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► To cite this version:

Alicia Bianchi, Giovanni Fusco, Karine Emsellem. Toponymic representation of spaces within the city through real estate ads. 23rd European Colloquium on Theoretical and Quantitative Geography (ECTQG 2023), Universidade de Coimbra, Sep 2023, Braga, Portugal. hal-04329864

HAL Id: hal-04329864

<https://hal.science/hal-04329864>

Submitted on 7 Dec 2023

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Toponymic representation of spaces within the city through real estate ads

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Keywords: Spatial analysis, real estate ads, toponym, spatial representation, fuzzy geographical location

Toponyms mark, segment and organise the urban space since their creation. They evolve with time and space, reflecting the historical, social, and cultural evolution of cities, including in terms of urban planning (Le Squère, 2006; Jordan, 2020; Giraut & al. 2016). They are perceived and identified by populations, thus contributing to the social representation of the different subspaces that compose the city. Toponyms respond to both spatial and social dimensions, making them difficult to identify. Their location and characterization present blurred and uncertain boundaries (Bunel, 2021). Several studies have dealt with the delimitation of fuzzy socio-spatial phenomena (Hu & al. 2019, Vasardani & al. 2013).

In this direction, we propose to reconstruct and characterise the toponymic landscape of the city from geolocated real estate ads, using an appropriate spatial analysis of the pieces of information on the urban space present in their text.

A geographic database was used, containing tens of thousands of pieces of geographic information extracted from real estate ads texts of the French Riviera through a combination of natural language processing (NLP) and artificial intelligence (Cadorel & al., 2021). The geographical information extracted, cleaned, and structured, is based on the places and their socio-spatial context, made of spatial relationships and associated attributes, recognizable in expressions like "*in the residential neighbourhood of Cimiez*".

The naming and delimitation of places based on a multitude of extracted information are complex processes, leading to blurred toponyms with unclear boundaries, even if spatial barriers can sometimes segment their use. To model the significance of toponyms in space, we have developed a protocol based on spatial analysis of geographical information extracted and geolocated with decametric precision on the street network. The street network is a fundamental feature for the perception and cognition of urban space (Lynch 1960), and we can assume that it can be a pertinent basis for its segmentation through toponymy.

Geolocated ads can be seen as a spatial sampling of toponym use. We thus interpolated toponym use with a kernel density-based approach on the street network with adaptive parameters for each toponym (Gelb, 2021; Lachance-Bernard & al., 2011). The toponyms are those present in the

database of extracted geographical information associated with a relationship of spatial situation (Blanchi & al., 2022).

From there, we extracted the relevant phenomenon (use of a given toponym) by imposing a minimal threshold and some spatial coherence in toponym use. Artefacts linked to erroneous geolocations or low presence of ads (a known bias introduced by the real estate market) could thus be reduced. Nevertheless, the presence of toponym use in space is not sufficiently indicative of its representation within the urban toponymic landscape. We therefore also assessed its absence within the same space, using the same interpolation method of all geolocated real estate ads that do not mention the toponym through a notion of situation.

Finally, we assessed the strength of a toponym in space using the concepts of core-space and support-space, derived from fuzzy set theory. First, the ratio between the kernel densities of presence and absence of toponym use on each street segment is used to model graduated presence of the phenomenon. Then, using the equivalent of an alpha-cut approach, the core was defined as the space where toponym use was predominant, and the support as the space of extended but more contested use. More precisely, morphological closures and connection checks were also carried out to impose spatial coherence on core- and support-spaces. Their mapping reveals how place-name usage produces meaningful patterns in intra-urban space, independently of administrative constraints.

However, some subspaces can be shared by different place names. Within the context of real-estate valorisation, some toponyms can be used more widely beyond their core. Supports overlap cores in an asymmetric way, showing the different power exerted by toponyms in the social representation of space. A local hierarchy among neighbouring toponyms can thus be calculated and mapped, producing new insight in the social meaning of the identified spatial patterns.

It was also possible to further characterise toponyms through their associated geographic entities. Entities like “*neighbourhood*”, “*sector*”, “*street*”, “*hill*” have different meanings in social perception and cognition. Finally, a correspondence analysis was carried out using toponyms, associated attributes, and localisation factors (features of space put forward by real estate ads, including proximity to interest points, urban services and environmental amenities and view factors). The interpretation of the factorial axes allowed for the identification of main oppositions within the toponymic landscapes of the cities of the French Riviera. In Nice, for example, a first major opposition is between what are perceived as toponyms of residential places on the hills surrounding the city, and two different subspaces within the latter: the historic and tourist-oriented city and the more utilitarian city signified by the presence of urban facilities and services.

In conclusion, the spatial analysis of toponyms and their relationships in space allowed us to represent the patterns of toponymic landscape as they are perceived, appreciated, and identified by people. However, it is important to note that our data comes from real estate ads, which are punctual data influenced by the dynamics of the real estate market and real estate valorisation.

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