Digital Atlas of Portuguese America

Tiago Luís Gil[*], Leonardo Barleta[‡]

[*] University of Brasilia, Brazil.

`tiagoluisgil@gmail.com`

[‡] Stanford University, USA

`lbarleta@stanford.edu`

Abstract

This paper presents the Digital Atlas of Portuguese America (Atlas Digital da América Portuguesa), a project that produces an interactive map of South America claimed by the Portuguese between 1500 and 1808, giving a detailed account on the development and structure of this digital cartographic platform. The paper narrates the stages that the project went through and details the structure of integrated tools as well as the process of gathering, organization, and production of the data made available through the Digital Atlas. The main topics include the customizations made in the GIS web-platform i3geo to include time as a central variable, the implementation of the data gathering tool Oduduwa, and the main corpuses of primary sources utilized in the project.

1 Introduction

The Digital Atlas of Portuguese America (Atlas Digital da América Portuguesa) is an interactive map of the American continent which was claimed and occupied by the Portuguese between 1500 and 1808. The Atlas brings together diverse geographic information about Portuguese America, including cities, towns, roads, urban plants, economic resources, and political features. It works as an online system, a "Google Maps" of colonial Brazil, providing important tools for historical research on space and territory. Using and extending the software i3geo (developed by the geographer Edmar Moretti) to meet the needs of the project, the Digital Atlas allows the user to select a period of time – a year or a decade, for example – and specific regions to see the shape of Brazilian space in the past. Visualization can be done in different scales, encompassing different types of geographic data, which range from streets of specific towns to the entire set of Portuguese settlements in the Americas. Moreover, a selection of geographic and statistical analyses is available to refine the analysis.

The project follows a long-standing tradition in historical scholarship regarding the use of maps to produce a narrative, to explain events and structures, and to trace spatial correlations amongst political, social, and cultural phenomena in the past. This practice, epitomized by a plethora of existing historical atlases (e.g., Duby, 2013), intends to establish the chronology of events of a historical epoch in a cartographic medium and trace the connections between time and space, events and geography. Portuguese America, for instance, is the topic of a few of these atlases, usually under the geographic macro-region of Latin America or the national boundaries of modern Brazil (Wilgus, 1969; LaRosa and Germán, 2007; Albuquerque and Campos, 1966). Regional atlases and general historical works, which seldom do not contain a map, also complement a significant corpus of cartographic information about Portuguese America (Fundação João Pinheiro, 1997; Westphalen and Cardoso, 1982). These

works produced a massive amount of geographic data about Portuguese America although, due to the medium of publication, the printed page, it remained fragmentary and dispersed.

In recent years, however, this restriction has become less important once the adoption of digital tools in humanities and social sciences expanded the limits of the physical paper. Atlases are among the types of projects that most benefited from change, since technology reduced the time and costs of production, substantially increased the quality of produced materials, and made the skills related to the cartographic practice more accessible. Consequently, many new projects flourished. A successful initiative, for instance, is the Digital Atlas of Roman and Medieval Civilizations (DARMC), which creates an interactive interface of the ancient and medieval societies, highlighting villages, cities, monasteries, cemeteries and other important places in the period under analysis. (McCormick et al.) Another original project is Mapping Gothic France, which combines Historical GIS, and architecture. It displays the spatial distribution and traces the chronology of Gothic buildings in Europe, especially churches and monasteries, allowing comparisons about the disposition and shape of the main churches and monasteries (Murray et al.). Finally, another example is a British project called Medieval Chester, which explores the urban landscape of the town between 1200 and 1500. (Clarke)

Each project, it is worth noting, has its particular scale and approaches the relation between time and space differently. The DARMC, for instance, underscores structural movement by adopting a small-scale cartography (that is, viewing from afar) and large geographic units (Roman and Medieval civilizations). On the other hand, Medieval Chester quite precisely depicts the urban topography of a late medieval town, but neglects the changes over time of that spatial setting. The detail of the space is deepened in Gothic France, which uses the spatial distribution of buildings to explore the differences in architecture by transitioning between maps to photographs. In this sense, by combining the same toolset, each project highlights (as much as hides) and constructs (or allows the user to by himself) the argument and story of the space under study.

