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# Spatial analyses of people's experiences in urban landscapes

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# Abstract

Limiting cities' negative impact for global sustainability suggests compact city development. However, extensive and accessible urban nature is important for urban dwellers' wellbeing. Aligning efforts to make cities locally and globally sustainable means resolving this conflict.

This thesis applies spatial analysis of urban dwellers' regularly occurring experiences, as these are important wellbeing indicators, looking specifically at Stockholm, Sweden. The aim is to contribute to a deeper understanding of urban environments' multifaceted influence on urban dwellers' experiences. **Paper I** investigates how accessibility to various environment features impact the probability that people have positive or negative experiences. **Paper II** applies resilience principles to investigate what experiences exist together in neighbourhoods.

Results show that the environment has considerable influence on people's experiences. Some common urban planning indicators display weak relationships with experiential outcome, while other less common ones have larger effects. Neighbourhood compositions of experiences display consistent patterns, spatially across Stockholm and with respect to resilience principles. Many neighbourhoods harbour diverse positive experiences, while a few are dominated by negative ones.

The results suggest that human-environment relations should be given more consideration in urban discourse and urban planning. A relational approach could improve urban dweller's experiences. For urban planning to be able to handle the complexity of such an approach, I suggest that resilience principles can be heuristics for an urban development that does not compromise people's experiences. The methodological framework developed here can be applied in other cities, as it can identify specific places for transformation, but also increase knowledge of the interplay between urban environments and people's experiences across different contexts.

**Keywords:** Urban planning, social-ecological system, human wellbeing, experiences, affordance, ecological psychology, resilience, spatial analysis, PPGIS, Stockholm

# Sammanfattning

För att begränsa städers negativa påverkan på global hållbarhet förordas ofta kompakta stadsmiljöer. För att säkra stadsbornas välbefinnande krävs emellertid stora och tillgängliga naturområden. Denna konflikt måste lösas för att nå en stadsutveckling som bidrar till både lokal och global hållbarhet.

Denna avhandling består av två studier av Stockholm som tillämpar rumslig analys av människors upplevelser, då dessa är viktiga indikatorer för välbefinnande. Den undersöker hur tillgänglighet till olika miljöfaktorer är relaterade till positiva och negativa upplevelser. Vidare tillämpar den resiliensprinciper för att undersöka vilka upplevelser som samexisterar på områdesskala.

Stadsmiljön har betydande påverkan på människors upplevelser. Vissa vanliga indikatorer inom stadsplanering visar svaga samband med upplevelser, medan andra mindre vanliga har större effekter. Sammansättningar av upplevelser på områdesskala uppvisar genomgående mönster, både rumsligt och i förhållande till resiliensprinciper. Många områden innehåller en mångfald av positiva upplevelser, medan ett fåtal domineras av negativa upplevelser.

Resultaten visar att relationer mellan människa och miljö bör ta en mer central plats i stadsplaneringen, då detta erbjuder möjligheter att förbättra stadsbornas upplevelser. Resiliensprinciper kan fungera som tumregler inom stadsplaneringen för en stadsutveckling som inte äventyrar människors upplevelser. Metoden som utvecklats här kan appliceras i andra städer, då den kan identifiera specifika platser för omvandling, men också leda till djupare förståelse för samspelet mellan stadsmiljöer och människors upplevelser i olika sammanhang.

**Nyckelord:** Stadsplanering, social-ekologiska system, välbefinnande, upplevelser, miljö kvalitet, ekologisk psykologi, resiliens, rumslig analys, medborgardeltagande, Stockholm

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## List of Papers

This thesis is based on the following papers, which are referred to in the text by Roman numerals.

### Paper I

Samuelsson, K., Giusti, M., Peterson, G. D., Legeby, A., Brandt, S. A. & Barthel, S. (2018). Impact of environment on people's everyday experiences in Stockholm. *Landscape and Urban Planning* 171: 7-17. doi: 10.1016/j.landurbplan.2017.11.009

### Paper II

Samuelsson, K., Colding J., & Barthel, S. (In review). Urban resilience at eye level: Spatial analysis of empirically defined experiential landscapes. *Landscape and Urban Planning*.

### Contributions to the papers

The entire process of collecting the experiential data that form the empirical basis of this thesis was done by MG, SB and me. For Paper I, I conceived and designed the research with inputs from SB, GP and MG, I analysed the data and I led the writing process. For Paper II, I conceived and designed the research with inputs from SB and JC, I analysed the data and I led the writing process.



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# Introduction

There is an unresolved conflict in current urban planning. The essence of the conflict is this: Decreasing cities' impact on global and regional environmental issues entails compact city development, while supporting the wellbeing of urban dwellers entails limiting crowding and keeping substantial space for nature in cities. Aligning efforts to make cities locally and globally sustainable means resolving this conflict.

