1), 38–60. <https://doi.org/10.22380/20274688.1237>.

Ramírez, A. (07 de octubre de 2021). *Entrevista a actores gubernamentales*. Instituto Nacional de Estadística. Universidad Nacional de Asunción.

Rivarola, M. (2021). *Imagoteca Paraguaya*. Acervo de Milda Rivarola. <https://imagoteca.com.py/>.

Rivarola, M. y Spatuzza C. (2011). *Memoria cartográfica del Paraguay: desde la Colonia hasta nuestros días*. Organización de las Naciones Unidas y Banco Itaú.

Roa Bastos, A. (1974). *Yo el Supremo*. Servilibro. <https://www.etp.com.py/libro/yo-el-supremo-67574.html>.

Rumsey, D. & Cartography Associates (2002). *David Rumsey map collection*. David Rumsey. <https://www.davidrumsey.com/>.

Oporto, J. (2023). Entrevista a profesionales de la cartografía en Paraguay. Andrés Ramírez. Director de Geoinformación Estadística e Infraestructura de Datos del Instituto Nacional de Estadísticas del Paraguay. En *Atlas Urbano de los municipios de José Domingo Ocampos y Juan E. O'Leary. Contribuciones desde el Centro de Investigación, Desarrollo e Innovación a la cultura cartográfica en Paraguay con software libre* [Trabajo de fin de grado]. Facultad de Arquitectura, Diseño y Arte. Universidad Nacional de Asunción.

Whigham, T. (1991). *La yerba mate del Paraguay (1780-1870)*. Centro Paraguayo de Estudios Sociológicos. [https://www.portalguarani.com/833\\_thomas\\_l\\_whigham/9202\\_la\\_yerba\\_mate\\_del\\_paraguay\\_1780\\_1870\\_obra\\_de\\_thomas\\_whigham\\_ano\\_1991.html](https://www.portalguarani.com/833_thomas_l_whigham/9202_la_yerba_mate_del_paraguay_1780_1870_obra_de_thomas_whigham_ano_1991.html).