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ORIGINAL ARTICLE

BUILDING A COLLABORATIVE ONLINE CATALOGUE OF GEOPORTALS IN BRAZIL

Construindo um Catálogo Colaborativo Online de Geoportais no Brasil

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Abstract:

It is currently possible to account for several institutions with geographic data shared through the INDE portal, with more than half of it being from federal jurisdiction. However, there are subnational geoportals not integrated with this infrastructure, which is difficult to quantify. Therefore, the research problem of this study is finding the state of subnational geographic viewers' availability, with the general objective of producing a Brazilian panorama and to identify factors that facilitate this availability. A research methodology based on different sources was applied in 27 states and 999 municipalities. As a result, we identified 17 regional, 82 state, and 274 municipal geoportals, with the highest concentration in the South and Southeast regions and lowest in the Northern region. In order to find factors related to geoportals availability, twenty characteristics of each municipality were collected, and Pearson coefficients were calculated, revealing significant correlations for population, economic and tax factors, and non-significant correlations for location factors. This acquired information is essential for the community and must be kept up to date. For this, an online collaborative map based on free software was created, allowing access without registration for data visualization and the registration of users for sending updates to the map.

Keywords: SDI; SDI Map; Local SDI; WebGIS; Geoportals.

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1. Introduction

The availability of data and services on the internet involving geographic resources has grown in recent years, such as the popularization of mobile phones with location services, the emergence of applications that consume or produce geospatial data, and Internet access by the population (IBGE 2018). This scenario of an abundance of geographic resources on the internet brings data management challenges since the decentralization of production can have side effects such as integrating resources, poor cataloguing and rework (CONCAR 2010).

Spatial Data Infrastructures (SDI) bring precisely the possibility of, through technology, better managing geographic resources, enabling their integration through the adoption of standards designed by the community, such as those of the Open Geospatial Consortium (OGC), and based on a legal framework, bringing benefits in promoting the economy, in environmental management and better governance (Rajabifard et al. 2000, Rajabifard, Chan and Williamson 1999, Williamsom, Rajabifard and Binns 2006).

Presidential Decree 6.666, of November 27, 2008, instituted the National Infrastructure of Spatial Data of Brazil (INDE), establishing the mandatory sharing of data and geospatial metadata by the agencies and entities of the federal executive power, leaving this action as facultative for the other governmental spheres of the executive (Brazil 2008).

In addition to this decree, in 2010, the National Cartography Commission (CONCAR), currently extinguished by decree 9759, of April 11, 2019 (Brazil 2019), prepared the Action Plan for the Implementation of INDE. It was an essential document to guide the implementation of the INDE portal, which today consists, among other elements, of a metadata and geoservices catalogue and a map viewer.

It is essential to highlight that this plan established implementation guidelines for ten years. The municipal level is defined as the last step of integration with the national infrastructure (CONCAR 2010), despite the importance and remarkable consumption and production of this government sphere's geographic data. Local-level geospatial data has diverse applications such as real estate registration, urban planning and urban control.

The viewer of the INDE portal integrates data from several institutions. It is currently possible to count shared data from 32 institutions, of which 20 are from the federal sphere, 9 from the state sphere, 2 from the municipal sphere and 1 academic. There are also 48 listed institutions with catalogue metadata, 29 of them (20 national, 5 state, 2 municipal and 2 academic) with at least one metadata shared (IBGE 2021).

From these numbers, it is possible to notice a predominance of federal and state institutions as INDE nodes compared to local nodes, even though the number of municipalities (5570) is much higher than the number of state-level units (27).

Some national SDI portals from different countries were consulted to account for available subnational spatial data infrastructures nodes. For example, at the Spanish SDI website (called IDEE), it is currently possible to find 78 institutions sharing some geographical resource, of which 29 are national, 17 from state-level, corresponding to each autonomous community in the country and 32 at the municipal level (Spain 2021).

In the Argentina SDI portal (called IDERA), there are 205 listed institutions as providers of geospatial resources. Among those, 52 are from the federal level, 40 from the state or provincial level, 45 from the local level, 46 from academic institutions, 8 from non-governmental organizations and 14 from companies (Argentina 2021).

As in the Brazilian case, it is possible to notice a predominance of institutions of federal and state jurisdiction in the national infrastructure portal of Argentina. This does not occur in Spain's SDI, where the number of municipalities with some SDI integrated into the platform (about 41% of the institutions) almost equals the sum of national and state jurisdiction (approximately 59% of the total institutions).

Some measures have already been taken to increase transparency and access to government information, such as the emergence of the Access to Information Law (Brazil 2011), the Electronic Government Interoperability

Standards (ePING) (Brazil 2017), the creation of the National Open Data Infrastructure (SLTI 2012) and Brazil's adhesion to the Open Government Partnership. However, a case study of SDIs from four countries (Netherlands, Canada, Australia and Brazil) pointed out a poor performance for opening Brazilian spatial data. They concluded this mainly because highway data (on a scale greater than 1:20,000) and land parcels boundaries were not available for the entire territory through the national infrastructure (Mulder, Wiersma and Van Loenen 2020).

On the other hand, Brazil has been ranking better in the Open Data Barometer. This index assesses the opening of various government data (including maps) from the pillars: readiness, implementation and impact. So that in 2013 it occupied the 28th out of 77 positions and in the last edition (2017 leaders' edition) ranked 14th among 30 countries. However, specifically concerning the opening of spatial data, the index showed an increase from the first edition in 2013 (where it scored 15%) until the third edition in 2015 (where it scored 80%) followed by a worsening in the last editions of 2016 and 2017 (in which it scored 65%) (WWW Foundation 2021).