At the global scale, urbanisation contribute to alteration of biogeochemical cycles (Grimm et al. 2008), loss of carbon pools (Seto et al. 2012b), loss of biodiversity (Seto et al. 2012a), and loss of often particularly fertile croplands (Bren d'Amour et al. 2016). On a regional scale, sprawling low-density cities have adverse effects on biodiversity (Soga et al. 2014) and many ecosystem services (Stott et al. 2015). These impacts conclusively point towards compact city development, because it decreases car dependency (Newman 2006), enables sustainable modes of transportation (Jabareen 2006), results in more efficient building energy use (Güneralp et al. 2017) and maintains space for nature to produce ecosystem services (Stott et al. 2015). In summary, compact city development is argued to limit the burden that cities put on the biosphere.

On the other hand, crowding can be a major threat to the wellbeing of urban dwellers (Evans and Lepore 1992). Fatigue and stress caused by being continually exposed to environments requiring directed attention can be remedied by nature experiences (Kaplan 1995). Such restorative experiences have the qualities of being detached from one's routine, effortlessly fascinating, immersive or involving activities with matching support in the environment (Korpela et al. 2001). There is substantial evidence of associations between nature experiences and mental wellbeing (Sugiyama et al. 2008; Alcock et al. 2014; Cox et al. 2017). Many psychiatric disorders are also more prevalent in cities than in the countryside (Peen et al. 2010), which might be linked to less exposure to nature while growing up (Engemann et al. 2018). As restorative effects of urban parks are mainly dependent on their size (Nordh et al. 2009), it is unlikely that micro-scale elements like street trees and green walls provide enough restorative benefits, valuable as they might be compared to a baseline of no nature. Another important sustainability aspect of urban nature environments is that continuous exposure to them can shape attitudes towards the environment (Hartig and Kahn 2016). This is important as environmental attitudes is a determinant of the likelihood to engage in environmentally friendly behaviour (Cheng and Monroe 2012; Soga and Gaston 2016), in turn an important leverage point for sustainability transformations (Abson et al. 2017). To contrast with the compact city, I call the kinds of urban environments that limit stress, are supportive of mental wellbeing and foster psychological connections between urban dwellers and the biosphere "the social-ecological city".

If the conflict outlined above is to be resolved, there is a need to understand how qualities with each development model can be combined. Qualities with the compact city are often not about urban form per se, but the sustainability benefits it results in. It is important to see that these are not inseparable. For example, the lower per capita electricity consumption observed in compact cities seems to be related to lower per capita floor space in such cities, rather than urban form (Kennedy et al. 2015). Extending this reasoning, it is conceivable that the total metabolism of the city could be limited also in less compact environments that nevertheless stimulate sustainable behaviours. Thus, rather than treating each model as a pre-assembled package, this thesis adopts a complex systems perspective of the city, where numerous different pathways between the environment and wellbeing play out simultaneously. The mediators for these pathways are the experiences that people have of the environment (Kytta et al. 2016), which is why the human experience is the main object of enquiry in this work.

### **Aim and research questions**

This thesis has two aims. First, to contribute to a nuanced understanding of the many ways urban environments influence urban dwellers' experiences, and how they together play out. Second, to develop methods and formulate guiding heuristics that are useful for urban planning and design.

To reach these aims, the thesis is guided by the following research questions:

1. How do urban environments influence urban dwellers' regularly occurring experiences?
2. How can a deeper understanding of urban environments' influence on urban dwellers' experiences facilitate a development in cities towards coupled local and global sustainability?

The two papers included in this thesis both address both questions, but emphasis in Paper I is on the first question, whereas in Paper II it is on the second.

# Theory

## **Ontology: cities are complex systems**

Many things in reality are complex systems. In complex systems, interactions between entities within and across scales occur without any global control, and autonomous selection processes render them adaptive (Levin 1998). Such processes of self-organisation give rise to emergent phenomena, i.e. macro-scale phenomena that are not deducible from micro-scale events but nevertheless exert influence over micro-scale entities (Goldstein 1999). This thesis investigates the city and its people. Cities are complex systems (Bettencourt and West 2010) – they are by definition because by definition they are concentrations of human interaction (Batty 2012). When a human settlement becomes complex enough we might start calling it a city. The understanding of the city as a web of interactions where no human is an island predates any formalisation of complex systems theory. Already more than a century ago, the German sociologist and philosopher Georg Simmel wrote, with respect to the city, about “the individual aspects of life and those which transcend the existence of single individuals. [...] The adaptations made by the personality in its adjustment to the forces that lie outside of it.” (Simmel 2002). Yet, in urban discourse, mechanistic conceptions of the human-environment relation dominated throughout much of the 20th century (Marcus et al. 2016). Only in recent decades has the emergent messy-but-ordered structure of urban form and its conditioning of human activity resurfaced as a topic for urban scholars (Batty 2008).

So, the city is not a laboratory in which every aspect of urban life can be controlled for. It is rather as if it is shrouded in mist – from a distance, we can perceive its outlines, but the details of every interaction on the ground are concealed for us. It can be very helpful to study the city “from a distance”. Striking regularities are found across cities regarding per capita wealth creation, innovation and infrastructure (Bettencourt et al. 2007), human interactions (Schlöpfer et al. 2014) and the fractal nature of urban form (Batty 2012). However, these regularities describe city averages. To better understand how the city conditions the wellbeing of its inhabitants, we have to immerse ourselves in it, to fully respect it as a complex system. Thus, this thesis studies experiences arising in authentic situations, describing a lived reality that is lacking in the laboratory, and a contextual sensitivity that has often been lacking in city science.

