International Cartographic Association
Association Cartographique Internationale

Collaboratively Updating National Cartography: An Automated Tool for Integrating OpenStreetMap Data into Topographic Mapping in Brazil

Leonardo Scharth Loureiro Silva[a,b,c]*, Silvana Philippi Camboim[b], Kauê de Moraes Vestena[b]

[a] *Brazilian Institute of Geography and Statistics (IBGE), Rio de Janeiro-RJ, Brazil – leonardo.l.silva@ibge.gov.br*
[b] *Graduate Program in Geodetic Sciences (PPGCG), Federal University of Paraná (UFPR), Curitiba-PR, Brazil – silvanacamboim@ufpr.br; kauemv2@gmail.com*
[c] *Department of Geoenvironmental Analysis (GAG), Federal Fluminense University (UFF), Niterói-RJ, Brazil*

* Corresponding author

Keywords: Topographic mapping update, Volunteered Geographic Information, QGIS Plugin.

Abstract:

The availability and maintenance of accurate and up-to-date geospatial information are critical for effectively planning and implementing public policies, particularly in infrastructure, health, education, security, environmental governance, and social promotion. Also, it is essential to support the achievement of Sustainable Development Goals (SDGs). This need is intensified in developing countries due to several particularly challenging circumstances, where resources for official cartography may be scarce. For example, in Brazil, the country lacks comprehensive coverage of reference mapping at larger scales, and much of the currently available national mapping was produced decades ago. To address this problem, the authors propose investigating alternative data sources, such as voluntary geographic information, which can be a low-cost alternative for updating national cartographic reference mapping. They focus on using data from the OpenStreetMap platform, which is rich in the amount of information available and the semantic correspondences with the Brazilian official conceptual model. However, several operational issues must be addressed to integrate this data by official data producers effectively. For example, despite the existence of numerous international descriptions of utilizing such data (Sarretta and Minghini, 2021; Brovelli and Zamboni, 2018; Mahabir et al., 2017), occasionally, these are more focused on theoretical aspects and do not address operational aspects effective for integration by official data producers. Thus, this study brings an innovative application to the geospatial community, as no similar approaches have been found in the literature. Furthermore, such issues involve legal, computational and methodological questions.

To this end, the authors have developed an automated tool (https://github.com/LeoScharth/osm_into_topomap) that integrates collaborative mapping data from OpenStreetMap into a reference database at a scale of 1:25,000 or smaller. This development implements a methodological flow to automate the selection, analysis and import of collaborative data into the reference database in a QGIS plugin to accelerate and simplify the integration. The choice of a free platform already used by the national mapping agency is part of the strategy to integrate this activity into the daily tasks of cartographic updates. The first stage of development involved automating processes with tools written in Python. This phase comprised the implementation of information import flows using QGIS Graphical Modeler and the Overpass API to download data from OpenStreetMap. The imports were carried out for object classes of the official cartographic base of the State of Rio de Janeiro at the scale 1:25,000, used as a reference database in this study. The results are incorporated in a PostgreSQL/PostGIS database. The process assumes verifying the collaborative features with their eventual homologous in the reference database. The geometry of collaborative features is imported only when there is no match.

Similarly, names and attributes defined as "of interest" are added only when the reference information is unavailable. It is also worth mentioning that the flow preserves the OpenStreetMap import records, which signals which information originates from the collaborative platform and keeps its element code (osm id). This link ensures that the entire information history is traceable and grants recognition of its authorship. This concern also ensures compliance with OpenStreetMap's data licensing (OpenStreetMap, 2022). The workflows were interfaced through the QGIS plugin, which facilitated information integration by incorporating geometries and element attributes. Figure 1 shows a diagram of the workflow of the plugin. This automated methodology is of significant value, as it reduces the human interaction of repetitive, tedious and operator-sensitive activities, such as semantic compatibilization. Moreover, it can be reproduced and improved for having been conceived in free and open source software, including adapted to different

Abstracts of the International Cartographic Association, 6, 236, 2023.
31st International Cartographic Conference (ICC 2023), 13–18 August 2023, Cape Town, South Africa.
https://doi.org/10.5194/ica-abs-6-236-2023

semantic mapping models from other countries. Currently, the semantic modelling is done by a table of correspondences continuously updated, but with human operators. In the subsequent work, the following phases foresee the inclusion of ontologies and computational interpreters.