The Digital Atlas of Portuguese America intends to follow and expand the intersection between history, geography, and computing. It is composed of three main elements that work together as an integrated geographic information system (GIS). It includes a management tool of geographic data (Oduduwa), a representation and analysis tool (i3geo – Iroko) and a virtual encyclopedia (BiblioAtlas). Oduduwa was created by our team and can process geo-referenced historical information (that is, those with coordinates), storing them in a geographic relational database. The geographic data handled by the database encompasses different types of geometries such as points, lines, and polygons, as well as a set of attributes and metadata about the feature (e.g., dates, authors, sources, classifications) composing a repository for the visualization tool and the encyclopedia.
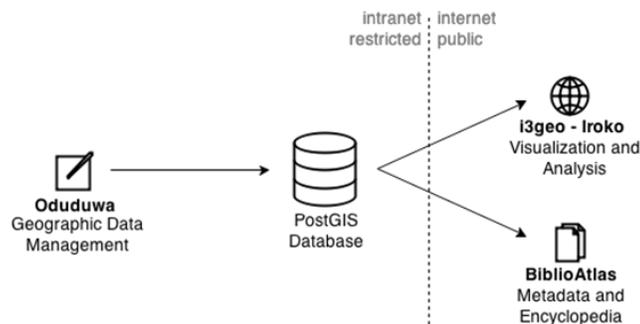

Figure 1: Basic scheme of the "Digital Atlas of Portuguese America"

The digital map – the central part of the project – automatically presents the geographic features stored in the database, using their coordinates to draw objects on the cartographic plane. The software i3geo, used to plot the interactive map, was adapted (in partnership with its creator) to include time as a key of analysis, leading to the creation of an extension named Iroko. The extension adds to the original package a series of tools to fetch the data based on specific dates or periods of time. For instance, it is possible to define an interval of dates and see the places that existed during that period, or to observe how a portion of the territory looked in a particular period. Iroko also extends the original software to include other functions related to the past, such as measurements in contemporary units (e.g., leagues or days of travel). In short, it works as a module to turn a GIS system into a historical tool. (Gregory and Ell, 2007)

The third part, BiblioAtlas, is the gateway of the Digital Atlas that leads the users to the other resources of the project. It consists of an online encyclopedia, based on MediaWiki system (the same as "Wikipedia"), that manages textual information such as short articles and encyclopedia entries. These entries tell the history of the places represented on the digital map. While producing the geographic information, the research team collects historical information about each site plotted on the interactive map, and uses it later to create a written complement to the spatial data. In this sense, points, lines, and polygons from the interactive map acquire meanings that are close to the traditional historical narrative. BiblioAtlas also works in an integrated form with i3geo and is a space for the publication of the metadata of the project.

The Digital Atlas collects, produces, and publishes geo-referenced historical information gathered form several primary and secondary sources in order to create a digital cartography that locates places, events, and processes between 1500 and 1808 in the area of the American continent claimed by Portugal in the early modern period. The project started in 2009, but the first public version was launched online only in 2011. The enterprise was originally developed by the Social History Lab ("Laboratório de História Social") at the University of Brasilia, but has become a collective experience involving researchers from other institutions in Brazil and Portugal. More than an atlas in the strict meaning of the word (i.e., a set of maps), the main objective of the project is to create a collaborative platform for the exchange of data and knowledge of the space of Portuguese America. On one hand, it gathers together in a single platform data produced by several researches on a variety of topics; on the other, it creates a common environment for a shared production of historical knowledge. So far, the project counts on more than 9,000 geographic features and more than 7,000 encyclopedia entries. Created by different researchers who share the common objective of including geographic space as a vector of analysis in their work, the Digital Atlas aims to be a departure point and a platform for many investigations in historical studies about Portuguese America. In this sense, it is a product of the so-called Web 2.0: interactive and collaborative.