## **An ecological approach to urban experiences**

Authentic situations are complex. A human experience in a given situation is conditioned by the person’s past experiences, bodily abilities, current mood, by social or cultural norms, by the environment’s layout, materials, cleanliness, by other people that are present, by plants and trees, by noises and smells, by the time of day and year, by the weather, or any number of other factors. Thus, this thesis relies on a branch of psychology explicitly incorporating such situational complexity – ecological psychology.

Ecological psychology has since its formalisation stressed the need for holistic descriptions of human perception and behaviour: “What psychology needs is the kind of thinking that is beginning to be attempted in what is loosely called systems theory” (Gibson 1986, p. 2). The word ecological reflects the view that it is impossible to separate the psychology of people from their environment. Ecological psychology asserts that humans perceive meaning in environments through affordances. Affordance is the noun to the verb afford – if a situation affords a behaviour the affordance for that behaviour is present. An opening in a wall means the affordance for walking through it is present. Scholars have debated whether affordances are properties of the environment (Greeno 1994; Heft 2001) or relations between abilities of animals and features of the environment (Chemero 2003; Stoffregen 2003). This thesis adopts the latter view, as well as the broader definition of affordances as not only inviting behaviour but also emotions (Heft 2001).

Ecological psychology thus offers two concepts that directly translate into units of analysis – situations and affordances. Different affordances – meaningful human-environment relations – come together in a situation from which an experience emerges. The situation captures all the contextual complexity of urban life, while affordances describe the specific links between environment and experiences that allows aggregation and systematic exploration.

## **Neighbourhoods: the emergent meso-scale**

Several influential urban writers have emphasised the neighbourhood scale, from Jane Jacobs (1961) to Jan Gehl (2010). The novelty of *The Death and Life of Great American Cities* (Jacobs 1961) was to see the city as a complex system, and to see that the neighbourhood is the scale at which this complexity often plays out in people’s everyday life. Considering the impact of Jacobs’ writings, it is somewhat surprising that much of the ample research that has been done on human-environment interactions on the neighbourhood scale lack a complex systems approach. For example, the way humans move through urban environments is often not captured in measures of accessibility or geographical context (Hasanzadeh et al. 2018). The most common approach is to consider the neighbourhood as a circle with some radius around some significant place (e.g. Neuvonen et al. 2007; Kytä et al. 2016; Sarkar et al. 2017). Other studies represent neighbourhoods as squares (e.g. Oakes et al. 2007; Soga et al. 2015), or merely study perceptions of the neighbourhood (e.g. Bonaiuto et al. 2003; Sugiyama et al. 2008; Howley et al. 2009). More sophisticated representations include measuring walking distance (Coombes et al. 2010), home range (Hand et al. 2017) or place based local activity spaces (Hasanzadeh et al. 2018). However, even though especially the last two examples contain rich descriptions of experiential outcome within environments, they do not capture how it is conditioned by systemic properties of those environments. This missing piece of the puzzle is important for translating insights from research into principles or heuristics that urban planning can apply.

In urban morphology research, the concept of spatial configuration has been used to describe these kinds of systemic properties of urban form. Spatial configuration refers to a system of spatial relations that describe features of spaces that are not captured by looking at them in isolation (Hillier 1996). The overarching finding from this field is that social and economic activity in urban spaces is closely linked to how they are topologically related to other spaces. Effects of spatial configuration on a population scale seems, at least in part, to be explained by spatial cognition in individuals being topological rather than metric (Penn 2001), aligning with the ecological approach to visual perception. Ecological psychology explains this cognitive geometry as a meaningful representation of space as a body perceives it under movement (Marcus 2015) – in other words a set of affordances where each street affords movement up and down it but each turn requires the body to perceive new affordances. Spatial integration, i.e. the topological centrality of streets and squares, is a much stronger predictor of pedestrian movement than metric centrality (Hillier et al. 1993). Put differently, spaces that the street network affords the “perceptually cheapest” access to are where most people are found.

The physical neighbourhood does not necessarily have to be seen as an emergent entity, and indeed very seldom is in planning. However, it is its systemic properties that condition local situations, and it is in turn from many local situations that the experienced neighbourhood emerges. This is what matters for the wellbeing of urban dwellers, and this is why the complex systems approach is crucial. Thus, this thesis integrates experiential evidence from specific situations with spatial configuration as a description of urban form. Insofar as this thesis discusses the entire city from an experiential perspective, it does so as a collection of neighbourhoods, a system of systems.

# Methodology

Development of appropriate methods is integral to the work in this thesis. As affordances are relations between the environment and people, to study them empirically, consideration has to be given both to how people's experiences are measured and how the environment is measured, so that these parts are consistent with each other and with the ecological conception of human-environment relations.