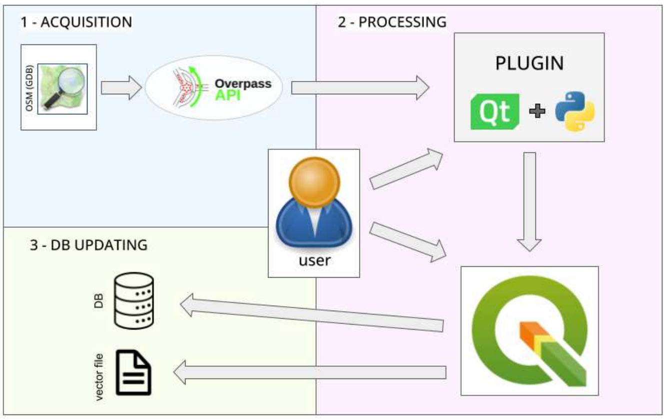

Figure 1. Workflow of the plugin operation.

The tool's use effectively increased the number of features in the cartographic reference base and in the percentage number of features with attributes. Table 1 presents examples of the results.

Object class	Database Features	Additional OSM features	Increase (%)	Features with name in Database (Qty / %)	Features with name in OSM (Qty / %)	Features with name after integration (%)
Power Section (length)	6,911 km	1,122 km	16.2%	0 / 0%	228 / 83.5%	-
Natural physiographic element	737	789	107.1%	599 / 81.3%	608 / 77.1%	81.2%
Landing Point - helipad	35	237	677.1%	0 / 0%	161 / 67.9%	63.6%
Ways (length)	95,591 km	8,480 km	8.8%	55,220 / 10.5%	5,867 / 16.8%	-
Field or sports court	2,872	3,934	137.0%	257 / 8.9%	492 / 12.5%	11.9%
Square	none	1,813	100.0%	-	1,813 / 100%	100,0%

Table 1. Examples of results of the import process.

It was confirmed that using voluntary geographic information to update and complement the reference mapping is entirely feasible. This process presents expressive results, a valid methodology, and an open-source tool ready for operation. Moreover, applying this methodology opens the way to a new reality in which the production of reference data can be allied to using citizens' local knowledge. Therefore, geospatial data represent more relevant information for society, becoming a new paradigm for producing and using more dynamic, contemporary and far-reaching maps. Using this automated tool has effectively increased the number of features in the cartographic reference base and improved the overall data quality. This study provides a practical solution to the challenge of updating national cartographic reference mapping in Brazil and offers a valuable model for other developing countries facing similar challenges.

References

Brovelli, M. A. and Zamboni, G., 2018. A New Method for the Assessment of Spatial Accuracy and Completeness of OpenStreetMap Building Footprints. *ISPRS International Journal Of Geo-Information*, [S.L.], v. 7, n. 8, p. 289, 24 jul. 2018. DOI: 10.3390/ijgi7080289.

Mahabir, R., Stefanidis, A., Croitoru, A., Crooks, A., Agouris, P., 2017. Authoritative and Volunteered Geographical Information in a developing Country: a comparative case study of road datasets in Nairobi, Kenya. *ISPRS International Journal Of Geo-Information*, [S.L.], v. 6, n. 1, p. 24, 20 jan. 2017. MDPI AG. DOI: 10.3390/ijgi6010024.

OpenStreetMap (OSM), 2022. Wiki. ODbL/License Transition/Guidance to Data Consumers. Available in: https://wiki.openstreetmap.org/wiki/ODbL/License_Transition/Guidance_To_Data_Consumers. Accessed in: Jun 26, 2022.

Sarretta, A. and Minghini, M., 2021. Towards the integration of authoritative and OpenStreetMap geospatial datasets in support of the european strategy for data. *The International Archives ff The Photogrammetry, Remote Sensing and Spatial Information Sciences*, [S.L.], v. XLVI-4/W2-2021, p. 159-166, 19 ago. 2021. Copernicus GmbH. DOI: 10.5194/isprs-archives-xlvi-4-w2-2021-159-2021.

https://doi.org/10.5194/ica-abs-6-236-2023