The structure and data presented is this article were the result of a long process of research and implementation. The version 1.0 of the Digital Atlas, released in August 2011, only showed towns and parishes of Portuguese America. Since then we have been working to include more specific information, such as districts, farms and ranches, urban maps, boundaries and frontiers, routes, historical processes and events, and demographic and statistical data. Similarly, the technological structure presented above is also a result of the development of the project over the last five years, which is related to issues of availability of sources, resources, and expertise. To understand the project, therefore, it is important to look at the choices we made since its inception.

2 The creation of the Digital Atlas: defining scope, sources, and technology

How does one start building a digital atlas? And how do theories and methods shape the development of the project? There was no cartography sufficiently complete or regular that we could base the project on. To define the scope of the project, then, we needed to have a better idea of the whole picture of the spatial configuration of Portuguese America. The first choice was to look at the basic units of Portuguese settlements: the towns, plotting them in space and time and tracing their histories[1]. The alternative path, more usual than the one we took, was to look at the captaincies, the "provincial" units under the rule of colonial governors. The problem was that they changed significantly over time. We would run the risk of projecting the current political formation of Brazil to that period, as many did before. (e.g. Schwartz, 1996: 70) Towns represented as points, on the other hand, seemed to be a more stable unit of analysis to begin with.

A comprehensive list of the towns, however, was inexistent for the colonial era forcing us to adopt an arbitrary methodological procedure. As the starting point, we used an 1872 list of locations in Brazil, composed as a sub-product of the first national census, made available by the Brazilian Institute of Geography and Statistics (IBGE). This source was a complete list of towns and cities in 1872, with the population and the region of each one. List in hand, we searched for each location's history, also compiled by IBGE in a project called The Brazilian Territorial Division[2]. Although this procedure had its problems, notably in a retrospective approach that can be potentially anachronistic, it was very fruitful because it gave us a homogenous picture of the territorial configuration of Portuguese America. There are no historical maps that covered the entire region in detail, not even chronological or chorographic information, let alone demographic sources or lists of villages[3]. With this procedure, then, we could comprehensively survey the territory in search for clues that would be compared with other sources in the future[4].

The work with the list of 1872 resulted in a new list of locations that existed in 1808, the end-point of the project. The list was geo-referenced and added to a database that classified what each location was at each moment in its history: a settlement, a parish, a town, a farm. Although this retrospective approach overlooks places that vanished before 1872 and tends to lose track of those whose names changed, it was possible to produce a comprehensive list of the locations in Portuguese America. This initial list, however, is constantly updated and corrected by our staff, by comparing data with several primary sources and secondary literature.

Besides the initial list, we collected a large amount of historical maps that were scattered throughout several archives in Brazil and Europe – including the National Library in Rio de Janeiro, Army Historical Archive in Brasilia, and Overseas Historical Archive in Lisbon – composing a collection of more than 1400 maps stored in

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[1] We noted that many places had a similar history: they started as an unstable settlement (a mining camp, a farm), followed by the creation of religious institutions (a chapel, and later, a parish) and finally became towns with their own municipal institutions. (Fonseca, 2011) It is worth noting that there is a long historiographical tradition arguing that the municipality (represented by its town council) is the central institution of the Portuguese domains. (Boxer, 1991; Boxer, 1965; Bicalho 2001)

[2] IBGE Cidades. http://www.ibge.gov.br/cidadesat.

[3] Even the first map that presents the Brazilian territory in its entirety, the *Mapa das Cortes*, which was used in the diplomatic territorial disputes between Portugal and Spain in the middle of the eighteenth century, neglects many important locations in Portuguese America.