## Measuring experiences

Experiences are measured by applying public participatory geographic information system (PPGIS). PPGIS is a method whereby laypersons of some targeted group of people or the general public are invited to access a GIS (often on an online platform), to provide location-based data on local knowledge (Brown and Kyttä 2014). One strength of this method lies in enabling collection of large datasets of the kind of rich multifaceted experiential data that traditionally has only been obtainable through qualitative methods (Kyttä et al. 2013). This allows for context-sensitive assessments of landscapes in relation to e.g. happiness (Kyttä et al. 2016), ecosystem services (Brown and Fagerholm 2015) or urban master plans (Kahila-Tani et al. 2015). Another strength is the geocoding of data within PPGIS applications, enabling co-analysis with other geographical data.

There are some caveats with PPGIS related to sampling. Difficulties encountered by groups of people in using digital technology generally, commonly referred to as the "digital divide" (Katz and Gonzalez 2016), is pertinent to PPGIS sampling. This bias can be relatively well known, if demographic data on respondents are collected. Moreover, open PPGIS surveys risk attracting people with values or preferences that do not represent the public well (Brown et al. 2013). This bias is much more difficult to evaluate. These caveats have, to my knowledge, not been successfully overcome in the PPGIS literature, so it is important that they are kept in mind when results are interpreted. However, though these weaknesses are important to acknowledge, PPGIS still facilitates broader involvement by the public in urban planning than traditional methods tend to do (Kahila-Tani et al. 2015).

The experiential data analysed in the papers of this thesis were collected through a PPGIS survey called *Where is your Stockholm?* (Giusti et al. 2017). The survey was actively designed to enable analysis of affordances within situations, but these terms were not used in any of the questions. Instead, respondents were asked to record regularly occurring positive or negative experiences. In order to as much as possible avoid priming respondents to record certain kinds of experiences, questions were neutrally worded (Figure 1). In order to have responses represent affordances, questions were asked about attributes of the experiences relating to the respondent (Figure 1), as well as to the place.

The survey was accessible online from September 21st 2015 until May 31st 2016. Information about the survey, as well as interest-raising comments provided by respondents, were spread through social media. It also featured at

Färgfabriken, an art hall and policy-practice arena in southern Stockholm, during an autumn 2015 exhibition, and several municipalities within Stockholm County spread information about the survey online and in local newspapers.

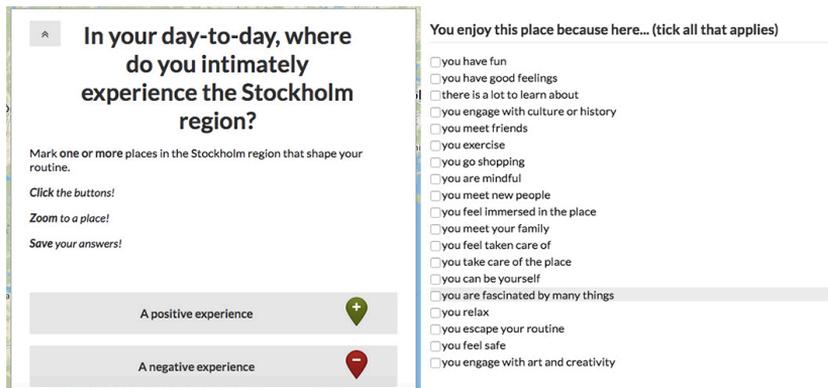


Figure 1. Screenshots of the online PPGIS survey “Where is your Stockholm?”. To the left, the initial screen of the survey is shown, where respondents were asked to record a positive or a negative experience. Respondents also had the option to provide detailed information about the experience. To the right, a list of attributes relating to the respondent in the moment of the experience is shown.

## Measuring the environment

No human experience is an island. This thesis adopts a holistic social-ecological landscape view of the urban environment, in which human experiences are assumed to arise in specific situations, influenced by constructed and natural features, as well as other people. To enable analysis of such social-ecological situations, a wide range of variables of the physical environment has to be incorporated. For this reason, the two studies rely on publically available data – gathering field data on all the relevant variables would be much too laborious. This entails some issues (e.g. that data on different variables were collected in different years), but potential weaknesses in any one data source will not influence results excessively, due to the approach of not relying on any single variable to explain experiential outcome. A strength of this approach is that it allows replication in any city with appropriate public geographic data.

In geography, not only spatial content but also spatial representation is important because it dictates both what questions can be asked and what tools can be used for analysis (Kwan et al. 2003). To understand how the urban environment influences people’s experiences, it has to be represented in a way that makes sense with respect to the human perception of it. In urban spatial configuration research, plenty of studies demonstrate how a particular representation of urban space, the axial map, enables striking predictions of pedestrian and traffic flows (e.g. Hillier and Hanson 1984; Hillier et al. 1993; Ståhle et al. 2005; Legeby 2013). Although not explicitly developed with reference to individual human perception and cognition, it implicitly encapsulates the way humans understand their environment (Penn 2001). An axial map is composed

of the fewest number of longest straight lines (axial lines) passing through all streets, paths, squares and other open surfaces in a defined urban landscape. Axial lines represent sightlines or “affordances of visibility and accessibility” (Marcus 2015).

