Geoinformation in environmental studies in the Carioca context

Geoinformação em estudos ambientais no contexto carioca

Geoinformación en estudios ambientales en el contexto carioca

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The dossier Geoinformation in Environmental Studies: Characterization, Mapping and Solutions for the Carioca Reality, volume 13, issue 4, of the Estudos Cariocas Collection — in which I had the honor of serving as guest editor — comprises ten full research articles and one opinion article. The latter presents a synthetic reflection on the nature of geoinformation in the twenty-first century, written by Luiz Henrique Castiglione.

The opinion article (Castiglione, 2026) discusses the profound transformations that geoinformation has undergone in recent decades, highlighting the transition from material representations, such as physical maps, to digital, dynamic, and dematerialized formats. This process has been driven by advances in technologies such as remote sensing, GNSS systems, aerial photogrammetry, and digital twins, which make it possible to represent the real world with a high level of precision. As a result, analytical and territorial management capabilities have expanded, especially in real-time monitoring and the mass production of geospatial data. However, Castiglione warns that this dematerialization may render geoinformation more ephemeral, putting its historical and cultural preservation at risk. In this regard, the importance of curating and preserving these data as scientific, cultural, and artistic heritage is emphasized.

The ten articles in the volume provide a diversified overview of the use of geoinformational data in representing and interpreting the territorial dynamics of Rio de Janeiro, encompassing different spatial and temporal scales. From a methodological perspective, various datasets and mapping techniques are presented and applied to case studies in areas relevant to the carioca context.

In the environmental field, particular attention is given to the study on transformations associated with urban expansion around Pedra Branca State Park, in the Vargem Grande region, between 2012 and 2022 (Guedes; Costa, 2026). Using NDVI and SAVI indices, the research identified a significant reduction in vegetation cover in areas under urban pressure, as well as intensified land occupation and the formation of new expansion zones, highlighting the environmental vulnerability of the area.

Another study analyzed land cover changes in the Special Urban Interest Area (AEIU) of Porto Maravilha between 2009 and 2024, using NDVI and NDBI indices applied to Landsat imagery (Manso *et al.*, 2026). The results indicate two distinct periods: from 2009 to 2016, marked by increased building densification and reduced vegetation; and from 2017 to 2024, characterized by stabilization of anthropogenic surfaces.

Regarding wetlands in the municipality of Rio de Janeiro, one study used Sentinel-1 and Sentinel-2 imagery combined with the Random Forest algorithm (Costa; Vicens, 2026). The results indicate that approximately 13% of Rio's territory corresponds to permanently or seasonally flooded areas, mainly concentrated in coastal plains and bays, reinforcing their ecological importance and the need for proper delimitation in urban planning.

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Another article (Souza; Ferraz, 2026) assesses deforestation associated with urbanization in Barra da Tijuca using the LandTrendr algorithm applied to Landsat time series (1985–2024). The period of greatest transformation occurred between 1985 and 1990, with changes three times greater than those recorded between 2010 and 2015, associated with real estate and urban expansion.

At a finer scale, one study analyzes the role of high-resolution mapping in assessing Urban Green Systems (Amaral *et al.*, 2026), emphasizing the importance of micro-scale analysis and the use of multi-sensor data for more precise diagnostics and monitoring, as well as support for urban planning. The authors also highlight the growing relevance of such mapping in the context of climate change.

Another contribution (Freires; Barbalho; Lima, 2025) investigates the relationship between the expansion of public transportation infrastructure and land use changes between 2009 and 2019. Based on the areas of influence of the Metro, BRT, and VLT systems, it was found that approximately 20% of the analyzed areas underwent significant modifications, demonstrating the structuring role of transportation and the influence of socio-spatial factors.

In the field of three-dimensional representation, one study analyzes vertical urban growth based on digital elevation models from 2013, 2019, and 2024 (Teixeira Coelho *et al.*, 2025), enabling the identification of demolition, construction, and stability areas, with applications in urban monitoring, risk assessment, and territorial planning.

In the area of Deep Learning, another study evaluated the U-Net architecture for identifying favelas in high-resolution orthomosaics (Souza; Silva; Nunes, 2026). Despite difficulties in small or low-contrast areas, the results confirm the method's potential for mapping informal settlements.

Finally, two articles address cadastral issues. The first analyzes the positional accuracy of the OpenStreetMap road network in the municipality of Rio de Janeiro (Antonio *et al.*, 2025), demonstrating quality variations between classes B and C at the 1:10,000 scale. The second investigates advanced 3D building modeling techniques (Badolato; Mota; Costa, 2026), highlighting the potential of open-source software in optimizing resources and seeking solutions suited to large cities in the Global South.

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About the Author

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Author Contributions

Conceptualization, C.B.M.C.; methodology, C.B.M.C.; software C.B.M.C.; validation, C.B.M.C.; formal analysis, C.B.M.C.; investigation, C.B.M.C.; resources, C.B.M.C.; data curation, C.B.M.C.; writing—original draft preparation, C.B.M.C.; writing—review and editing C.B.M.C.; visualisation, C.B.M.C.; supervision, C.B.M.C.; project administration, C.B.M.C.; funding acquisition, C.B.M.C.. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

About *Coleção Estudos Cariocas*

Coleção Estudos Cariocas (ISSN 1984-7203) is a publication dedicated to studies and research on the Municipality of Rio de Janeiro, affiliated with the Pereira Passos Institute (IPP) of the Rio de Janeiro City Hall.

Its objective is to disseminate technical and scientific production on topics related to the city of Rio de Janeiro, as well as its metropolitan connections and its role in regional, national, and international contexts. The collection is open to all researchers (whether municipal employees or not) and covers a wide range of fields — provided they partially or fully address the spatial scope of the city of Rio de Janeiro.

Articles must also align with the Institute’s objectives, which are:

1. to promote and coordinate public intervention in the city’s urban space;

2. to provide and integrate the activities of the city’s geographic, cartographic, monographic, and statistical information systems;

3. to support the establishment of basic guidelines for the city’s socioeconomic development.

Special emphasis will be given to the articulation of the articles with the city's economic development proposal. Thus, it is expected that the multidisciplinary articles submitted to the journal will address the urban development needs of Rio de Janeiro.