[4] It is important to bear in mind that the actual configuration of the Brazilian territory is far from resembling the colonial area. The expansion into the backlands became consistent only after the mid-seventeenth century and notably the eighteenth century.

digital media. The collection encompasses a wide variety of cartographic material covering specific regions of the Portuguese America, and using different techniques, scales, and levels of detail. They constitute, thus, a mosaic of regional and local maps. Each of them was included in a separate database, after a systematical analysis about its authorship and publication information, visual language, and geographic data. The database consists of the following field structure:

Metadata	Title of work
	Authorship
	Data
	Language
	Subject
	Scale
	Projection
	Size
	Colors
	Reference
Geographic Elements	Points, lines, and polygons in map (to list)
	Mentioned places (to list all)
	Main space frame of map
	Morphology description and contents of map
	Descriptive memorial of the analysis
Authorship and Technical details	Author (s)
	Author's biography
	Birth and death dates
	Style and techniques
	Activity
	Studies
	Licenses
	Used sources

Table1: Structure of the database

The work was performed as in an "assembly line," which main objective is to train the research assistants in the interpretation of historical maps and produce information that could be useful to find points, lines and polygons. The team, mostly composed of history undergraduates, was not familiar with this kind of source and, to ensure quality and methodological rigor, we created a supervised production system. Each member of the team had controlled access to a "working tray" with maps recommended by the coordinator. They analyzed each map individually, following a series of pre-defined steps, and submitted a standardized report for each cartographic piece. The steps include the identification of the places named on the map, the analysis of the cartographic conventions and techniques (scales, projections, perspective, and symbols), identification of the artistic style, and a brief research about the author. The supervisor, then, could check each report, pointing out inaccuracies and other issues for revision, and approve the entry (after corrections, if necessary). Besides providing data about the locations, the analyses of the historical maps resulted in a reliable source of information about maps, cartography and cartography techniques.

This database supported (and supports) the next stage of the project, comparing the list of places that we created based on the 1872 list with the historical cartography. This is an ongoing process, repeated with every new entry in the Digital Atlas, which intends to improve the accuracy of the information. When we get new information about a location, we check its accuracy against the data produced by contemporary cartographers. Additionally, this database helped us to find places that disappeared over time – for example, those that became depopulated or destroyed to build dams – and those that are not very well-known in the records of current historiography.
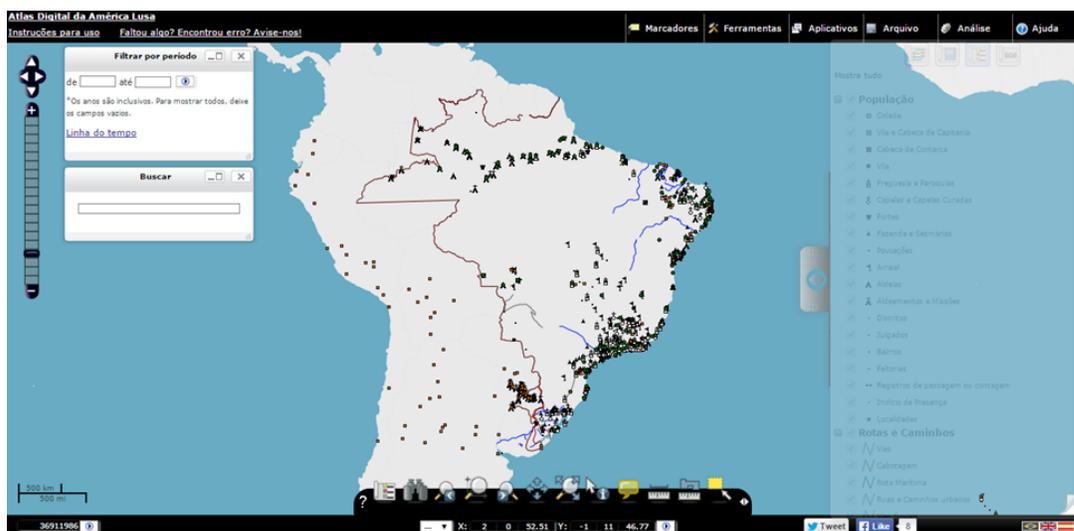

Figure 2 – The "Digital Atlas of Portuguese America" operating under the software i3geo

At this point, we had data for cities, towns, and main parishes in Portuguese America; the next problem was how to make it available to the public. We were considering a tool that, on the technical side, was scalable and flexible enough to allow customizations and large datasets and, on the user's side, encompass the main characteristics of the modern geographic information platforms, notably a high level of interaction (multi-scale, complex hierarchy of data, measurements, and customization of the visualization) and a potential for visual and statistical analysis. For this project it was particularly important that the platform be able to deal smoothly with data, such as Google Maps, in different scales – from the urban plan of a city right up to the continental level – since external sources varied immensely in this aspect. Furthermore, as a historiographical project, the necessity of including time (or temporal

scales) in the processes of fetching and displaying information was a crucial matter. Although this requirement is rarely available in standard GIS packages, we needed, at least, to be able to extend and customize the platform to our own needs.