In this thesis, axial lines are used to measure accessibility or connectivity. The way these terms are used in this thesis, they are related but not identical. A place in one geographical location can be accessible for a human at a different geographical location, whereas two geographical locations are connected if they are within the boundaries of accessibility for a human. There are no formal definitions of accessibility, because it depends on many contextual factors. Since this thesis is an investigation into everyday interactions with the environment, accessibility is here thought of as what is usually within effortless everyday walking distance for most people. Paper I investigates how the surrounding environment influences individual experiences. In it, 500 metres is defined as the boundary of accessibility, as this number is often used by researchers (Coombes et al. 2010; Kyttä et al. 2016), urban planners (Gehl 2010) and authorities (Stockholms Parkprogram 2006). Paper II investigates the compositions of experiences that emerge on the neighbourhood scale and how they are related to urban spatial properties. Because it deals more directly with systemic properties of urban space, it relies on spatial configuration methods, following research from Stockholm that has found that effortless walking distance most often correspond to 3 to 6 axial lines (i.e. 2 to 5 directional changes) (Ståhle et al. 2005). Figure 2 shows a schematic illustration of how accessibility and connectivity is measured in the respective papers.

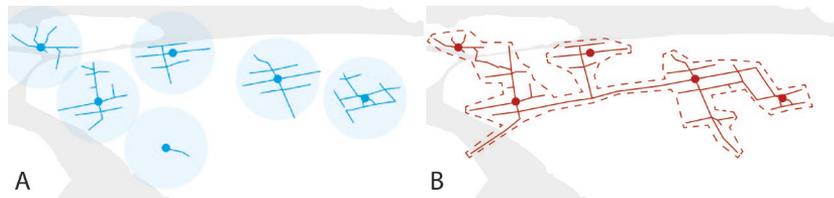


Figure 2. Schematic illustration of how accessibility and connectivity is operationalised in the two papers. Each dot represents an experience recorded in the PPGIS survey. In Paper I (A), what is within 500 metres distance (walking or radial) from an experience is considered accessible from it. In Paper II (B), experiences that are within 2 (inner city) or 5 (suburbs) topological steps (directional changes) from each other are considered connected.

# Summary of papers

## Paper I

There is an unresolved conflict in current urban planning. Limiting cities' negative impact for global sustainability (Grimm et al. 2008; Kennedy et al. 2015; Bren d'Amour et al. 2016) suggests compact city development (Jabareen 2006; Newman 2006; Kennedy et al. 2015; Soga et al. 2015; Stott et al. 2015). This is the compact city narrative. However, extensive and accessible urban nature is important for urban dwellers' well-being – by providing restoration from stress (van den Berg et al. 2007) and promoting physical and mental health (Mitchell and Popham 2008; Sugiyama et al. 2008; Gascon et al. 2015). It is also important for realising the prospects of planetary stewardship – interaction with nature fosters a psychological connection with the biosphere (Giusti et al. 2014; Soga and Gaston 2016). This is the social-ecological city narrative. To resolve the conflict between these narratives, urban development needs to combine beneficial aspects of both.

Paper I aims to increase understanding of how these narratives can be combined. Because the conflict is spatial in nature, it employs spatial analysis, and because experiences are a mediating factor between environment and human wellbeing (Kytta et al. 2016), we analyse urban dwellers' experiences. The primary research question is (i) How does accessibility to various environment features impact people's regularly occurring experiences? To answer this, another question is (ii) How does spatial accessibility to these features differ across Stockholm, Sweden?

To answer the questions, we develop a novel method combining public participatory GIS (PPGIS), accessibility analysis and spatial regression. Both PPGIS and accessibility analysis are compatible with the ecological psychology account of human-environment interactions, and specifically affordance theory (Gibson 1986). The method developed here enables comprehensive analyses of how urban environments, through affordances in them, relate to human experiences.

We estimate the probability of positive and negative experiences in places based on 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 show significant associations with experiential outcome, after accounting for spatial autocorrelation among the data. Number of residents and proximity of nature and water, all common indicators in urban planning, display weak statistically significant relationships. 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. This shows that there are considerable differences in experiential outcome, with different ramifications for human wellbeing, within compact environments as well as within nature-abundant environments, and that the dichotomy of "dense vs. green" is unhelpful for creating sustainable urban environments. Urban planning practices need to acknowledge these differences to limit negative impacts on the

biosphere while promoting human well-being. The method developed here can prove useful for identifying and targeting interventions to areas where experiential outcome can be improved.

## **Paper II**

In urban sustainability, a research gap is how to undertake the much-needed transformation to lower levels of metabolism while not eroding the capacity of social-ecological systems to generate wellbeing for urban dwellers (Paper I). Relations between urban spatial form and wellbeing are complex and differ across different contexts (McCrea and Walters 2012; Kytta et al. 2016), involving several interrelated pathways. Denser environments generally feature greater accessibility to urban services (Bramley and Power 2009; Kytta et al. 2016) and promote walking or biking (Durand et al. 2011). Meanwhile, crowding can challenge well-being through perceived unpredictability and sensory overload (Evans and Lepore 1992), whereas nature environments seem particularly fit to offer restorative experiences (Kaplan 1995; MacKerron and Mourato 2013). Understanding how these different pathways between urban form and well-being together play out is key to creating resilient cities with happier and healthier inhabitants.

