Brazilian National Spatial Data Infrastructure (INDE): Applicability for Large Scale Data

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Abstract. This work is part of a research on Spatial Data Infrastructure and aims to analyze the applicability of spatial data and metadata standards proposed by the Brazilian Spatial Data Infrastructure. In order to avoid duplication of effort and expense in acquiring spatial data, the Brazilian Government started systematic studies aiming at the integration and standardization of spatial data produced by various federal institutions in 2003. The Decree 6666, approved on November 27th 2008, set up the National Spatial Data Infrastructure (INDE). This decree is mandatory for National Government institutions, but not for the other producers of spatial data. Once the standardization of spatial data and metadata proposed by INDE meets the standard scales covered by the Brazilian Mapping System, and this official mapping system represents the national territory by a series of adjacent and homogenous quadrangle maps at the standard scales 1:25000, 1:50000, 1:100000, 1:250000 and 1:1000000, topographic mapping at scales larger than 1:25000 still demands a normalization. The use of spatial data and metadata rules promoted by INDE for cartographic design on large scales represents a step forward in this direction and is in line with the INDE Action Plan recommendation. Considering the importance of large scale data for the different segments of Brazilian society that use spatial information, our main research objective is to analyze the applicability of spatial data and metadata standards proposed by the INDE for large scale topographic maps. In order to perform the intended analyzes, we established some procedures that entails the mapped features analysis, to define their types and representation; the relation of these features with the categories, classes, sub-classes and attributes of objects, in accordance with the INDE standards; the implementation of a spatial database; and the association of metadata. Data used in the development of this work refer to 123 topographic maps at scale 1:2000. The implementation of the spatial data-

base was done using the software ArcGIS, 9.2 version, and for metadata we used the Geonetwork, in accordance with the national metadata standards. The results confirm the applicability of spatial data and metadata standards proposed by INDE for large scale data. However, because of the levels of detail inherent to 1:2000 representations, some adjustments were necessary. Consequently new classes, attributes and attribute domains were created.

Keywords: Brazilian Spatial Data Infrastructure, Applicability, Large scale data

1. Introduction

A common situation in information and communication technology is the redundancy of data and the lack of standards for these data. The same data is often produced, managed, stored and used by different organizations using a variety of formats and standards.

The increasing availability and interest in spatial data, resulting from technological advances, contribute to the generation of large volumes of spatial data and information by public and private organizations. As far as this information is usually produced to meet the requirements of specific projects, it is often incompatible and leads to inefficiencies and duplication of effort.

Over the last decades Spatial Data Infrastructures (SDIs) have become an important element to facilitate management and use of spatial data (Nebert 2004). Many countries have implemented their National Spatial Data Infrastructures (NSDI) to support governmental policies and projects (FGDC 1997). In Latin America, some NSDI are already formalized and operational, as in Colombia, Chile, Venezuela, Uruguay, Argentina, México and Brazil.

Regarding the regional SDI in the Americas the efforts has been going on for almost 20 years. The process started in 1993 with the establishment of the Geocentric Reference System for the Americas (SIRGAS), in Asuncion, Paraguay. SIRGAS is recommended as the official reference system for all American countries and provides the geodetic reference for the regional SDI. The Permanent Committee for Geospatial Data Infrastructure of the Americas (PC-IDEA) was established in Bogota, Colombia, in 2000. PC-IDEA represents the region in the United Nations Global Geospatial Information Management (UN-GGIM). The Geospatial Network for Latin America (GeoSUR) was established in 2007 in Brasilia, Brazil, aiming at the integration and dissemination of spatial data in Latin America and the Caribbean. The PC-IDEA published, in 2012, the diagnosis on relevant topics of

geospatial information management and development of regional SDI for the 24 member countries, including Brazil (PAIGH, SIRGAS, PC-IDEA, GeoSUR 2013).

