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Research Paper

Impact of environment on people's everyday experiences in Stockholm

Karl Samuelsson[a,⁎], Matteo Giusti[b], Garry D. Peterson[b], Ann Legeby[c], S. Anders Brandt[a], Stephan Barthel[a,b]

[a] *Department of Industrial Development, IT and Land Management, University of Gävle, Kungsbäcksvägen 47, 801 76 Gävle, Sweden*
[b] *Stockholm Resilience Centre, Stockholm University, Sweden*
[c] *School of Architecture, KTH Royal Institute of Technology, Sweden*

A R T I C L E I N F O

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A B S T R A C T

In order to construct urban environments that limit negative impacts for global sustainability while supporting human wellbeing, there is a need to better understand how features of the environment influence people's everyday experiences. We present a novel method for studying this combining accessibility analysis and public participatory GIS (PPGIS). Seven environment features are defined and accessibility to them analysed across Stockholm municipality. We estimate the probabilities of positive and negative experiences in places based on these environment features, by using spatial regression to extrapolate from the results of an online PPGIS survey (1784 experiences of 1032 respondents). Six of the seven studied environment features have significant impact on experiential outcome, after accounting for spatial autocorrelation among the data. The results show that number of residents and proximity of nature environments and water, all common quality indicators in urban planning and research, have weak statistically significant effects on people's experiences. However, areas dominated by large working populations or proximity to major roads have very low rates of positive experiences, while areas with high natural temperature regulating capacities have very high rates, showing that there are considerable qualitative differences within urban environments as well as nature environments. Current urban planning practices need to acknowledge these differences to limit impacts on the biosphere while promoting human wellbeing. We suggest that a good way to start addressing this is through transformation of negatively experienced urban areas through designs that integrate closeness to urbanity with possibilities to have nature experiences on a daily basis.

1. Introduction

As the world continues to urbanise, cities need to develop so that negative impacts for global sustainability are limited (Bren d'Amour et al., 2016; Grimm et al., 2008; Kennedy et al., 2015), while wellbeing among urban inhabitants is supported. Much of current thinking in urban sustainability research and policy promotes compact cities – cities with high citizen density and contained extent. Compact city development is argued to mitigate climate change impacts by decreasing car dependency (Newman, 2006), enabling sustainable modes of transportation (Jabareen, 2006) and requiring less energy-spending on heating (Kennedy et al., 2015). Moreover, compact cities have further gained favour, as they can promote biodiversity conservation (Soga, Yamaura, Koike, & Gaston, 2014) and ecosystem services (Bren d'Amour et al., 2016; Stott, Soga, Inger, & Gaston, 2015) outside cities. However, the compact city paradigm has been challenged by research highlighting the importance of urban inhabitants interacting with nature environments (e.g. Soga et al., 2014). Such interactions provide possibilities for restoration from stress (van den Berg, Hartig, & Staats, 2007), foster psychological connections between urban inhabitants and the biosphere (Soga & Gaston, 2016) and promote physical and mental health (Gascon et al., 2015; Mitchell & Popham, 2008). In the words of Hartig and Kahn (2016), "cities designed well, with nature in mind and at hand, can be understood as natural, supportive of both ecosystem integrity and public health". Here, we refer to this narrative of urban development as the social-ecological city. These conflicting spatial paradigms must be reconciled to achieve urban environments that support social and ecological sustainability at scales from the local to the global. We approach this issue by studying how environment features emphasised within each paradigm together influence people's regularly occurring experiences.

Experiences are a mediating factor between the environment and

⁎ Corresponding author.
E-mail addresses: karl.samuelsson@hig.se (K. Samuelsson), matteo.giusti@su.se (M. Giusti), garry.peterson@su.se (G.D. Peterson), ann.legeby@arch.kth.se (A. Legeby), sab@hig.se (S.A. Brandt), stephan.barthel@hig.se (S. Barthel).

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wellbeing (Kyttä, Broberg, Haybatollahi, & Schmidt-Thomé, 2016). We study the relationships between environment and experiences by applying affordance theory (Gibson, 1979), both in our quantification of the physical environment and analysis of experiential outcome. Chemero (2003) defines affordances as "relations between abilities of organisms and features of the environment". Affordances only emerge when different characteristics of the individual, such as her physical abilities, emotions and intentions, are matched in meaningful relations with environment features (Withagen, de Poel, Araújo, & Pepping, 2012). However, realisations of affordances are probabilistic rather than deterministic (Altman & Rogoff, 1987). Typically, affordances refer to opportunities or restrictions for behaviour, but there has been a growing understanding of affordances in urban environments as also including opportunities or restrictions related to experiences (Kyttä, Broberg, Tzoulas, & Snabb, 2013), and development of environmental attitudes (Marcus, Giusti, & Barthel, 2016).