Based on this information, it is possible to observe the low transparency of geographic data, mainly municipal data. Although there is a forecast of creating territorial information systems in the municipalities (Brazil 2009), these data are not currently integrated into the national repository. The point is that these spatial data exist, but they are distributed in different formats. So they become invisible to the central administration of INDE and society in general because they are dispersed portals, not catalogued and in general not integrated with SDIs.

We can find many studies on the literature that assesses SDIs based on different approaches (Masser and Crompvoets 2018, Burroughs et al. 2019, Putra, Sekimoto and Shibasaki 2019, Rahman and Szabó 2020), however little of them generated a geographic overview of local initiatives that are not connected to their respective national SDI. In this context, it is possible to mention a panorama of implemented SDI from INSPIRE member countries that identified, between 2009 and 2011, about 119 geospatial infrastructures (Noucher et al. 2017).

Additionally, in 2019, a study evaluated local SDIs in Croatia by sending questionnaires to 127 cities. It was found that 43% of the municipalities had some kind SDI and that positive factors for their establishment are the budget, the population and specialist human capital (Marasović, Crompvoets and Poslončec-Petrić 2019).

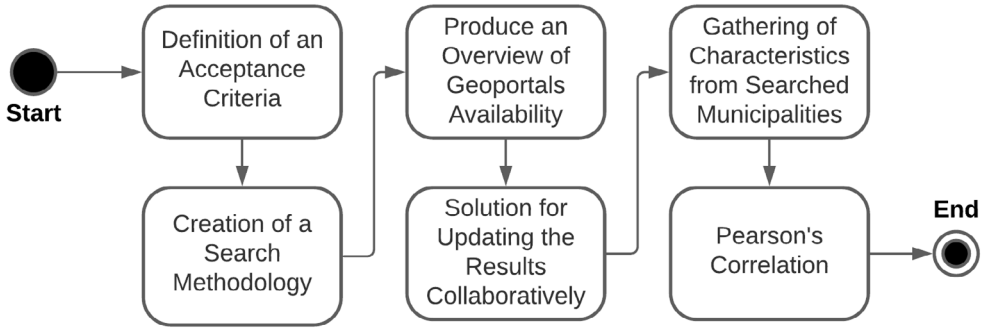
Also in the same year, a study assessed the state of SDIs of the members of the United Nations Regional Committee on Global Geospatial Information Management for the Americas (UN-GGIM: Americas) and the results of the 36 countries were made public through an interactive map platform (Gómez et al. 2019).

Considering the context abovementioned and a scenario of low "geographic transparency" of municipal data and low adherence in the national infrastructure, the research problem of this study is to discover the state of availability of interactive geographic viewers from subnational government that are not integrated with the national platform, with the goal of presenting their spatial distribution and developing an open and collaborative platform for updating this information.

We also investigate possible driving factors that can contribute to the availability of local infrastructures to support research and related public policies. Finally, we expect that with the evolution of technology linked to SDIs (Borba et al. 2017, Borba et al. 2015), this type of study might support proposals for integrating decentralized platforms not necessarily endorsed by the architecture of standardized geoservices that have traditionally been built.

2. Methodology

The following are the methodological steps adopted to achieve the results presented in this study, better detailed in the image below (Figure 1), in the following order: section 2.1 shows the methodology used to search for Brazilian municipal geoportals; section 2.2 offers the steps for implementing the collaborative geoportal platform; section 2.3 explains the analysis of the characteristics and correlations calculated for the investigated municipalities.



Source: The authors (2021).

Figure 1: Flowchart of the methodological tasks followed.

2.1 Definition of Geoportal and Searches

Since this research's main problem was to quantify the availability of Brazilian subnational geoportals not integrated with INDE, it was necessary to define an acceptance criterion, that is, to determine what could be considered a geoportal according to some essential chosen characteristics.

Pragmatically, a geoportal can be defined as an access point on the internet that, with the help of technology, makes the intermediation between providers that share geographic information and data openly with users, who in turn consume these resources according to their needs, being able to offer services of storage, search, manipulation, visualization, analysis and processing of spatial data in a similar way to Geographic Information Systems (Goodchild 2012, Jiang et al. 2019).

Based on the definition extracted from the literature, within the scope of this article, for a page to be considered a "geoportal", it must present, at a minimum, free access to geographic resources on the internet to allow interaction between the user and geographic data directly through the access point. Interactivity with spatial data, within the scope of this article, was defined as a user's ability to perform basic operations with the digital map: activate and deactivate layers, increase and decrease the scale and move horizontally and vertically on the digital map.

Therefore, using the criteria established above, the web pages that only allow the viewing of static maps for localization and printing or only allow the download of maps for local consumption or via FTP servers were excluded from searches. An example of a page that did not match the criterion is the webpage from Belém/PA, with data from the master plan (http://www.belem.pa.gov.br/planodiretor/paginas/planodiretoratual.php) in which it is possible to download data only for local consumption. In contrast, an example of acceptance is the data portal of the municipality of Brasília/DF (https://geoportal.seduh.df.gov.br/mapa/) due to the presence of interactivity between users and spatial resources.