In order to avoid duplication of effort and expense in acquiring spatial data, the Brazilian Government started systematic studies aiming at the integration and standardization of spatial data produced by various federal institutions in 2003. The Decree 6666, approved on November 27th 2008, set up the National Spatial Data Infrastructure (INDE) (Brasil 2008). This decree is mandatory for National Government institutions, but not for the other producers of spatial data. (CONCAR 2010)

INDE is a service based SDI. The National Commission on Cartography, through the Specialized Committee of the National Digital Map Collection, developed the Technical Standards for Vector Geospatial Data Structure (ET-EDGV) (CONCAR 2007) and the Technical Standards for Vector Geospatial Data Acquisition (ET-ADGV) (CONCAR 2008). The database is structured in categories that represent the main classes of information. Each category of information has its classes of objects (features) with specific geometric and semantic aspects. As established in the INDE Action Plan, metadata must be defined and implemented in accordance with the Brazilian Geospatial Metadata Profile (MGB profile), that was developed on the basis of ISO 19115:2003 (Brasil 2009 & CONCAR 2009).

The standardization of spatial data and metadata proposed by INDE meets the standard scales covered by the Brazilian Mapping System, and this official mapping system represents the national territory by a series of adjacent and homogenous quadrangle maps at the standard scales 1:25000, 1:50000, 1:100000, 1:250000 and 1:1000000. But topographic mapping at scales larger than 1:25000 still demands normalization. The use of spatial data and metadata rules promoted by INDE for cartographic design on large scales represents a step forward in this direction and is in line with the INDE Action Plan recommendation. Considering the importance of large scale data for the different segments of Brazilian society that use spatial information, our main research objective is to analyze the applicability of spatial data and metadata standards proposed by the INDE for large scale topographic maps.

2. Approach and Methods

In order to perform the intended analyzes, we established some procedures that entails the mapped features analysis, to define their types and repre-

sentation; the relation of these features with the categories, classes, subclasses and attributes of objects, in accordance with the INDE standards; the implementation of a spatial database; and the association of metadata.

The study area for this research is the city of Canoas, located in the metropolitan area of Porto Alegre, capital city of the State of Rio Grande do Sul, in the south of Brazil (*Figure 1*). The total area of Canoas city is 131 km^2 and its population is around 332.000 inhabitants.

Spatial data used in this work refer to 123 topographic maps, in vector format, at scale 1:2000. The implementation of the spatial database was done using the software ArcGIS, 9.2 version, and for metadata we used the Geonetwork, in accordance with the national metadata standards.

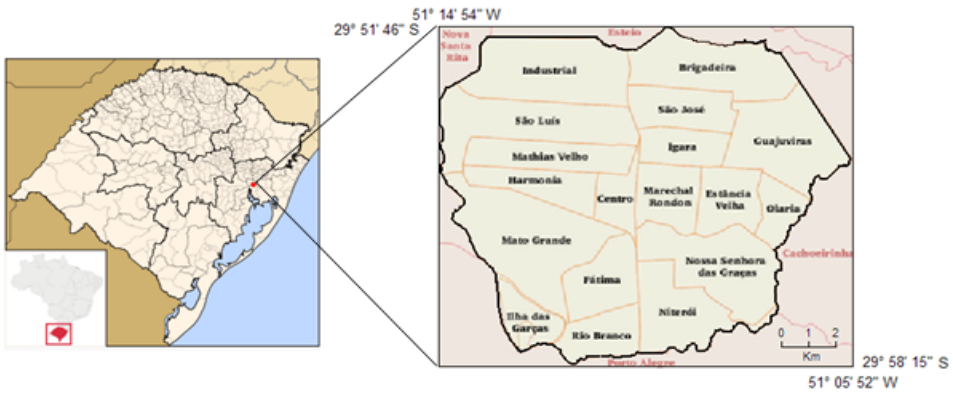


Figure 1. Map of study area.

2.1. Analysis of the mapped features

The objective of this analysis is to identify the relation of the features represented on the topographic map with the categories, sub-systems, classes and attributes of objects defined by INDE. To support this procedure we set up a database containing two groups of information. One related to the topographic map (Map Group), depicted by feature, graphic primitive and cartographic representation, and the other related to the INDE (INDE Group), described by category, candidate classes, subsystem and observation.

To get the information for the Map Group we first created an unique base map (*Figure 2*) and then, by visual inspection (map and layers), we listed all features represented on the base map, their graphic primitives (point, line, polygon) and their cartographic representation. Afterwards, we filled the corresponding fields on the database.

In order to select a smaller and representative set of feature, we selected from the base map and the database some regions where all features were represented. From this procedure, we generated a pilot map as shown in *Figure 2*.

