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Accessibility to urban green spaces in Chilean cities using adaptive thresholds

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ABSTRACT

Open spaces in cities, such as green spaces and parks, are key elements of urban landscapes and urban sustainability. Open spaces improve the quality of the environment, quality of life, and promote social interaction and inclusion. There is evidence of positive impacts on health. This research analyses the potential accessibility to open spaces in two Chilean cities, Valdivia and Temuco. Analysis of accessibility is based on patterns of daily mobility by travelers while considering their trips and transport modes, in particular walking. Statistical analysis of trip length forms the basis of an adaptive threshold for the calculation of a cumulative potential measure of accessibility. The analysis shows that, for these two cities, variations in accessibility tend to be driven by age and gender, and less by income. There are also variations between the two cities, with Temuco showing better levels of accessibility, as a consequence of residents generally undertaking longer walking trips.

1. Introduction

Urbanization in Chile in the past 30 years has been characterized by growing numbers of households living in peripheral locations. This is true for social housing, and to a lesser extent also for condominiums preferred by higher income households. Much of this growth has been in low-density development and, as a consequence, transportation has become an increasingly essential mediating factor for accessibility to opportunities for daily life activities. Transportation can increase or reduce the spatial segregation for those living in the periphery of urban centers. Poor transportation conditions can lead to spatial polarization in which lower income groups in peripheral areas face challenges to access quality services and facilities (Sabatini and Brain, 2008). It is for this reason that accessibility is considered an important indicator of social equity (Lucas, 2012).

Among urban services, green spaces are recognized as key elements that improve urban landscapes and enhance urban sustainability. Urban green spaces enhance the quality of life of urban residents, by improving their physical, social, and psychological well-being (Fuller and Irvine, 2010; Keniger et al., 2013). Open green spaces are thought to promote social interaction and inclusion, and can support biodiversity and provide important ecosystem services as well (Bolund and Hunhammar, 1999; Chiesura, 2004; Wolch et al., 2014), This includes the provision of habitat for urban biodiversity (Bolund and Hunhammar, 1999; Tratalos et al., 2007), hydrological regulation (Bradshaw et al., 2007; Ryan et al., 2010), carbon sequestration (Nowak and Crane, 2002), and attenuation of urban heat island effects (Arnfield, 2003), among others.

A number of benefits associated with accessibility to urban green spaces have been researched in the past. For instance, accessibility to green spaces increases the probability of residents visiting, and therefore contribute to increased physical activity (Krenichyn., 2004; Roemmich et al., 2006). The benefits, on the other hand, are not only to physical health, since access to green spaces offers opportunities to reduce stress and mental fatigue (Burgess et al., 1988; Chiesura, 2004; Van den Berg et al., 2010). Lower access to urban green spaces, in contrast, correlates with a higher risk of being overweight or obese, as well as with poorer self-perceived health, and higher mortality risks (Mitchell and Popham, 2007; Mitchell and Popham, 2008). Moreover, recent evidence indicates that the loss of human-nature interactions can have profound negative effects on society and, in a city, these interactions occur mainly in open spaces. Other green features of the city, such as private or domestic gardens, are not necessarily good substitutes (Barbosa et al., 2007). Given the above, it is not a coincidence that green spaces are of interest for public health reasons (Dai, 2011).

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Given the potential benefits of green spaces, and the fact that their mechanism of delivery is through accessibility pathways (Keniger et al., 2013), accessibility to green spaces is recognized as an environmental justice issue (Wolch et al., 2014). From this perspective, accessibility refers to the potential for exercising the right to use from particular places, at particular times, and by specific people. Critical factors that are relevant (see Handley et al., 2003) include physical constraints (such as distance from home and the ability to move), as well as socio-economic and demographic factors.

Previous research has focused primarily on two aspects of accessibility, namely, distance to green spaces and area available at that distance. In some cases, accessibility is defined in terms of only one of these factors. For example, the European Environment Agency (EEA) recommends that residents have access to green space within 15 min walking distance of their place of residence (Stanners and Bourdeau, 1995), but does not specify the amount of green space to be reached. More frequently, accessibility is defined as a combination of proximity and area. Coles and Bussey (2000), for example, assess the ability to reach at least 2 ha of green space with a 5–10 min walk (approximately 100–400 m). Van Herzele and Wiedemann (2003) propose a 5-min walk (equivalent approximately to 400 m) to reach 1–10 ha of green space. The measure of accessibility used by Handley et al. (2003) is based on 2 ha of green space within 300 m from home or 20 ha within 2 km. Richardson et al. (2010) considered both walking and cycling and defined a radius of 1300 m using a buffer around a usable area of 5 km^2 of green space. The government agency English Nature, in Handley et al. (2003), recommends a provision of at least 2 ha of green space within 300 m from the place of residence. Using floating catchment areas, Dai (2011) determined the potential accessibility to green spaces based on a 10 to 30 min bandwidth for walking distances. According to this analysis, accessibility within a radius of 15 min ranges between 0.49 and 18.31 acres/1000 people in a case study of Atlanta.

