Scales of Inequality in Urban Brazil. A Multi-scalar Analysis of Environmental Justice

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My Ph.D. thesis[1] investigates the relations between socioeconomic, ethnic, and environmental variables in the production of spatial inequalities in Brazil's largest cities. The study applies a multi-scalar geostatistical approach, examining census and other geospatial data at different levels of extension and resolution in order to capture crossscale patterns. For this conference, I will focus on environmental risk (flooding and landslide) as a dimension of socioeconomic and racial inequalities[2]

Every year the world population is becoming more urban. In 2018, 55% of the global population resided in cities, increasing to 68% by 2050. In Brazil, 87% of the population lives in urban areas; a figure estimated to rise to 92% by 2050 (United Nations, 2019). Such aggressive urbanization impacts heavily on natural areas, including coastal strips, wetlands, floodplains, and forests (Abreu, 1987; Cabral et al., 2016; Dean, 1995), which may lead to greater exposure to environmental risks, especially in large cities such as Rio de Janeiro (Herzog, 2014). These increasing risks pose questions about the links between people and nature and demand more attentive consideration of the distribution of environmental benefits and damages.

Many studies have been conducted to understand better such environmental justice issues. However, this literature tends to take spatial scale for granted, generally adopting a single-scale approach. Most works unproblematically focus on a single city (Ajibade et al., 2013; Alves & Ojima, 2013; Maantay & Maroko, 2009), a country (Fielding, 2018; Walker & Burningham, 2011), a macro-region (Alvalá et al., 2019), or a district (Keerthiratne & Tol, 2018; Romero et al., 2012). As a result, these studies fail to address the complexities of measuring and analyzing phenomena at different urban levels, with their results being potentially misleading in guiding public policy. Moreover, climate change's impacts are being felt and need to be tackled on global, regional, and local scales, which requires research on the scaling of climate action (Knuth et al., 2020). Multi-scalar approaches are better placed to capture the complexities of human-environment systems (Debbage, 2019) and thus to inform public policy (Barrett, 2013). Multi-scalar approaches provide a coherent framework for analyzing data patterns across scales, providing relevant information for each stage of decision-making, as well as supporting policymakers, planners, and investors to minimize urban environmental risk. Using the latest available census carried out by the Brazilian

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Institute of Geography and Statistics (IBGE, 2010) and the susceptibility to landslide and flood database produced by the Brazil Geological Service (CPRM, 2014), this study sets out to assess the relations between income, color/race, and risk to flooding and landslide at three urban scales: metropolitan area, municipalities, and boroughs in Rio de Janeiro and São Paulo. Our ethnic and economical lens relates to the strong legacy of slavery, which was abolished very late in Brazil (i.e. in 1888). Racism and the lack of public policies to integrate formerly enslaved people have left these minority groups with no access to land and adequate housing, living in the most precarious areas of cities (Valladares, 2005). By examining the relationship between these variables, the objective is to appraise environmental (in)justice in Rio de Janeiro and São Paulo, and determine whether any identified relationships replicate across various urban scales. The underlying goal is to provide evidence and a coherent narrative that informs future policies and planning in Brazilian urban areas that effectively address environmental risk in vulnerable communities, considering the urban scales of climate action. Using the statistical technique known as k-means clustering in cells of 200 x 200 meters, we ran a multivariate analysis by creating four clusters with similar average values for the variables studied in each analytical scale. It allowed us to understand the relations between those variables in their statistical and spatial entanglements. The results obtained so far for Rio de Janeiro and São Paulo corroborate the literature by showing that the most affected by environmental risk are non-white and low-income people. However, it goes beyond that by unveiling that this relationship is replicated across urban scales, which we argue is a structural process. We found a similar environmental justice pattern when manipulating data at the metropolitan area, municipalities, and boroughs scales. It implies that the actions also need to be addressed in a multi-scalar approach to effectively minimizing environmental (in)justice.

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