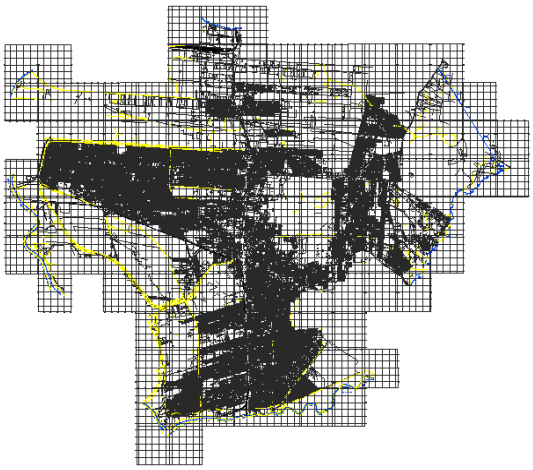


Figure 2. Base map.

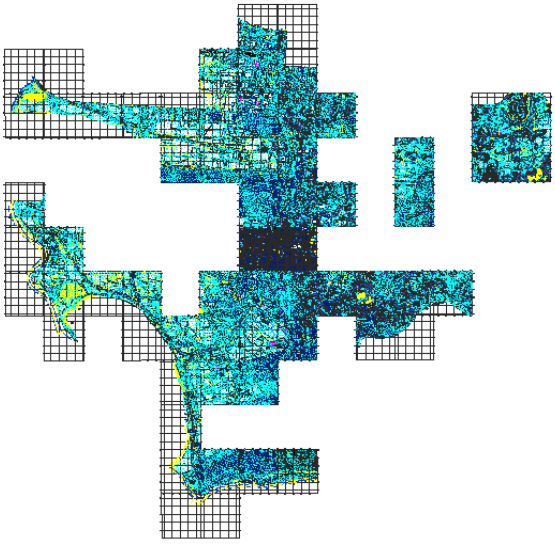


Figure 3. Pilot map.

To fit the features represented on the topographic map with the categories, sub-systems, classes and attributes of objects defined by INDE we used the base map, the database with Map Group information and the technical standards for data structure and data acquisition ET-EDGV, ET-EDGV – ANEXO A and ET-ADGV.

Primarily, we compared the features from Map Group with the classes described on ET-EDGV – ANEXO A, looking for similarities. Then, we used the ET-ADGV to check the compatibility between features and the chosen classes. For some specific features, we used the ET-EDGV to evaluate if the feature could be better fitted on another category and class, or if a new class should be created. After that, information related to INDE Group (category, classes, subsystem and observation) were incorporated into the database.

2.2. Spatial database implementation

After defining the categories, sub-systems, classes and attributes of objects corresponding to the topographic map features, we performed the spatial database implementation.

From the database containing the Map Group and the INDE Group information, we generated the geospatial data set. The first part of the work consisted in assembling classes without the attributes. The pilot map (CAD file) was edited and converted to shapefile (ESRI). Considering this and the levels of detail inherent to 1:2000 representations some adjustments were necessary. Therefore new features, classes, attributes and attribute domains were created.

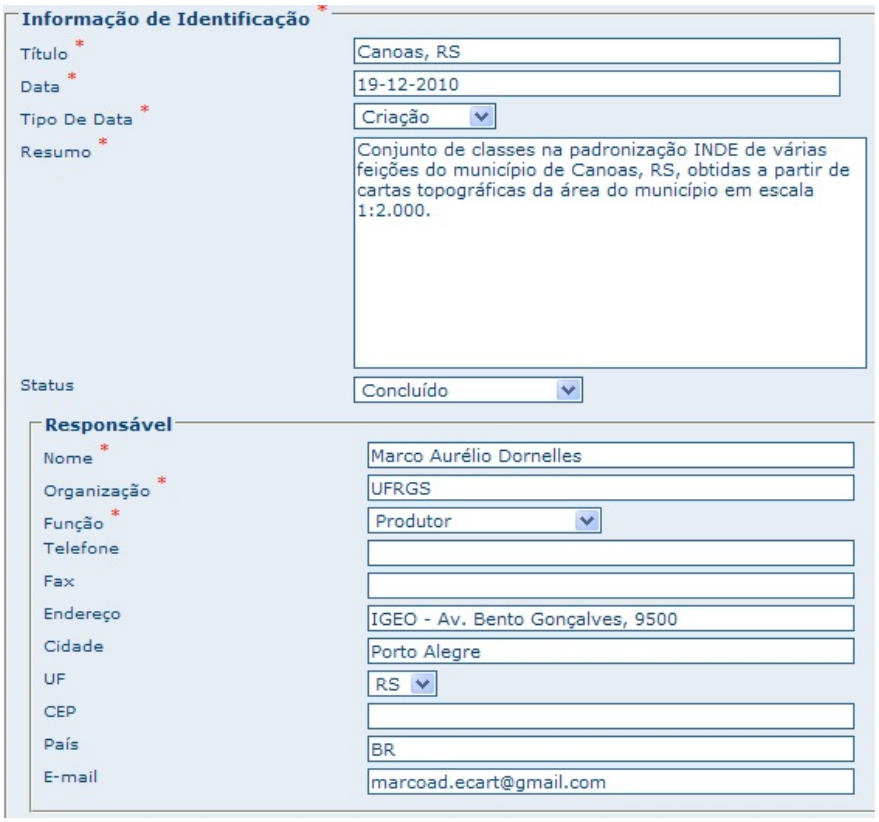
An auxiliary feature with the toponyms was created in order to support the attributes completion. New features to represent confluence points and highways, railways, streets and rivers axes were generated. And new classes, like land parcels for example, were created.