For the identification of geoportals, the search took place in a sequence of groups as described in the following list:

a) Given the number of municipalities in Brazil (5570), limiting the number of searches was necessary. First, a search was done in the 399 municipalities of the state of Paraná. However, there was the need to conduct those searches in the other Brazilian states to obtain a national overview. To define this criterion, we started from the hypothesis based on some literature (Pashova and Bandrova 2017, Kalantari Oskouei et al. 2019, Putra, Sekimoto and Shibasaki 2019, Mulder, Wiersma and Van Loenen 2020) that municipalities with a larger population have more financial and human resources to create an SDI. It may be more likely to find geoportals in these municipalities. Therefore, the first scanned group was the medium or large cities, cities with more than 100,000 inhabitants.

b) Google web search engine: seven keywords related to geoportals were defined combined with the jurisdictional level, in such a way that the first ten results obtained were analyzed: “ide”, “ide municipal/estadual/nacional”, “infraestrutura de dados espaciais”, “sigweb”, “geoportal”, “webgis” and “mapa interativo”. In this procedure, the search engine was set to return only pages from Brazil and in the Portuguese language;

c) Institutional pages: for each municipality, state or country searched by the previous procedure, it was also explored through the available links and in the citizen services section of the institutional page of the place to find links to geoportals not found by the previous step;

d) Questionnaires: during 2020, questionnaires were sent to assess municipalities’ state of preparation for implementing local SDIs in several cities in Brazil (Silva and Camboim 2021). In this questionnaire, among other questions, we asked the availability of local geoportals (with information of the web address by the interviewee), so the data of 10 respondents was considered too;

e) Facebook groups and web pages: publications on 39 groups related to geotechnologies were scanned to find publications that contained links to the respective geoportals. The searches were performed using the previously defined keywords. Besides, six web pages containing lists of geographic data sources were investigated;

f) Portfolio of companies: for each geoportal found by the previous methods, it was also searched within the companies’ pages that implemented such solutions to find other sharing platforms within their other services and clients. Overall, portfolios and clients from 23 companies were investigated. The complete list of groups, web pages and companies investigated was published on Figshare, accessible through the following address: https://doi.org/10.6084/m9.figshare.14226998.v1.

In addition to these municipalities, we searched over 50 towns identified in a previous study, which explored locations with auction notice to acquire territorial information systems (SIT) between 2016 and 2019 (Nubiato and Delazari 2021). We understood that the availability of already established interactive maps could also be more likely in these places.

2.2 Collaborative Platform: Geoportais do Brasil

With the searches completed, it was then possible to produce different visualizations of the municipal and state data from the data obtained in maps and tables, generating an overview of the current situation. However, the status of each location sought can change over time. Over time, new municipalities and states may create geoportals. Others may decide to stop making their geographic resources available openly and interactively or choose to implement their local SDIs and integrate them with INDE.

This situation pointed to a need for constant updating of the results obtained and generation of updated panoramas. On the other hand, this task, due to a large number of existing municipalities, would take a long time to be performed by a few people, which led to the need to create a tool to update this data collaboratively, to allow the community to publish the web addresses of the geoportals they know about.

It is possible to imagine both users and producers interacting inside this platform: a typical user could be a researcher or a planning institution gathering geospatial data from multiple places for making regional analysis or studies. On the other hand, members from city halls could act as producers and use the platform to promote their local geoportals visibility. Managing members of INDE could also be interested in producing an inventory of potential municipalities’ nodes for the national platform.

First, the system was planned by creating a UML (Unified Modeling Language) use-case diagram to briefly

represent which actors would be present and their operations. Also, a diagram presenting the system's architecture was designed to have a general preview of the solution. After modeling the system, the cartographic language of the maps was defined. Thus, based on the conceptual model and the cartographic design created, a geographic database was implemented using the PostgreSQL software and its PostGIS spatial extension.

Subsequently, a map server and a file server were created, using Geoserver software and Apache software. Also, a web page was created, using HTML and JavaScript, with the jQuery library's aid, and its access to the database was performed through algorithms programmed in PHP with the Ajax methodology's support.

The manipulation of the geographic data of the page was implemented using the Leaflet library and its plugins. Finally, a login system was created with validation of the reCAPTCHA service, with the access to the platform being limited by the creation of three user profiles:

1) Viewer: users from the general public that only want to view the data shared on the platform, without the need to register;
2) Editor: registered users from the general public that intends to contribute to the platform through the inclusion, exclusion or edition of geoportal information;
3) Administrator: expert users and managers of the platform, who have privileges to include and exclude layers, as well as permission to make substantial changes to the database, servers, page and maps of the platform to improve and maintain their proper functioning.

Additionally, a Uniform Resource Locators (URLs) validation of data filled out by users in the form, based on built-in HTML functions and regular expressions, was added to the portal to mitigate problems of fake or mistyped websites addresses. In a future platform update, implementing an additional validation of URLs can also prevents the sending of malicious websites links to the server database.

2.3 Municipality Analysis

Once the quantification of geoportals by municipalities was raised, it was possible to investigate the factors leading to certain cities having some form of an interactive map, in contrast to others that do not have such tools. It is essential to highlight that some municipalities had more than one geoportal, which was accounted for in the calculations. For each municipality, data characteristics of the location sought from the IBGE were obtained to compare with the number of available geoportals for each area. In order to measure the correlation between the variables investigated, we calculated Pearson's Correlation (1), a coefficient generated from the variance and covariance between the chosen variables. This coefficient takes values between 1 (a perfect positive correlation) and -1 (a perfect negative correlation), and takes a 0 value when there is no dependence between variables.

$$\rho = \frac{\sum_{i=1}^{n}(X_i - \bar{X})\,(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \bar{X})^2}\,.\,\sqrt{\sum_{i=1}^{n}(Y_i - \bar{Y})^2}} \tag{1}$$

Where:

ρ: Pearson's coefficient;

X_i and Y_i: measured values for the variables;

$\bar{X}$ and $\bar{Y}$: arithmetic means of both variables;

n : number of measured values for both variables.

For this study, the following variables of municipalities were analyzed: whether it is capital; geographic region; federal unit; estimated population for 2020; if it is a metropolitan area; type of urban concentration; classification in the urban hierarchy; if it belongs to the legal Amazon; if it is from semiarid; gross added value of agriculture; gross added value of the industry; gross added value of services; gross added value of public administration, defense, education and health and social security; total gross added value; taxes; gross domestic product; gross domestic product per capita; activity with higher gross added value; activity with second-highest gross added value and activity with third-highest gross added value.

