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A spatial analytic approach for classifying greenspace and comparing greenspace social equity

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ABSTRACT

Urban planners frequently adhere to 'park minimum standards' to ensure that public health and environmental benefits associated with greenspace are socially equitable. These standards denote the extent and placement of greenspaces, but rarely consider their form and function. Arguably, an inclusive evaluation of greenspace social equity requires the comparison of greenspace types. To address if greenspace types are socially equitable, I develop a novel spatial analytic approach that classifies 4265 greenspaces according to twelve functional, physical characteristics. I then compare the social equity of these greenspace types using multiple operationalizations of social equity (provision, accessibility, and population pressure) throughout 4524 neighborhoods in a capital city in Australia. I find that greenspace social equity varies for each of these types. For example, results reveal that affluent households have an abundance of amenity rich greenspaces and few amenity poor ones. Further, by comparing across multiple social equity operationalizations, I find that affluent households may have a deficit of the amenity poor greenspace type, but live closer to this type. These findings confirm that employing a greenspace typology and multiple social equity operationalizations can deepen our understanding of the association between social equity and greenspace provision. This spatial analytic approach is both adaptable for examining other urban land use types, and portable to other urban contexts, and can aid urban planners, researchers, and policy makers to understand how to improve the social equity of publicly beneficial greenspace types.

1. Introduction

The term 'public greenspace' typically describes public spaces enhanced by the presence of vegetation (Coolen & Meesters, 2012; Feyisa, Dons, & Meilby, 2014). This vegetation can benefit the public by: capturing and sequestering airborne and waterborne contaminants (Yang, Mcbride, Zhou, & Sun, 2005); negating the urban heat island effect (Feyisa et al., 2014); aiding immune response development (Hanski et al., 2012); improving exercise effectiveness (Akers et al., 2012; Qin, Zhou, Sun, Leng, & Lian, 2013); and reducing anxiety (Mackay & Neill, 2010), depression (Beyer et al., 2014), cortisol levels (Tyrväinen et al., 2014), and blood pressure (Pretty, Peacock, Hine, & Sellens, 2007); and elevating moods and self-esteem (Barton & Pretty, 2010). Greenspaces are also associated with social benefits that include fostering place attachment (Hur, Nasar, & Chun, 2010) and inter-group trust (Mason, 2010); increasing efficacious behavior (Cohen, Inagami, & Finch, 2008); and stabilizing long-term social networks (McCunn & Gifford, 2014).

To ensure greenspace benefits are socially equitable, urban planners frequently adhere to 'park minimum standards'. These standards typically recommend both: a minimum area of greenspace per local resident, and a maximum distance that any resident should travel to reach their closest greenspace (Byrne, Sipe, & Searle, 2010). Yet these standards generally lack specificity regarding the frequency, type, or proximity of greenspace amenities. I define greenspace amenities as features built by council to extend the functionality of greenspace, and thus appeal e.g. playgrounds, seating, services, and sporting amenities (Baum & Palmer, 2002; Cohen et al., 2010; Henriksen & Tjora, 2014). If greenspace size and placement are the chief concerns in particular settings, this may explain why greenspaces can reduce or interrupt the continuity of neighborhood social ties (Hipp, Corcoran, Wickes, & Li, 2014) and social support (Fan, Das, & Chen, 2011). Further, unappealing greenspaces may extinguish residents' desires to act as place guardians, which in turn leads to higher crime in some

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greenspaces (Groff & McCord, 2012; Kimpton, Corcoran, & Wickes, 2016), and increasing crime in adjacent areas (Crewe, 2001; McCord & Houser, 2015).

When Ebenezer Howard proclaimed in 1898 that urban greenspace was a way to combine all the benefits of both urban and rural lifestyles by improving "the standard of health and comfort of all" (1898/1965, p.51), the notion that greenspace could be publically detrimental was unlikely. Howard's influential *Garden Cities of Tomorrow* (1898/1965) spurred the ideologically-driven Garden Cities Movement; the same movement that many conclude was responsible for the spread of greenspace throughout modern cities (Kabisch, Qureshi, & Haase, 2015; Swanwick, Dunnett, & Woolley, 2003). An unintended consequence of this movement is that we preserve the undesirable and detrimental greenspaces at the expense of urban consolidation. Indeed, every hectare of greenspace within the urban form displaces a hectare outside, and yet it is the hectare within the urban form that: 1) extends daily commutes; 2) interrupts the flow of social ties; and 3) exposes residents to criminal victimization. This brings to the fore the importance of distinguishing types of urban greenspaces that bring the greatest benefits to urban dwellers. This then enables urban planners to provide more of the beneficial greenspace types and repurpose the detrimental greenspace types.