After surveying the available tools in the market, we opted for the i3geo system, produced by the geographer Edmar Moretti, which met most of our requirements. Moreover, the direct contact with the developer also favored our choice and, in the long term, proved to be essential to the success of the project. According to the author:

i3geo is an internet software based on a set of other free softwares, mainly Mapserver. The main objective is to facilitate the availability of geographic data and a set of navigational tools, the generation of analysis, and the sharing and generation of maps upon demand (Wendt and Barreto, 2013).

The next step, after choosing a tool to display the data, was to deal with its management – that is, its creation, continual editing, and storage. As the standard format of the industry, GIS users are usually comfortable with shapefiles, vector-based geographic files that compose a layer of a specific type of data (point, line, or polygon). At first, they seemed the natural choice for the project, and some unproductive experiments were done with them. In general, shapefiles are very static (it is a single file with a delimited amount of data) and unsuited to deal with the complexity and ambiguity of historical data[5]. They became a problem when we had to divide the geographic features into different categories in order to organize the visualization of the final digital map. It turned out to be very difficult to accurately define in which "box" each feature should fit. For example, a mining camp (arraial) was at the same time a population unit (where people live) and an economic unit (where people work). It could also have a small chapel (making it a religious unit) or be the stage of an armed conflict (the place of an event). This complex historical information, therefore, could hardly fit into the shapefile structure of attributed fields. Redundancy of data, resources, performance, and maintenance issues would become huge hindrances for the development of the project.

We needed an additional solution to the use of shapefiles that would enable us add historical information to the geographic features plotted in the map, but that was still simple enough to be the subject of an "automatic" processing. We adopted a "labeling system," which does not prescribe inherent attributes to a certain geographic feature. Instead, we could add a handful of tags to the same geographic element, indicating the roles of the object in different contexts. For instance, the mining camp could be labeled as a "population unit" but also, in economic terms, as a unit of production or a site of free or slave labor; it could also be a Catholic center of devotion, and a place where religious festivities take place. All of the categories are attached to a particular point, line, or polygon in the map, without changing the database entry for the geographic feature or having limitations of quantity. Consequently, this system allowed a same feature to appear in many different contexts, scales, and filters, originating diverse visualizations.

In technical terms, the labeling system was developed using a relational database that supported geographic features (such as a field) – PostgreSQL with PostGIS extension. This database setting, however, required an extensive knowledge of SQL, a specific language to manipulate certain types of databases, that was not available in the toolset of the research assistants of the project. Furthermore, even if we could train the team to use the language, it direct use is very little practical in most of the cases. As a solution, we conceived and implemented a new software called Oduduwa.

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5 For instance, Anne K. Knowles (Knowles, 2002; Knowles and Hillier, 2008) published two collections of articles written by the historian using this technology.

Oduduwa was conceived as a practical and versatile solution for most problems of data management in the Digital Atlas. It is a web-based system developed in PHP that creates a friendly interface to include and manage geographic data based on coordinates (filled in as a web form) or KML files, transforming every spatial feature into a standardized database entry. These records, then, could be fetched in many different ways – mainly by region, time, and classification. This is the main information Oduduwa handles:

	Type of data (Point, Line, Polygon)
	Geographic Feature (WKT syntax)
Historic-Geographic Data	Creation date of the site (cities, towns, etc.)
(Time-Spatial Data)	Extinction of the site
	Classifications (many)
	(Historical and Modern) Name of the Place
Attribute Data	Precision of the information
	Method used to create the data (historical maps, written sources, etc.)
	Author of the research
	Author of the database entry
Metadata	Date and time of creation and edition
	Sources used in the research