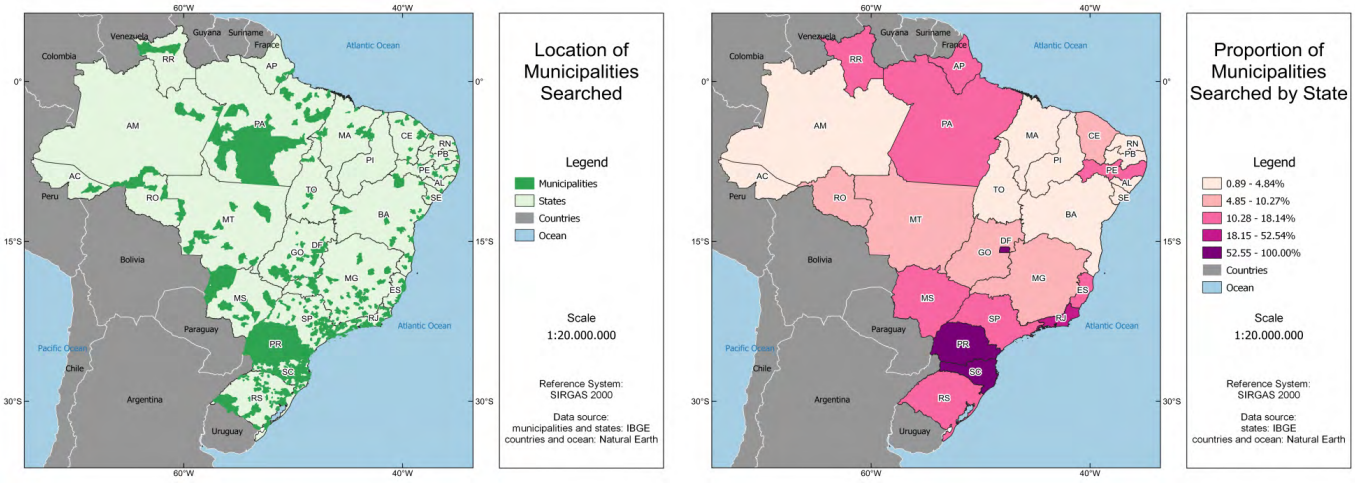
To calculate the correlations between variables, it was necessary to transform the values from textual classifications into numbers. Therefore, a value was assigned to each textual category. As an example of that procedure, the variable “capital” received the value 0 when the category response was “no”, while the value 1 was assigned to the category “yes”. Finally, some hypotheses were elaborated from the calculated correlations compared to some SDI evaluations that already exist in the literature.

3. Results and Discussion

According to the methodology applied, this study will present the results and discuss their most essential issues. Section 3.1 is dedicated to showing the municipalities where the searches were done and the results of the availability of subnational geoportals by state through different maps; section 3.2 presents the diagrams for modeling the collaborative platform and its access page; in section 3.3, Pearson’s correlations are given for the municipalities searched.

3.1 Panorama of Brazilian Geoportals

Searches were carried out in 999 municipalities, corresponding to approximately 18% of the total municipalities and 15% of the Brazilian territorial area. As seen on the map (Figure 2), the cities cover all states, with the following distribution by region: 34 from the North, 77 from the Northeast, 215 from the Southeast, 629 from the South and 44 from the Midwest. The federal units with the highest proportion of municipalities investigated were the Distrito Federal, Paraná and Santa Catarina.

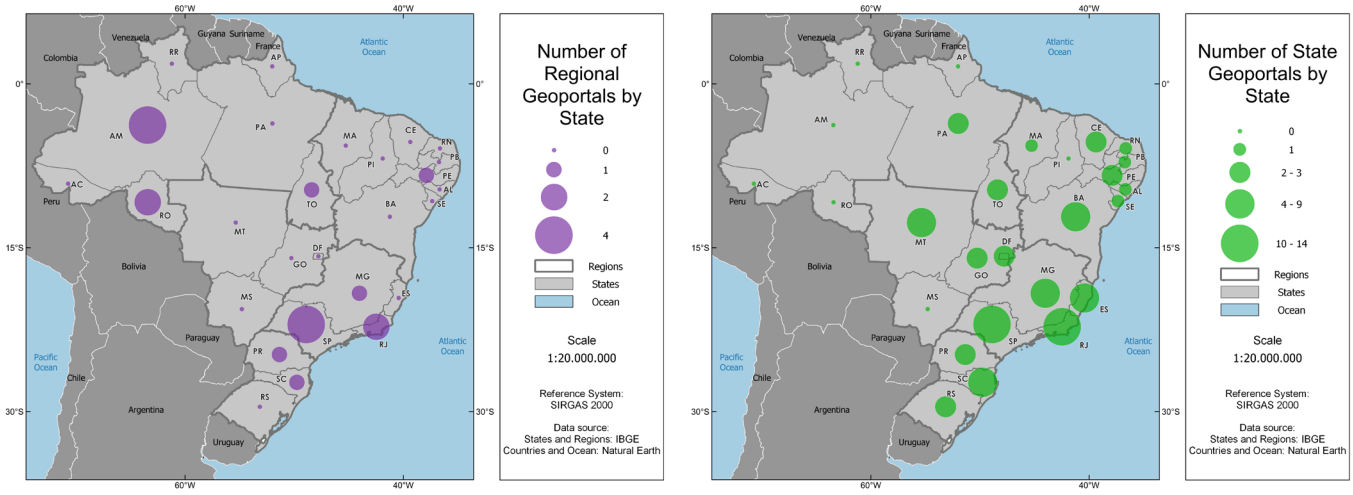


Source: The authors (2021).