While it is possible to locate multiple studies, reports, and planning schemes that distinguish greenspace types (see Appendix 1), on whole studies do not provide greenspace typologies that are portable to a new urban context. Further, given that these studies employ unique greenspace typologies, research findings are generally incomparable between studies. For example, one study may employ a two-type greenspace typology (Barbosa et al., 2007) that is incomparable to another study that employs a nineteen-type greenspace typology (Bell, Montarzino, & Travlou, 2007). Further, while two studies may employ the same label to describe their greenspace type, the type may vary between studies. For example, a "neighborhood park" may describe a greenspace smaller than 4 ha in one study (Brown, Schebella, & Weber, 2014) but a cluster group of greenspaces with similar spatial, land cover, built, and social characteristics for another (Ibes, 2015). Last, how studies observe these characteristics can also vary. For example, the "amenity" characteristic could be the count (Sugiyama, Francis, Middleton, Owen, & Giles-Corti, 2010), diversity (Ibes, 2015), or qualities of greenspace amenities (Bell et al., 2007). Despite the challenges of classifying greenspace, it remains theoretically important given that multiple studies suggest residents prefer particular greenspace types (Brown et al., 2014; Korpela, Ylén, Tyrväinen, & Silvennoinen, 2009; Sugiyama et al., 2010), and that residents are willing to pay higher property prices to live closer to particular greenspace types (Anderson & West, 2006; Ham, Champ, Loomis, & Reich, 2012; Panduro & Veie, 2013; Saphores & Li, 2011).

This willingness to pay higher land prices to live closer to particular greenspace types also has important theoretical implications for greenspace social equity given that some social groups can better afford these optimal locations. Likewise, this process may displace some social groups to locations closer to greenspace types that bring few benefits and can even be harmful. Greenspace social equity research has mixed findings since both poorer (Astell-Burt, Feng, Mavoa, Badland, & Giles-Corti, 2014; Crawford et al., 2008; Dai, 2011; Estabrooks, Lee, & Gyuresik, 2003; Mitchell & Popham, 2008; Sister, Wolch, & Wilson, 2010; Timperio, Ball, Salmon, Roberts, & Crawford, 2007) and wealthier social groups are associated with having greenspace inequities (Barbosa et al., 2007; Macintyre, Macdonald, & Ellaway, 2008; Mavoa et al., 2014). These contradictory findings may be contextual but it is also notable that few of these studies distinguish greenspace types (for exceptions, see Ham et al., 2012; Ibes, 2015; Macintyre et al., 2008) and social equity operationalizations routinely vary between studies (see Appendix 2), which again limits comparability between studies. Each of these social equity measures can be considered as belonging to one of three general operationalizations of social equity that from this point onwards I classify as: (1) provision, (2) accessibility, and (3) population pressure. The *provision* operationalization examines greenspace social equity by capturing the local abundance of greenspace. It is the most common operationalization and it is generally captured as the proportional area of greenspace within a buffer or neighborhood unit (Astell-Burt et al., 2014; Crawford et al., 2008; Estabrooks et al., 2003; Ham et al., 2012; Macintyre et al., 2008; Mavoa et al., 2014; Mitchell & Popham, 2008; Saphores & Li, 2011; Timperio et al., 2007). The *accessibility* operationalization in contrast examines greenspace social equity by capturing the travel cost of visiting the nearest greenspace. It is the next most common operationalization and it is generally captured as either, the Euclidean or network distance from each household or neighborhood centroid to the nearest greenspace (see Barbosa et al., 2007; Ham et al., 2012; Mavoa et al., 2014; Panduro & Veie, 2013). *Population pressure,* a relatively uncommon operationalization, examines greenspace social equity by capturing potential greenspace crowding if every resident visits their nearest greenspace. When captured, the greenspace becomes the unit of analysis rather than neighborhood, and requires counting the local resident population within each greenspace service area that is spatially defined by either fixed buffers, floating Gaussian-based polygons, or Thiessen polygons (Dai, 2011; Ibes, 2015; Sister, Wolch, & Wilson, 2010).

Each of these three greenspace social equity operationalizations assume some relationship between neighborhood residents and greenspace. For example, *provision* assumes that residents derive equal benefit from all their neighborhood greenspaces rather than their closest or most visited, and that a hectare of greenspace provides the same benefits whether whole or fragmented throughout the neighborhood. In contrast, *accessibility* assumes that residents only visit their nearest greenspace, and that they universally dislike longer neighborhood journeys to the greenspace. Last, *population pressure* assumes that encountering other residents is undesirable, and again that residents only visit their nearest greenspace. Given these notable assumptions, it is surprising that only Ham (2012), and Mavoa et al. (2014) employ multiple greenspace social equity operationalizations. Both studies employ a provision and an accessibility operationalization and reveal social inequities exist according to the accessibility operationalization, but only Mavoa and colleagues' findings reveal that social inequities also exist according to the provision operationalization. Given that both operationalizations reveal social inequities, Mavoa and colleagues advise that conceptualizing greenspace social equity as a multidimensional concept may deepen current understandings of the issue.

This paper seeks to redress these limitations and aims to: (1) develop a spatial analytic approach for distinguishing greenspace types that is both comparable between studies and portable to other urban contexts; and (2) to compare the social equity of these greenspace types by observing multiple dimensions of social equity. For my first aim, I introduce a novel measure for empirically capturing greenspace shape. Following, I develop a program that classifies a large volume of greenspace amenities according to keywords found within each amenity's descriptive text. Last, I introduce a unique type of cluster analysis that can group greenspace according to the conventional continuous characteristics such as size but also can uniquely group greenspace according to binary characteristics such as the absence/presence of each amenity type. For my second aim, I operationalize social equity according to three conceptually distinct operationalizations: