The nature of geoinformation in the 21st century

A natureza da geoinformação no século XXI

La naturaleza de la geoinformación en el siglo XXI

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Abstract

This article discusses the transformation of geoinformation in the 21st century, highlighting its transition from material representations to digital, dynamic, and largely dematerialized forms. Through a historical trajectory ranging from the first maps of the 16th century to modern techniques such as aerial photogrammetry, remote sensing, GNSS, and digital twins, the text seeks to demonstrate how technological evolution has exponentially expanded the possibilities for territorial analysis and management. However, this same dematerialization and speed of production raise concerns regarding ephemerality and future preservation. The article concludes by reflecting on the need for the curation and conservation of geoinformation as a cultural, scientific, and artistic product, which is essential for enabling future generations to understand and continue the knowledge produced in the present.

Keywords: geoinformation; preservation; territorial memory

Resumo

Este artigo discute a transformação da geoinformação no século XXI, destacando sua passagem de representações materiais para formas digitais, dinâmicas e amplamente desmaterializadas. A partir de um percurso histórico que vai dos primeiros mapas do século XVI às técnicas modernas de aerofotogrametria, sensoriamento remoto, GNSS e gêmeos digitais, busca-se evidenciar como a evolução tecnológica ampliou exponencialmente as possibilidades de análise e gestão territorial. Contudo, essa mesma desmaterialização e rapidez de produção levantam preocupações quanto à sua efemeridade e preservação futura. O texto conclui refletindo sobre a necessidade de curadoria e conservação da geoinformação como produto cultural, científico e artístico, fundamental para que as gerações futuras compreendam e deem continuidade ao conhecimento produzido no presente.

Palavras-chave: geoinformação; preservação; memória territorial

Resumen

Este artículo discute la transformación de la geoinformación en el siglo XXI, destacando su transición de representaciones materiales hacia formas digitales, dinámicas y ampliamente desmaterializadas. A partir de un recorrido histórico que va desde los primeros mapas del siglo XVI hasta las técnicas modernas de aerofotogrametría, teledetección, GNSS y gemelos digitales, se busca evidenciar cómo la evolución tecnológica amplió exponencialmente las posibilidades de análisis y gestión territorial. No obstante, esta misma desmaterialización y rapidez de producción plantean preocupaciones en torno a su carácter efímero y a su preservación futura. El texto concluye reflexionando sobre la necesidad de la curaduría y conservación de la geoinformación como producto cultural, científico y artístico, fundamental para que las generaciones futuras comprendan y den continuidad al conocimiento producido en el presente.

Palabras clave: geoinformación; preservación; memoria territorial

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A flyover of the article titles published here seems to compel us to notice how the new nature of geoinformation makes it multifaceted and dynamic. It remains, of course, an informational representation of the geospatial dimension of phenomena, as it has been since the first mappings that represented our marvelous city of Rio de Janeiro. However, if in those days, due to all technical circumstances, it was slow to produce and of absolute materiality in representation, its technical conditions and possibilities today make it so dynamic that it inevitably brings to mind the fear that it is becoming not only fleeting but also ephemeral. This could render impossible in the future, for example, the immense delight of appreciating the collection of historical maps of Rio de Janeiro, presented in the beautiful book **From the Cosmographer to the Satellite: Maps of the City of Rio de Janeiro**[1], organized by Jorge Czajkowski and published in the year 2000 by the Municipal Secretariat of Urbanism and the Rio de Janeiro Center for Architecture and Urbanism.

The first maps of the city on record are from the 16th century, when the French and Portuguese disputed dominion over what is now Guanabara Bay and its surroundings. I do not wish to believe that the Tupinambás, the indigenous peoples of this land, did not also have their geoinformational representations; after all, practically all indigenous peoples had some form of representation of the spatial dimension of their phenomena of interest, although very few of them, unfortunately, have endured over time. The History of Cartography provides very clear indications that the many diverse human societies have always had some form of geospatial representation, of geoinformation, mainly because it is indispensable for territorial management, even when precarious and ephemeral, given the technical maturity of the society. It is truly a pity that most of them, ephemeral due to their material bases of representation, have been lost. And, returning to the reflection about our current ones, which have become dematerialized, the doubt arises as to whether they will have in the future the same invisibility that many of the geoinformations of indigenous peoples have today. Of course, we are facing the paradox of comparing past geoinformations that were lost due to the precariousness of their preservation conditions versus powerful and dynamic geoinformations, like the current ones, which, however, have become so dematerialized that they may, after all, share the same fate, given the accelerated transformations of digital technology. Is the concern justified, or will the cloud preserve everything?

The historical map collection, assessed while browsing the book, highlights the technological evolution of geoinformation over time. The first maps, still in the 16th century, are little more than sketches, serving functions of special cartography, whether to support navigation in the bay and its adjacencies, or to explore, record, and instruct the occupation of the region. They are expeditious cartographies, with low fidelity to reality and with a representation of the relief — which in this region is especially important and referential — still very schematic, almost pictorial.