Table 2: Types of information collected

Having set up Oduduwa, we revisited the data that we had gathered in previous steps to publish in the Digital Atlas. The main goal was to establish a methodological procedure to define place, time, and classification of each piece of geographic information we had. Based on our previous experience, we adopted two different methods. The "historical-textual method" draws on traditional historical sources like travelogues, official acts, or even visual representations, from which we gather the basic characteristics (name, date, classifications) of a geographic feature. We combined this information with that which we had in the list of places and in the historical map databases. Once we had sufficient information about the location, we used modern satellite imagery (usually Google Earth) to find the geographic coordinates of the place. For example, we would make a small research about a church (possibly a parish seat) and look at Google Earth for the geographic coordinates of its location. In the other method, "geo-referencing," we associate historical maps to a coordinate system and directly include the data by visually comparing it to a current map. Some "tricks" help to improve accuracy, like slicing the map into smaller pieces or correcting the position of the map by connecting to the locations in the map that we already know. This method was useful, for instance, to draw urban plans and roads. This second method, however, still needed a lot of historical information, sometimes considering changes in the locations of places or different statuses through time.

We obtained the geographic information mainly through Google Earth, which has proved to be a powerful and practical tool for several reasons. First, it allows searches by name of place (a non-existent feature in satellite maps available on other sites, such as Landsat). Second, it has intuitive tools for marking points and drawing lines and polygons in space. These features could be easily exported as KML (and open XML format for geographic data) and, using a functionality of Oduduwa, imported into our geographic database. Finally, an interesting advantage of

Google Earth is the possibility of using "crowdsourcing knowledge." Several people have spatially tagged photos of places they have already been to and indexed them with keywords, especially the names of places. In this way, as a result of contributions from anonymous people who sent their data to Google servers, we can obtain useful clues about places that are barely known to modern audiences, but which are available on the local level. Since there is no review process nor are the users experts in GIS or history, the degree of reliability of this information is considered extremely questionable by the team. Even so, when handled cautiously and using them as leads for further investigation, we have been able to make several findings that would have otherwise been impossible.

The project is presently in the stage of comparing primary sources with data obtained from lists produced based on the 1872 census. As we have indicated, cartographic sources have been the priority of the project until now. The following steps include the study of primary narratives (chronicles, serial sources, among others) and the critical assessment of data gathered from books, articles, and other publications. Similarly, the set of tools and resources of the project is under constant improvement, and new functionalities are expected to be available as the project advances. The "Digital Atlas", therefore, is a work in progress, based on constant updating, and with no end in sight.

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Biography of the authors

Tiago Gil is Associate Professor of Brazilian History in the Department of History at University of Brasilia, Brazil and coordinator of the Digital Atlas of Portuguese America. He holds a B.A. in History from Federal University of Rio Grande do Sul (2000) and M.A. (2003) and Ph.D. (2009) in Social History from the Federal University of Rio de Janeiro. He is the author of *Infiéis transgressores : elites e contrabandistas nas fronteiras do Rio Grande e do Rio Pardo, 1760-1810* (Arquivo Nacional, Brazil, 2007), which won the 2005 Research Prize of the Brazilian National Archive. He also authored "Storici e informatica: l'uso dei database (1968-2013)" *Memoria e ricerca*, n. 50, (Sep./Oct. 2015) and "Redes e camadas de relacionamentos na economia: metodologias para o estudo da confiança mercantil na América Portuguesa do Antigo Regime" *Revista de Indias*, vol. 75, n. 264 (2015), among other articles, chapters and books.

 Leonardo Barleta is a doctoral candidate in Latin American History at Stanford University and co-coordinator of the Digital Atlas of Portuguese America. He holds a B.A. (2010) and M.A. (2013) in History from Federal University of Parana. His ongoing dissertation investigates the territorial evolution and development of domestic markets in colonial Brazil.

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