Within the compact city narrative, urban environments are argued to support wellbeing through opportunities for social and economic interactions between people (Dempsey, Brown, & Bramley, 2012; Legeby, 2013a). Jane Jacobs' (1961) writings were seminal for the understanding of how configurative properties of neighbourhoods influence possibilities for services, social capital and street life to emerge. Urban space is not simply a setting for social and economic activities, but directly shape them through its configurative properties (Hillier & Hanson, 1984). For example, the preconditions for people to collectively share public space influence social segregation (Legeby, 2013b). Configurative properties of neighbourhoods also condition labour market opportunities (Legeby, Pont, & Marcus, 2015) and possibilities for outdoor recreation (Ståhle, 2008; Vries et al., 2007). Consequently, urban inhabitants' experiences of their everyday environment are important indicators of opportunities to access urban resources (Legeby, 2013b).

Within the social-ecological city narrative, urban nature is argued to support wellbeing both through direct interaction and processes that are passively enjoyed. Often termed urban ecosystem services (Bolund & Hunhammer, 1999), these benefits are generated within landscapes (Andersson, McPhearson et al., 2014) and their supply is influenced by urban form (Tratalos, Fuller, Warren, Davies, & Gaston, 2007). For instance, if regulating services, such as temperature regulation, are to be enjoyed it is important that they are locally supplied (Andersson, Barthel et al., 2014). In environmental psychology research, a large body of literature has identified access to nature and water corresponding with psychological restoration (van den Berg et al., 2007), subjective wellbeing (MacKerron & Mourato, 2013), lower prevalence of mental health issues (Gascon et al., 2015), and increased physical activity (Frank, Kerr, Chapman, & Sallis, 2007). On the contrary, regular exposure to major roads is associated with adverse health outcomes (Passchier-Vermeer & Passchier, 2000). In addition to direct effects, perceptions of one's environment mediates wellbeing outcomes (Gidlöf-Gunnarsson & Öhrström, 2007), stressing that definitions of spatial accessibility need to be meaningful from a perception and cognition perspective.

This study aims to integrate the compact city and social-ecological city narratives to create a nuanced understanding of how urban environments influence people's regularly occurring experiences. To do this, we quantify relationships between different levels of spatial accessibility of a wide range of environment features and people's experiences. Our primary research question is *(i)* How does spatial accessibility to various environment features impact inhabitants' regularly occurring experiences? To answer this, we also answer *(ii)* How does spatial accessibility to these features differ across Stockholm, Sweden? As increasingly called for (Andersson, McPhearson et al., 2014; Kyttä et al., 2016), our method is spatially and experientially explicit and integrates 1) a social-ecological perspective of nature environments, operationalized through ecosystem service mapping, 2) a configuration perspective of the built environment, operationalized through accessibility analyses and 3) an ecological psychology approach for analysing human-environment relationships, operationalized through public participatory GIS (PPGIS).

2. Methods

2.1. Study area

Our study area is Stockholm municipality. It forms the centre of the Stockholm urban region. The larger region is home to approximately 1.5 million people, of which around 950,000 live in the municipality. It is situated between the Baltic Sea and Lake Mälaren, and has large areas of nature and water for a city − built-up areas, nature areas and water bodies each make up roughly one third of the study area. The city's inner core consists of mostly compact neighbourhoods with a central business district and surrounding mixed-use neighbourhoods, whereas suburbs include detached housing areas, apartment blocks and more recent mixed-use neighbourhoods. The municipality's population has grown by 26% over the last decade, and it faces challenges of maintaining large connected nature areas while accommodating an increasing population.

2.2. Selection of environment features

To assess how environment features emphasised within each paradigm together influence people's experiences, we chose features whose impact is well documented in the literature on spatial accessibility of urban resources, urban ecosystem services or environmental psychology. We also ensured that public geographic data for the entire area was available and that the data had sufficient spatial resolution. We assessed the accessibility to six features: residential population, working population, nature environments, playgrounds and schoolyards, water bodies and major roads, as well as local provision of natural temperature regulation (Table 1). Temperature regulation here refers to the ability that vegetation has to regulate local temperatures, and capacities depend on volume and type of vegetation, as well as continuous size of vegetated areas (Barthel et al., 2015).

2.3. Quantifying features

Accessibility to environment features was mapped across Stockholm to visualize their spatial patterns. As our definition of accessibility had to be relevant for analysing regularly occurring experiences, rather than using administrative boundaries, it was defined as being within 500 m from a measurement point. This distance is used in Stockholm municipality's own planning documents (Stockholms Parkprogram, 2006) and similar to applications in other studies (Coombes, Jones, & Hillsdon, 2010; Kyttä et al., 2016). To analyse our data consistently, we created a grid with 10 m resolution encompassing all land surfaces in the study area, and used cell centres as measurement points. This resolution provides a level of detail relevant for most urban planning projects, while not being overly computationally taxing to analyse. Cells closer than 500 m from the municipality border were excluded from the analysis, as they would suffer from edge effects due to data lacking outside the border.

Accessibility analysis of environment features was done using Place Syntax Tool (Ståhle, 2012). The accessibility of all features, but temperature regulation, was quantified by measuring the walking distance to them (see the Supplementary Material). Residential and working population were calculated as population within 500 m walking distance. Thus, quantifications for these features depend not only on street layouts but also citizen density, but for simplicity we refer to these quantifications as measuring accessibility. For nature environments, playgrounds, water and major roads, the distance to the closest feature was measured with 500 m as the maximum distance considered. The remaining feature, temperature regulation was quantified as average