One of the first maps in which the proportional relationship between the representation and reality is recognized is from the late 18th century, from the hand of Francisco João Roscio. The topography remains schematic, but much more attuned to reality. At a time when the cartography of large areas was essentially the result of compiling many previous bases and the expeditious astronomical survey of only a few reference points, this is a map in which the essence of the technique and art of cartography reach a peak of interweaving. Still in the 18th century, but at its beginning, the first large-scale cadastral plans of the city also stand out, certainly made possible by topographic surveys that were already common for Europeans at that time. The challenge of representing the relief remained, however, now less schematic but still merely pictorial.

Even in the beautiful plans from the late 19th century, certainly already produced by compiling and cartographic mosaicking of various cadastral mappings, the relief is positioned more accurately, planimetrically, but continues to be represented

[1] Do Cosmógrafo ao Satélite: Mapas da Cidade do Rio de Janeiro

pictorially in its three-dimensional modeling, which is very beautiful but useless from the perspective of its instrumental use in engineering. Missing is the representation that revolutionized the three-dimensionality of the map in the 20th century, which was the generation of contour lines, which appear in the 1905 city plan of Rio de Janeiro, from the time of Mayor Pereira Passos, just 120 years ago, almost nothing in terms of the long history of geoinformation, which holds prehistoric records like Çatal Hüyük, from about 8,000 years ago, in what is now Turkey.

The 20th century is the century par excellence of aerophotogrammetry as a technique for surveying extensive areas. Urban geoinformational production still takes the form of cadastral maps, generated by stereocompilation or stereophotogrammetric restitution, based on aerial photographs, which highlight the beauty of Rio de Janeiro's landscape. Photographs and maps still have a material basis and greatly resemble their predecessors from the early 20th century, when remote sensing was not yet common as a technique. With all the geotechnological contribution of aerophotogrammetry in the 20th century, urban mappings became a fundamental tool for the management and spatial analysis of urban transformations in large cities, and Rio de Janeiro, in this case, was always well represented, including with aerophotogrammetric mappings of community areas with intricate planimetric configurations, which would be impracticable to map by other methods.

The most disruptive change, however, occurs not with the change of techniques or their production methodologies. They did transform, for example, with the generation of orthoimages and digital three-dimensional models, despite these techniques already existing in the 20th century. The structural rupture occurs, however, due to the complete dematerialization of the means of geoinformational production and representation. Images transform from a film base to a digital file base, land surveys transform from the physical annotation of data to the acquisition of digital data, the generation of geoinformational bases, which in material representation were fundamentally maps, charts, and plans on a plastic or paper base, transforms into a myriad of geoinformational products as diverse as the possibilities created by graphic and imagery computing, ultimately hinting today at the representation of almost total fidelity called Digital Twins, precise in the geometric and imagery 3D representation of real-world objects.

The almost total dematerialization of geoinformation is also associated with an abundant and fast data production, due to the incorporation of the fourth dimension, time, into geoinformation. Dynamic georeferencing through GNSS and inertial systems, associated with the diversity of remote sensors we have today, allows for the monitoring of various phenomena and their fleeting real-time representations, this being another aspect of the disruption caused by dematerialization. There is, of course, an obvious advantage to this. The capacity to analyze the most diverse environmental and geospatial aspects of the most diverse phenomena grew exponentially with the dematerialization of geoinformation. The articles presented here evidence this. Without the technological evolution and dematerialization I superficially described, the vast majority of the analyses presented here would be impracticable. They would not be impossible, because with 20th-century techniques they were already technically feasible, therefore not impossible, but impracticable, that is, without effective practical possibility. Articles presented here that analyze the variability of building heights based on laser scanning data are an example of the possibilities created by new geoinformational production technologies.

What is concerning, however, is how much the dematerialization that enables all this knowledge production will not make it ephemeral. Geoinformation is a fundamental cultural product for a society, like the arts and other human cultural expressions. What will remain of what is produced in terms of geoinformation in the 21st century? Who will do the curation that selects what should be permanent from what can be ephemeral? How to ensure permanence decades or centuries ahead, as museums guarantee the beautiful historical maps we have today? It frightens me to realize that digital mappings I worked on in the 1990s have been lost, some due to technological

transformations, others due to the loss of the original digital files. We worry today about preserving the natural environment, thinking of future generations. Geoinformation is technique and art, it is a tool of science, it is culture, it is an expression of a society and an era. What will we preserve of ours so that future generations understand us and can make their time an evolution of ours?

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About the Author

Luiz Henrique Guimarães Castiglione is a cartographic engineer who graduated from UERJ in 1979. He worked as a geoinformation production manager and consultant for over 40 years. He is currently a full professor in the cartographic engineering course at UERJ, where he has been teaching since 1982. His research interests pertain to the epistemology of geoinformation.

Author Contributions

Conceptualization [L.H.G.C.]; formal analysis [L.H.G.C.]; investigation [L.H.G.C.]; writing—original draft preparation [L.H.G.C.]; writing—review and editing [L.H.G.C.].

Conflicts of Interest

The author declares no conflict 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.