Paper II aims to increase understanding about what experiences promoting or hindering wellbeing that exist together on the neighbourhood scale, and how these compositions of experiences are related to urban spatial properties. Drawing on social-ecological urbanism (Barthel et al. 2013), we conceptualise urban form as a slow variable in the structuring of human experiences and operationalise resilience principles (Biggs et al. 2015) to assess what urban environments provide “resilience at eye level” - a diversity of experiences and a level of connectivity between them that limits adverse outcomes. The research questions are: How can resilience principles help us understand how urban environments structure human experiences? And how should urban environments be structured to afford experiences that promote urban dwellers’ wellbeing while undergoing urbanisation?

We analyse geocoded experiential data (1460 experiences from 780 respondents) together with variables of the physical environment. The method builds on the one developed in Paper I to also reflect more nuanced differences between experiences than simply being positive or negative. The diversity principle is operationalised by latent class analysis, creating a classification of experiences based on attributes respondents assigned them. Connectivity between experiences is assessed by topological spatial analysis, and a new classification of experiences is created based on their own and spatially connected experiences’ categories, simultaneously taking diversity and connectivity into account to describe the experiential composition of a landscape.

We found 11 categories of experiences (7 positive and 4 negative). These make up 8 typologies of experiential landscapes, with differing levels of experience diversity and connectivity. There is a general trade-off between connectivity and the proportion of experiences that are positive, but also some devia-

tions from this pattern. Diversity of experiences is highest at intermediate levels of connectivity. Our analysis suggests that typologies supportive of wellbeing exist in environments that balance residents and workplaces, avoid extreme spatial integration or density and have accessible nature. Typologies hindering wellbeing fail in one or several of these respects. The method developed here can act as a guiding heuristic for cities navigating urbanisation to not compromise human wellbeing, as it uncovers general patterns about what experiences that tend to occur together in different environments, but also makes spatially explicit where densification could favourably take place.

## Discussion

At the outset of this thesis, I sketched out a conflict between the compact city and the social-ecological city that can be summarised with the question “Is densification a good or a bad strategy for urban development?” Previous research has challenged the idea that this question is possible to answer categorically (McCrea and Walters 2012; Kytta et al. 2016). In Paper I, we showed that it is also directly unhelpful for the pursuit of urban sustainability, because any categorical answer will disregard crucial parts in achieving social and ecological sustainability at scales from the local to the global. From modelling experiences on environment features, we found evidence that more fine-grained understandings of the interplay between environment and wellbeing can underpin strategies that might considerably improve people’s experiences in the city. For example, neighbourhoods with similar population densities produce wildly different experiential outcomes, depending on whether most people live or work there. Residential density has very limited influence on experiential outcome, while high workplace densities are closely associated with negative experiences. That a mixing of primary functions, like housing and workplaces, within neighbourhoods spur spontaneous social and economic activity was observed (albeit anecdotally) already by Jane Jacobs (1961). Paper I provides evidence that the same is true of positive experiences. Paper I also aligns with other work to demonstrate the beneficial effects of nature for urban people (e.g. van den Berg et al. 2007; Mitchell and Popham 2008; Colding and Barthel 2013; MacKerron and Mourato 2013). However, the natural temperature regulating capacity of nature areas predicts probabilities of having positive experiences in them better than their accessibility for people. This capacity is dependent on nature areas being large and continuous and containing many voluminous trees. Thus, that nature is accessible is important but not enough – what kind of nature it is matters both for the ecosystem services it provides and how it is experienced.

Scholars have understood cities as complex systems for decades (Batty 2008). It should come as no surprise that the way they are experienced by humans contains complexities. Still, much of current urban planning features the functionalistic understanding of urban space that characterised modernism (Marcus et al. 2016), as well as a lack of contextual sensitivity (Kytta et al. 2013). Overcoming the dichotomy between the compact and social-ecological city narratives is just as much about recognising complexity within them as conflict between them. This thesis is part of a growing body of work using ecological psychology as a means for this. In ecological psychology, city and nature are not seen as intrinsic categories – there is only an environment, that humans shape in countless ways and with which humans form countless meaningful relations.

Putting these human-environment relations centre stage and acknowledging their complexity is crucial for an urban development supporting human wellbeing within the planet’s carrying capacity. A novelty of the thesis lies in the

very direct spatial application of relational values in cities, at all stages of conceptualisation and analysis. At the most local scale, there are affordances – human-environment relations realised in specific situations. Affordance theory underpins the two main methods of this thesis – PPGIS and accessibility analysis based on the axial map. The two studies in this thesis are, as far as I know, the first to combine these methods. The result is a methodological framework that accounts for the contextual sensitivity of individual experiences, as well as the way configurations of urban space influence how people move through and experience it.

On an aggregate scale, this methodological framework facilitates a complex systems understanding of experiences in the city. However, even though Papers I and II analyse all of Stockholm municipality, it is important to note that the scale at which the method operates is not the entire city, but the neighbourhood. Much work has been done concerning complex systems analyses of cities on city-wide or even regional scales (e.g. Batty 2012; Bettencourt 2013). Less effort has been put into empirically testing and advancing Jacobs' (1961) legacy of viewing neighbourhoods as complex systems, despite much of urban life playing out at this scale. In Paper II, systemic properties of experiences in neighbourhoods are considered, as the level of analysis is placed at this scale. An important insight from this analysis is that on the city level, many different kinds of neighbourhoods harbour experiences contributing to wellbeing, while much fewer environments clearly hinder wellbeing. The implications for planning are that cities should strive for diverse environments while avoiding those that hinder wellbeing.

Environments hindering wellbeing are those that in one or several ways are extreme. Paper I shows that they have an extreme density of workplaces, while paper II shows that they are highly spatially integrated (i.e. they are centrally located in the city's spatial network). These findings resonate with some principles for building resilience in social-ecological systems – maintaining diversity and managing connectivity (Biggs et al. 2015). Neighbourhoods with an extreme density of workplaces are functional monocultures, inhibiting experiential diversity. I speculate that because they lack accessible green areas, experiences of crowding and stress during the day are not easily remedied, and because they lack residents, they are experienced as unsafe outside workhours. In Stockholm, these neighbourhoods are also the most spatially connected, exacerbating the issue of crowding. It has been known for long that compartmentalisation in ecosystems may increase their stability by isolating the impacts of disturbance (May 1972). As supported by the evidence presented in this thesis, such knowledge may inform the building of more resilient street networks in a city. City streets make up a “foreground network”, facilitating socioeconomic exchange and social interaction, and a “background network” that creates secluded spaces facilitating socio-cultural continuity (Hillier 2009). This dynamic is useful but should not be brought to an extreme. Currently, Stockholm's central areas (parts of its foreground network) are being further densified with mainly workplaces, and reducing connectivity in the urban landscape

runs completely counter to current planning practices. Unfortunately, the evidence from Papers I and II firmly suggests that developments of Stockholm's central parts will only further aggravate experiential outcomes in them.

## **Further research**

Questions central for letting human-environment relations guide urban planning still remain open. Below I discuss two research areas that can build on this work: 1) how experiences in urban environments influence individuals' wellbeing over time, and 2) how synergies can be found between resilient wellbeing outcomes and other aspects of urban sustainability or resilience.

Papers I and II present strong evidence for relationships between properties of physical environments and human experiences within them. However, both studies rely on cross-sectional research designs providing a snapshot in time of the city. This thesis cannot provide insights into how Stockholmers' wellbeing is sustained or changing over time, or how it changes as the city changes. It is possible that a diversity of experiences within the same person contributes to that person's wellbeing through an enriched meaning-making of the world. By way of analogy, we constantly use memories of previous experiences to interpret current experiences, as well as augment our accumulated experience to make future analogies more fine-grained (Bar 2007). Such interpretations also continuously assemble our emotional vocabulary – in fact there are no clear-cut distinctions between emotions, perceptions and cognitions (Barrett 2009). The ability to recognise emotional complexity has in turn been linked to wellbeing benefits (Quoidbach et al. 2014; Kashdan et al. 2015). Here it is worth mentioning some other valuable work looking at urban environments and wellbeing. Kytta et al. (2016) use structural equation modelling to model experiences as mediators between environment and wellbeing. However, they also rely on a cross-sectional design with a one-time estimate of general wellbeing. Longitudinal designs include Alcock et al. (2014) that links relocation from less green to greener areas with mental health improvements, and Pyko et al. (2017) that links residential exposure to noise to an increased risk of developing obesity. However, these studies do not take the same comprehensive approach to experiences in the urban environment as Kytta et al. (2016) or indeed the studies in this thesis. No one has yet investigated the interplay between different experiences in urban environments and its influence on wellbeing over time. There are different designs that could be utilised for such studies. One option is to use a smartphone app, similar to MacKerron and Mourato (2013), to prompt respondents to at random times estimate their momentary experience in urban spaces, and also through longer surveys regularly ask them to rate their subjective wellbeing. This approach can produce high-quality spatial and experiential data in order to understand how movement habits create “urban habitats” and what their repercussions for wellbeing are. The risk of this approach lies in creating respondent fatigue resulting in high drop-off rates. Another option is to combine satellite imagery and machine learning, similar to Jean et al. (2016), to obtain data on changes in affordances in a city over time, and analyse this together with health records. This approach can be

used to test hypotheses related to the resilience of wellbeing outcomes in cities, by for example looking at threshold values in the relationship between affordance provision and public health, or time lags between modification of environments and wellbeing outcomes. A weakness of this approach is controlling for broader, societal changes over time. One way of overcoming this weakness could be to compare cities, or sub-areas of a city, with a recent history of socio-economic and socio-cultural similarities, but differences in urban development.

It is crucial that cities do not erode the capacity of social-ecological systems to generate wellbeing for their inhabitants. It is also crucial that cities decrease their metabolism, as well as build adaptive capacity towards future shocks. This begs the question if and under what circumstances environments that support resilient wellbeing outcomes also are resilient from other perspectives. Decreasing cities' metabolism requires behavioural changes in urban dwellers, which will only be achieved if desired behaviours are made easier to perform, for example by modification of the environment (Sörqvist 2016). Affordance theory has been suggested as a suitable heuristic for facilitating sustainable behaviour in cities (Kaaronen 2017). Were synergies to be found between experiences supporting wellbeing and behaviour supporting the biosphere, it would provide enormous leverage in urban planning for designs enabling such synergies. Common property management of urban gardens can facilitate social learning about environmental processes (Bendt et al. 2013), but does this learning influence participants' wellbeing or behaviour, or both? Sustainability benefits of compact cities rely on dense environments not affording well certain behaviours, such as taking the car to work, but can similar benefits be obtained in less dense environments through designs focusing on positive affordances inviting sustainable travel behaviour? That might avoid the increasingly energy-consuming leisure travel that policies for reducing energy consumption of everyday travel can result in (Holden and Linnerud 2011).

As for building capacity towards shocks to cities, natural temperature regulating capacity as a buffer towards extreme heat events will only grow more important as climate change unfolds. Compact built environments have been advocated in order to reduce the vulnerability towards extreme heat events (Stone et al. 2010), as continuous nature areas are better temperature regulators than fragmented ones (Stott et al. 2015). On the other hand, affordances of walking access to secluded environments requires the urban fabric to not be extensive in all directions. Achieving these two objects at once is very much a question of urban morphology. It is possible to discern an idea of an urban form that is contained but not compact, in some way nested and sharing long, porous edges with nature areas. Yet, understanding more precise conditions that minimise the trade-off in nature areas between access for people and capacity to generate regulating services requires further studies.

Although both of the research areas discussed above are natural extensions of this thesis, I foresee myself addressing the first in the immediate future. The main reason is that the temporal aspect is at the heart of the central concepts of this thesis. Wellbeing is a good life sustained over time. Resilience is the ability to cope well with change. Therefore, a better framework for how cities can

produce resilient wellbeing outcomes would demonstrate that they do so over time. The way I see it, once this piece of the puzzle is better known, it becomes more meaningful to investigate what urban forms can achieve resilient wellbeing outcomes in conjunction with sustainable behaviour or regulating ecosystem service provision.

## **Concluding remarks**

This thesis found empirical evidence for relationships between properties of physical urban environments and human experiences within them. These relationships shed light on how to address the conflict of obtaining sustainability benefits with compact cities while not eroding the capacity of urban environments to generate wellbeing for their inhabitants. To move beyond unhelpful dichotomies towards urban environments that promote social and ecological sustainability at scales from the local to the global, human-environment relations must be placed centre stage in urban discourse and they must fundamentally inform how we conceptualise, analyse and design urban space. Obvious as this insight might appear, if we take it seriously urban discourse could develop in a very different trajectory. I think of this trajectory as a relational paradigm. Chan et al. (2016) provide a convincing argument for letting human-environment relations guide environmental policy and practice widely. They refer to this as a culture change, in order to “overcome the unhelpful dichotomy of sustaining either human well-being or nature for its own sake”. This dichotomy is analogous to the conflict between the compact city and the social-ecological city.

In this thesis, I have developed a methodological approach combining experiential data on actual urban situations with a description of the urban environment based on ecological psychology and the city as a complex system. The evidence suggests that this relational approach offers new knowledge that can be used to improve the experiences of the people of Stockholm. This thesis also suggests that improving people’s experiences in the city is not necessarily coupled with making its metabolism less efficient. Density of urban environments is a poor indicator of experiential outcome, so sustainability benefits of compaction can be combined with environments promoting wellbeing in better or worse ways. Distinguishing these ways from each other requires placing the scale of analysis where it makes sense for people – from the micro-scale up to the neighbourhood.

A relational paradigm is about embracing the city as a complex system, but urban planners need methods and tools to handle this complexity. I suggest that affordance theory in combination with resilience principles can act as guiding heuristics for structuring urban space in ways that limit adverse experiential outcomes. There is no one-size-fits-all solution for constructing neighbourhoods that promote wellbeing, and a resilient approach is one that recognises uncertainty in urban development and keep options open for the future. However, there are clear indications that environments hindering wellbeing can be addressed by promoting functional diversity, avoiding over-connection and avoiding extreme densities. I think that coupling these heuristics with measures

to reduce cities' metabolism can create a narrative of a city that gives consideration to its inhabitants and the biosphere alike.

This thesis relies on data from Stockholm. I have no doubt replicating studies in other cities will produce somewhat different results. The importance of context is a major reason why my suggestions for urban planning do not contain numbers. Hopefully, the methodological approach developed here will see application elsewhere. In part because it is of direct practical use, as it can identify specific places that require transformation. But also to increase understanding of how urban environments support or hinder wellbeing throughout the world, so that in this coming urban century, all cities can develop within their own context while also addressing the challenges that are shared by all of us.

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## Papers

Associated papers have been removed in the electronic version of this thesis.

For more details about the papers see:

<http://urn.kb.se/resolve?urn=urn:nbn:se:hig:diva-29047>