After this procedure, the mandatory and optional attributes were included in the spatial database, in accordance with the INDE (ET-ADGV) standards. Lastly, we included the symbols to represent the classes.

2.3. Metadata

As established in the INDE Action Plan, metadata must be defined and implemented in accordance with the Brazilian Geospatial Metadata Profile (MGB profile) (Brasil 2009 & CONCAR 2009).

The association of metadata was done using the Geonetwork. Geonetwork is free and open source software designed to enable access to geospatial data. It provides templates for metadata edition and supports several metadata standards like ISO19115, FGDC, Dublin Core, and others. Among the available templates there are two of them that meet the INDE specifications: the "complete MGB profile" and the "summarized MGB profile". In this research we used the summarized template to generate the metadata. *Figure*



4 presents part of the metadata input using the summarized template.

Figure 4. Part of the summarized MGB profile used for metadata input.

3. Results

The results were achieved from the analysis performed during the implementation of spatial data and metadata for the large scale data set. The fea-

tures were satisfactorily represented by the data structures proposed by INDE, requiring few adjustments. Thus, as a result of this analysis, we created new classes, attributes and attribute domains.

During the analysis of the mapped features we observed the following situations:

- one feature (MAP) corresponds to one class (INDE);
- one feature (MAP) corresponds to more than one class (INDE): to fit in the proper class we had to perform additional analysis (documents, images, photos);
- more than one feature (MAP) corresponds to one class (INDE): we used the attributes to distinguish the features.
- one feature (MAP) corresponds to none class (INDE): new classes were created;
- one feature (MAP) corresponds to one class (INDE) but the type is different and not available: we extended the attribute domain;
- one feature (MAP) corresponds to one class (INDE), but the subclass is not available: new attribute were created.

Considering this and in order to meet the national spatial data standards, we created the new classes: “Road_ Shoulder”; “Plat” and “Staircase_Slope”. Also, we created the new attributes: “Street“; “Gallery_Culvert” and “Elevation_Point”. And one new attribute domain was created: “Terrain_ Delimitation”.

4. Conclusion

Spatial data and metadata rules proposed by INDE meets the standard scales covered by the Brazilian Mapping System but spatial data at scales larger than 1:25000 demands normalization. INDE Action Plan recommends the use of spatial data and metadata standards for large scales cartographic design. Considering this recommendation and the importance of large scale data for the different segments of Brazilian society that use spatial information, our main research objective was to analyze the applicability of spatial data and metadata standards proposed by INDE for large scale data.

The analyzes were performed during the implementation of the spatial database and further metadata definition, for a representative set of features obtained from 123 topographic maps at scale 1:2000.
Because of the levels of detail inherent to 1:2000 representations, some adjustments were necessary. Three new classes, three new attributes and one attribute domain were created. These results confirmed the applicability of INDE standards for large scale data.

At last, it is important to mention that the Specialized Committee for Cadastral Mapping Standards (CNMC), created on 2006, is working on an extension of ET-EDVG to meet the demands for cadastral data.

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