An underlying assumption in the analysis of accessibility is that shorter distances to green spaces (assuming a minimum surface area) increase accessibility – and consequently the likelihood that people will use the area (e.g., Coles and Bussey, 2000; Peschardt and Stigsdotter, 2013). Nevertheless, as discussed by Páez et al. (2012), although these accessibility measures consider the spatial characteristics of locations, they often fail to account for observed variations in individual mobility patterns. In other words, use of a fixed buffer (e.g., 5, 10, 15 min walks), while perhaps appropriate for normative analysis, is inadequate to understand accessibility for different segments of the population. By assuming that accessibility is determined by location only, the characteristics of the potential users of urban services are ignored. The assumption that accessibility depends on location only is, therefore, unrealistic, given various well-documented variations in mobility by different individuals (e.g., Morency et al., 2011; Reyes et al., 2014). As a consequence, a key question, given the impact of access to green spaces, is whether variations in patterns of mobility can exacerbate disparities in accessibility to various urban services, including parks and open spaces.

There is evidence of differential accessibility in several regions in the world. The question of accessibility to urban green spaces has been studied in US cities, for instance with a focus on race and ethnicity (Dai, 2011) and in the UK in relation to geodemographic variables that describe social diversity (Barbosa et al., 2007). Similarly, there is a rising concern surrounding rapidly growing Asian cities, where deficient accessibility to green areas has been detected (Wolch et al., 2014; Yin and Xu, 2009). In contrast, there is a dearth of studies in developing countries. This is certainly the case in Chile, where rapid urban growth has been accompanied by an uneven distribution of parks and urban green areas (Reyes and Figueroa, 2010). The OECD (2013), for instance, found that Chile's urban regions tend to have a relatively low supply of green spaces: on average, just 4.15 m^2 per capita. Recent studies about the accessibility to urban green spaces in Santiago de Chile, found that there is an unequal distribution in surface and accessibility to parks, and that these inequalities are directly correlated with income in three case studies of Santiago (Reyes and Figueroa, 2010) as well as the different opportunities to spatial interactions in parks (Krellenberg et al., 2014).

In this context, the objective of this research is to investigate the levels of walking accessibility to urban green spaces in two medium size Chilean cities, namely Temuco and Valdivia. Selection of these cities was based on data availability. Data have become available, in turn, due to a new interest in green spaces from a policy and planning perspective in these cities. This is a timely endeavor, given that Chile is in the process of implementing a new National Urban Policy (CNDU, 2015). The study, thus, is well aligned with the objectives of recent urban policies, and can provide valuable information to planners as they work towards more equitable access and increased connectivity and accessibility of urban public spaces including the green areas. The research is motivated by concerns with equity, understood as justice or fairness of treatment, which implies a proportional distribution of resources between areas, depending on the needs and preferences of the same (Tsou et al., 2005). This is of particular importance in countries like Chile, where there are marked levels of socio-economic inequality. In such cases, the distribution of open green spaces can contribute to a more just distribution of ecosystem services (Pauchard and Barbosa, 2013).

For the analysis, we follow the approach used by Reyes et al. (2014) in Montreal, which is based on the use of adaptive bandwidths. Whereas the focus of Reyes et al. (2014) was on children, our interest is in age, gender, and income. These are all factors known to influence accessibility (Barbosa et al., 2007; Reyes and Figueroa, 2010; Dai, 2011; Reyes et al., 2014). The crux of the method is the revealed behavior of travelers, and the ease with which different individuals can overcome the distance between two places and, thus, exercise their right to use urban spaces.

2. Study context

Temuco and Valdivia are two cities characterized by socio-spatial segregation between traditional city centers and more recent peripheral growth. These issues have historically been compounded by limited urban planning. Although both cities have open green spaces with high ecological value (CEDEUS, 2013a; CEDEUS, 2013b; Pauchard and Barbosa, 2013), the available supply in each city is quite different. Whereas Temuco is identified as one of the cities in Chile with the best provision of urban green areas (with 10.98 m^2 per capita), green space is more limited in Valdivia with around 6 m^2 per capita according to a recent study (OECD, 2013).

2.1. Green spaces

We collected data regarding green spaces in the cities of Temuco and Valdivia from two different sources. Data for Temuco were digitalized and provided to us by the GIS Office of the Regional Government of Araucanía (2015), and were verified by the first author through photo-interpretation. Data regarding green spaces in Valdivia, on the other hand, were collected by Silva et al. (2015).

In Temuco green spaces are defined as urban spaces predominantly occupied or destined to be occupied by trees, shrubs or plants, and that provide public leisure and recreation space. These are: parks, squares with vegetation, and median strip. Most of them have maintenance from the government but to improve this classification we also include spaces with vegetation but without maintenance, such as wetland and floodplain rivers.

In Valdivia, green spaces are parcels with permeable surfaces and open access to the public, with predominant use for vegetation, including grasses, trees, shrubs, and/or plants. These spaces can be used freely for leisure and recreation activities. There are a number of different spaces that fulfill these characteristics, including municipal parks or plazas, public gardens attached to public buildings, sports fields,