Figure 2: Location of the municipalities investigated and proportion of municipalities searched**.**

As we can see, there was a predominance of municipalities searched from the South and Southeast regions. In the South region, it was due to a complete search carried out in all cities of Paraná, while in the Southeast region, it was due to a large concentration of municipalities with more than 100.000 inhabitants in the states of São Paulo (81), Minas Gerais (33) and Rio de Janeiro (30).

Regional interactive maps were also searched, totalizing 17 regional geoportals belonging to 9 states (Figure 3). In addition to these, state geoportals were searched for all 27 states, using the same previously defined keywords, resulting in a total of 82 geoportals belonging to 20 states (Figure 3).



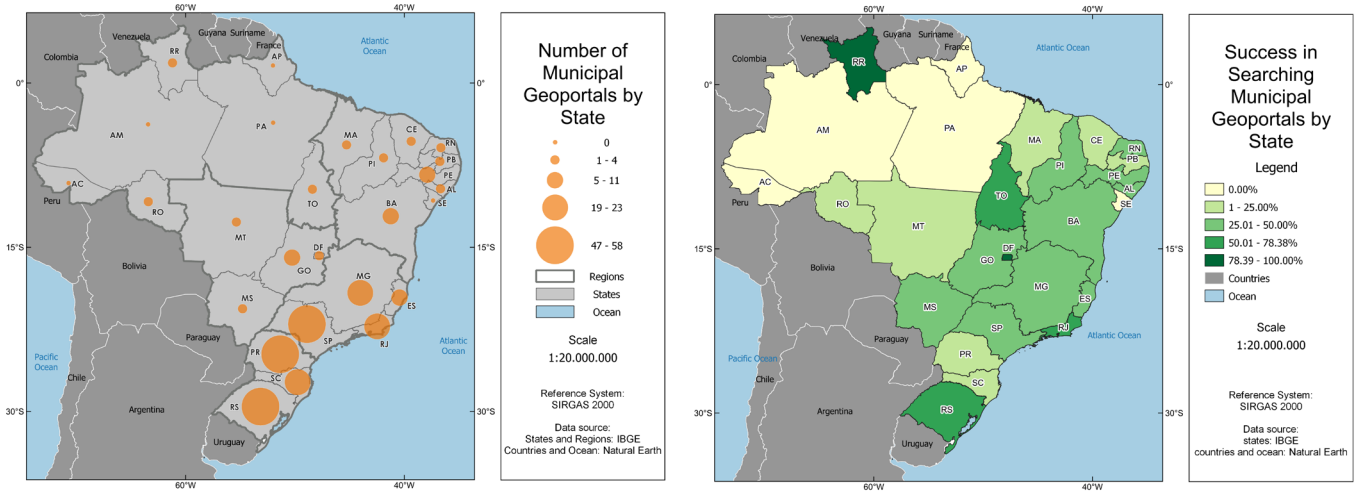
Source: The authors (2021).

Figure 3: Number of regional and state geoportals found by state.

As seen in the right side of the figure above, the states with the highest concentration of state geoportals found were Rio de Janeiro and São Paulo, while the states of Roraima, Amazonas, Acre, Rondônia, Amapá, Piauí and Mato Grosso do Sul were those that did not have geoportals found through the applied search methodology. For the regional level (left side of the figure), Amazonas and Sao Paulo had the most significant map viewers count (four each).

In total, 274 municipal geoportals were found (left side of the next figure), belonging to 237 municipalities, which represents an overall search success rate of approximately 24% (right side of the next figure). That is, for every four cities searched, one of them had some type of interactive map accessible through the internet (Figure 4). The states that accounted for the most significant number of geoportals were Rio Grande do Sul and Paraná.

All the results of the searches carried out in this study were published online on the Figshare server and can be accessed through the following web address: https://doi.org/10.6084/m9.figshare.14214386.v1.



Source: The authors (2021).

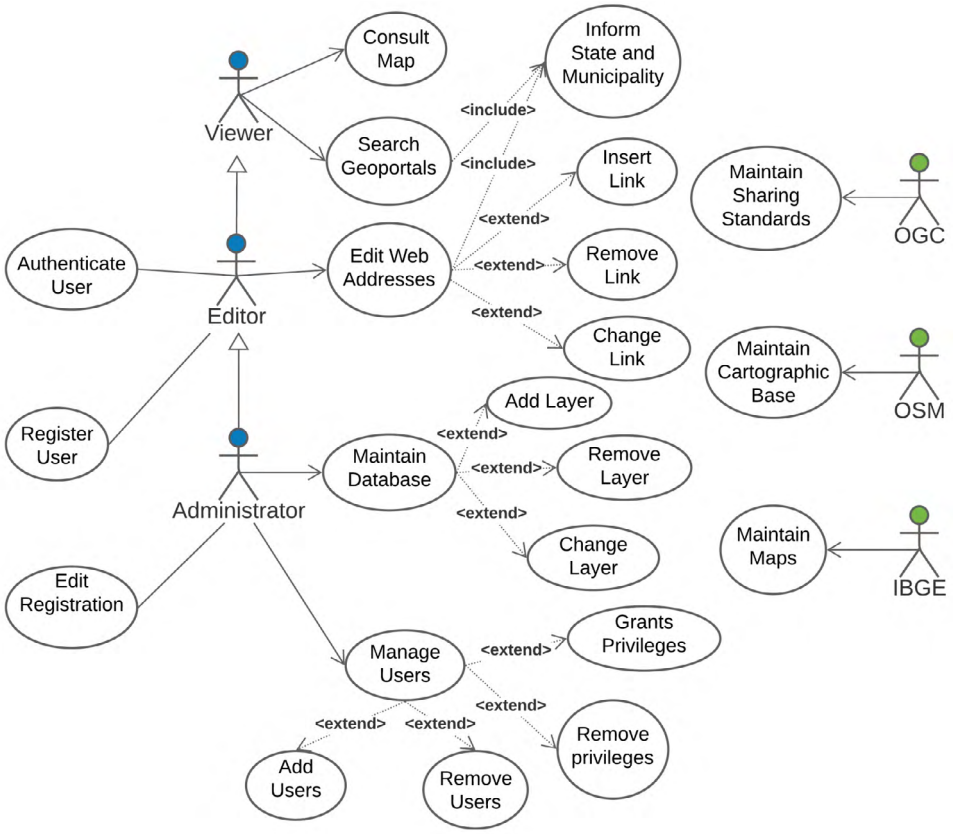
Figure 4: Number of municipal geoportals and search success rate by state.

On the other hand, the states with the most success rate in the searches were the Distrito Federal and Roraima. This occurred because these federative units have the lowest number of municipalities in the country. In all the few cities searched for, some geoportals were found. The same did not happen for the state of Amapá. Despite having few municipalities (16), the searches carried out did not return geoportals, which made this state, together with Acre, Amazonas, Pará and Sergipe, the states with less successful search rates.

3.2 Catalogue of geoportals

As previously explained, the survey presented here represents municipalities and states' situation for a given time, which may not necessarily apply to future cases, considering the limitations imposed by using a limited sample. Therefore, a collaborative system was designed to assist in this task.

Such a system was designed through a use-case diagram (Figure 5) to present the stakeholders' main interactions and the proposed approach. In total, 22 use cases were designed for the platform. The expected users of the system were thought to be members of prefectures to promote their municipal geoportals, people from academic and planning institutions, when dealing with regional studies and managers from state and national level SDIs, for providing a map of potential nodes for future integrations.

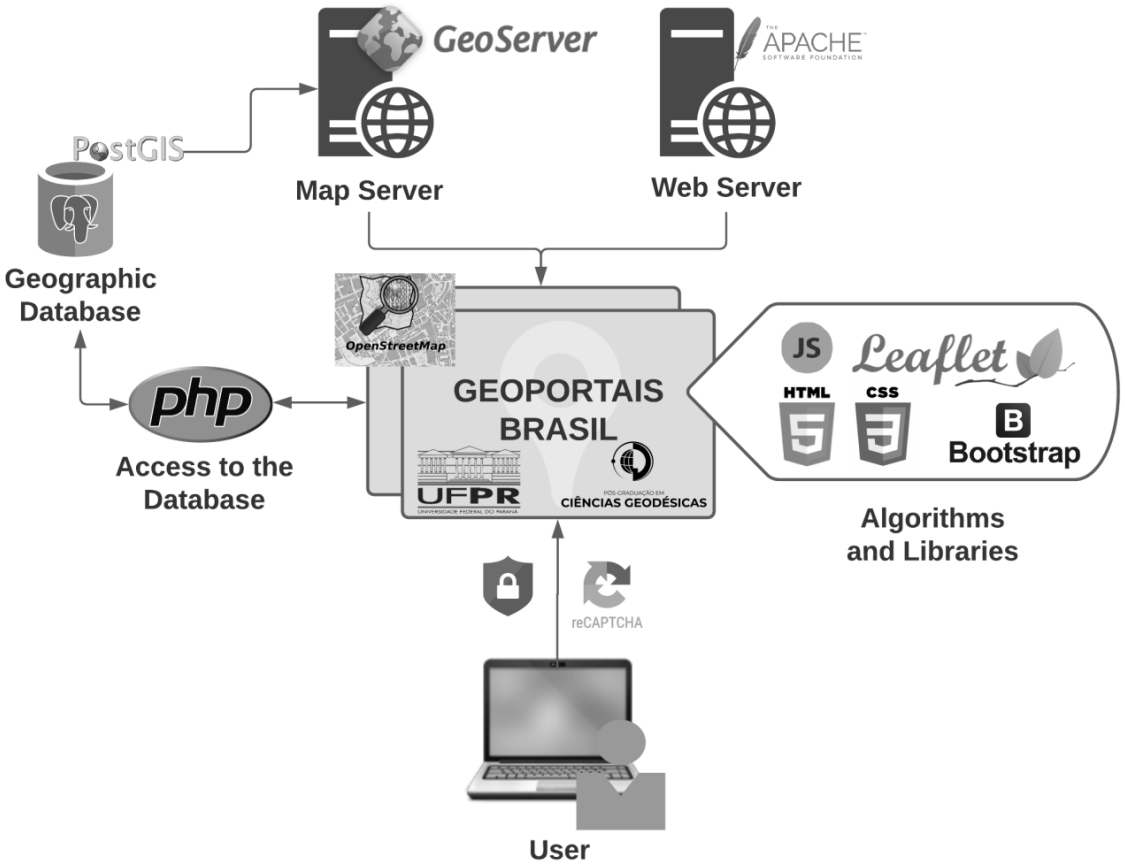


Source: The authors (2021).

Figure 5: Use-case diagram of the proposed system.

In this diagram, it is possible to identify six actors, seen here as the parts that are related in some way within that environment: “viewer”, “editor”, “administrator”, “OGC”, “OSM” and “IBGE”. The first three (in blue) are actors directly linked to the consumption and maintenance of the collaborative platform. Simultaneously, the last three (in green) are indirectly related to the system. In the case of OGC, through the publication of standards to be followed; in the case of OSM, by providing a reference base map; and in the case of IBGE, as a provider of reference and thematic map layers.

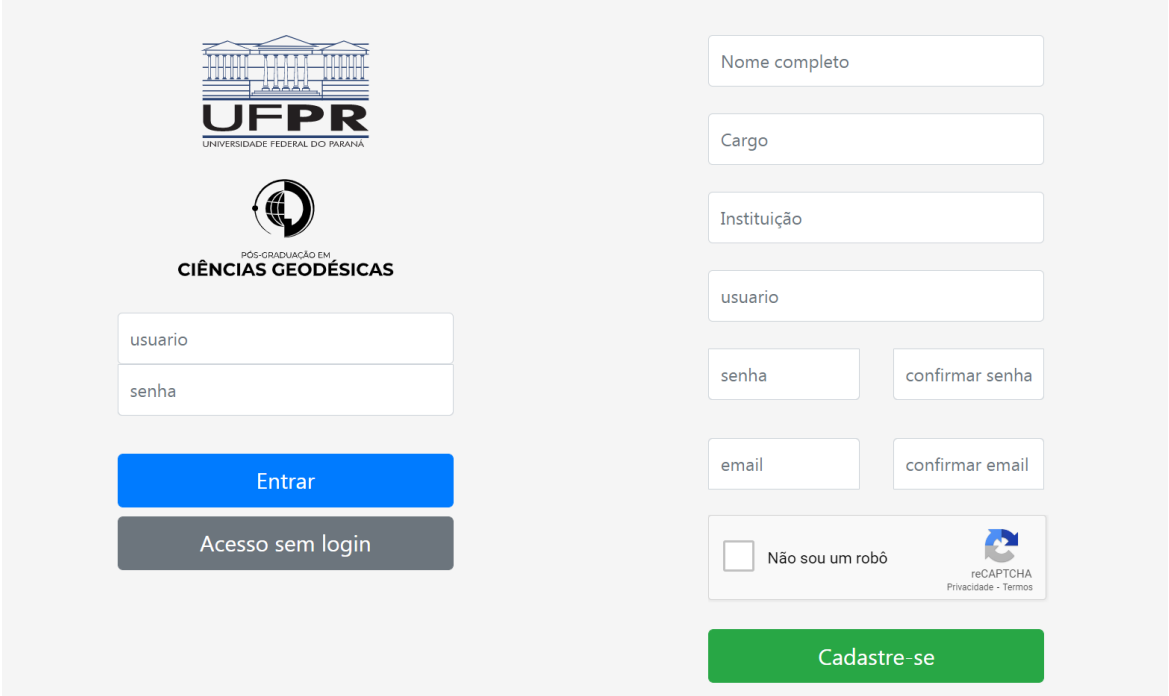
In addition to this diagram, a diagram of the system architecture was elaborated (Figure 6), presenting the main components and interactions of the system. From the image, it is possible to observe four main interactions of the webpage: with the client (user), through the internet and mediated by a login system; with the geospatial database, through PHP language; with the map server and file server in order to present the data to the user; and with the algorithms and libraries required to maintain the portal functioning. Besides that, the system interacts with the Open Street Map to present a base map layer to the user.



Source: The authors (2021).

Figure 6: Architecture of the system.

The components illustrated above are exposed on the internet through the file server implemented by the Apache software foundation, and the website is available at: www.labgeolivre.ufpr.br/geoportais_brasil/. When accessing this web address, the user is redirected to a web server where the page is stored, and the first screen presented is a login page (Figure 7).

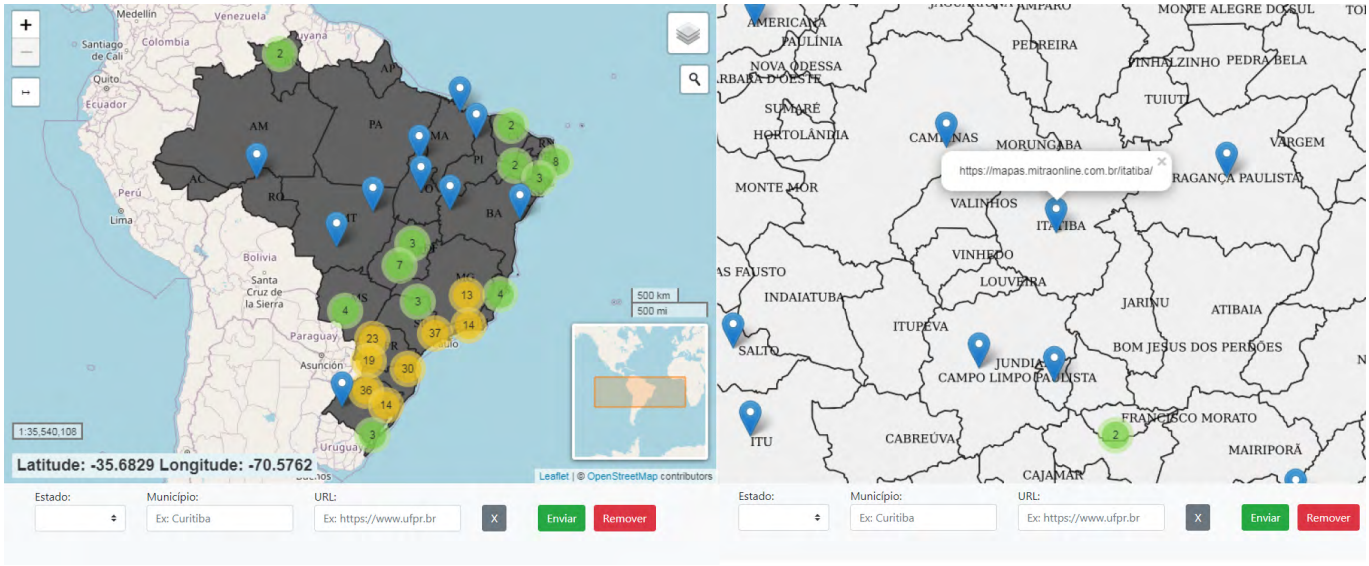


Source: The authors (2021).

Figure 7: Login page of the collaborative portal.

As can be seen in figure 6, the developed portal has a screen in which the user can be logged in with the credentials of the user “editor” or “administrator”, or the registration of new users can be made. Furthermore, on this same screen, the option of access without login is made available to the general public with a “viewer” profile.

After the user logs in, the second screen (Figure 8) shows the collaborative map with the geoportals found in each municipality and grouped using the marker cluster plugin. The page offers the option to add, change or remove web addresses through the state’s acronym, the city name and the geoportal URL. In addition, the data can be submitted through the “Enviar” button.



Source: The authors (2021).

Figure 8: Proposed collaborative portal.

The platform was implemented using the Bootstrap library's aid to be responsive and adaptable to the user's device's screen sizes. As can be seen on the right side of the above image, as the user zooms in on the map, the municipalities' layer activates, and we can access the links of geoportals associated with each centroid on the map.

In order to achieve a better management of the webpage, all the code produced in the implementation of this platform was made available on the following Github repository: https://github.com/eduardosilverio1990/geoportais_brasil. In the future, this platform could be a data source for research activities, being an alternative and auxiliary way of finding geodata and geoservices from different municipalities. Therefore, as the updates on the platform occur, would be interesting to promote it through institutional webpages and social groups from the Brazilian GeoCommunity, since this could maintain the map up-to-date.

3.3 Correlations and hypotheses

Pearson's coefficients were calculated for a total of 20 variables, compared with the total number of geoportals found in each of the 999 municipalities searched (Table 1). As shown in the table below, it is possible to observe that the most remarkable positive correlation found was between the number of geoportals available in the municipality and the estimated population variable (45.5%). Other significant positive correlations (over 40.0%) were the variables of Gross Value Added for Industry (44.4%), Total Gross Value Added (41.2%) and GDP (41.1%).

Table 1: Calculated correlations

Variable	r (%)	Variable	r (%)	Variable	r (%)	Variable	r (%)
Capital	37.2	Type of Urban Concentration	14.8	Gross Added Value of Industry	44.4	GDP	41.1
Geographic region	-4.6	Urban Hierarchy	30.2	Gross Added Value of Services	39.3	GDP per capita	14.5
State	-1.5	Legal Amazon	-6.4	Management Gross Added Value	29.9	Activity with higher Gross Added Value	7.6
Estimated population	45.5	Semiarid	1.1	Total Gross Value Added	41.2	Activity with second highest Gross Added Value	1.2
Metropolitan region	1.7	Gross Value Added of Agriculture	3.5	Taxes	39.8	Activity with third highest Gross Value Added	-5.3

These data are similar to some statements found in the literature about SDI and the need for institutions to maintain an SDI project financially (Pashova and Bandrova 2017, Gómez et al. 2019, Kalantari Oskouei et al. 2019, Marasović, Crompvoets and Poslončec-Petrić 2019). Local governments with more significant financial conditions (closely linked to the city's size for receiving government resources) can acquire geographic data and hire the necessary technical staff to implement geographic sharing mechanisms on the internet.

On the other hand, no correlations were found (below 10.0%) with variables related to the location of the municipalities searched (Geographic region, state, metropolitan region, Legal Amazon and Semiarid). This may indicate independence between the geographical characteristics concerning the possibility of sharing geographic data on the internet.

4. Conclusion

Despite the importance of geospatial data in large cartographic scale for management and everyday life, few integrated subnational SDIs are nodes at INDE. Nevertheless, these data exist and are available, but often invisible, in geoportals spread across the country. This work aimed to collect and offer a tool to update this information, a crucial step for evolving our SDIs to a more comprehensive and user-centric infrastructure.

In the course of this study, the importance of integrating subnational data with INDE was presented, especially those from municipalities, which currently have the legal provision for the creation of their territorial information systems, but which are not yet obliged to share these resources through the national infrastructure. However, the sharing of this information is guaranteed by the Access to Information Law, therefore making information available through map viewers, even if not integrated with INDE, can increase the transparency and reuse of data from states and municipalities.

Given the low integration scenario with the national infrastructure, this research catalogued the current availability of subnational geoportals not connected to INDE. Furthermore, this research also presented a methodological alternative for geographic viewers' searches through the combined use of different search sources: the search engine with keywords, institutional pages, social media groups, questionnaires and portfolios of companies. The search methodology used proved to effectively identify the viewers of subnational maps, revealing a proportion of approximately 24% of municipalities with geoportals within the investigated sample.

The amounts raised allowed us to generate a previous map of the Brazilian situation, which pointed to a higher concentration of geoportals for the states in the south and southeast regions and a lower concentration for the North and some states in the Northeast region.

This research presented a solution to update the Brazilian panorama, using a collaborative platform based on free and open software, which allows the community to inform the availability of municipal geographic viewers and consume the information available by the users.

Finally, Pearson's correlations were calculated to investigate factors linked to the availability of municipal geoportals compared to twenty municipal characteristics published by IBGE. This indicated more significant positive correlations with the population variable and the variables related to the municipalities' economy and taxes, which is in line with other studies on SDI assessments. Besides, no significant correlations were found with variables regarding the location of the municipality.

Recommendations for further research include investigating a more significant number of variables, which express both characteristics of municipalities and institutions' organizational characteristics, such as, for example, the presence of specific departments, positions or professionals. It would also be interesting to analyze the geographic resources available through these geoportals and apply assessment methodologies for these geographic viewers.

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