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GREEN PERCEPTION FOR WELL-BEING IN DENSE URBAN AREAS – A TOOL FOR SOCIOECONOMIC INTEGRATION

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Abstract

A previous study (n = 24,819) of semi-urban and rural areas in the Skåne region, southern Sweden, showed that people living in flats are dependent on having green space with several characteristics for different affordances close to their homes to be satisfied with their neighbourhood. The two studies presented in this paper focuses on the urban area of Malmö, the largest city in Skåne. Equivalent criteria for the presence of certain characteristics within 300 m from home were used, however analysed from other kinds of data than the regional study. In both the previous rural/semi-urban study as well as the urban studies presented here, respondents report being more satisfied with their neighbourhood the more qualities that are present within 300 m of their home. Less than half of the apartment-dwelling respondents in the Malmö urban area are satisfied with their neighbourhood if less than half of the characteristics are available within 300 m. Even when there are few characteristics close by, people living in their own house are generally more satisfied with their neighbourhood (70 % or more irrespective of area type) than tenants are. A relatively high concordance between the two studies, despite the fact that they represent different kinds of landscape (semi-urban and rural vs. urban) and different scales (region vs. municipality), adds validity to the recreational characteristics as a tool for assessing well-being qualities of neighbourhood landscapes.

The results from the studies of Malmö were also related to average household income and a clear association between our studies' data on accessibility to serene areas and household income was found. This finding suggests that creating additional serene green space in low-income areas could be a tool to help the municipality reduce segregation.

Keywords:
well-being, perception, characteristics, park, nature, recreation, socio economy, densification

Background and research question

While densification projects in urban areas in Sweden today typically focus on buildings and residences, green space is seldom considered a legitimate densification object (Berg, Granvik and Hedfors, 2012). Unbuilt open areas close to developed land, often spontaneously used as pure nature for local recreation and children's play, is often considered «not yet built land», although there are often good societal reasons for transferring them into parks or nature environments in future planning regulations (Lövrie, 2003). In city planning, concepts related to the «greening» of urban spaces, such as «green infrastructure» and «ecosystem services», are mostly limited to biological, technical and ecological functions, but seldom to health or well-being, e.g. BreeamCommunities (2012). Jennifer, Byrne and Newell (2014) pointed out that urban green space – such as parks, forests, green roofs, streams, and community gardens – provides critical ecosystem services as well as promoting physical activity, social participation, psychological well-being, and the general health of urban residents. After reviewing the Anglo-American literature on urban green space, especially parks, they conclude that the distribution of such space often disproportionately benefits predominantly white and more affluent communities. Access to green space is therefore increasingly recognized as an environmental justice issue (Ibid.).

Most previous studies of local green space in residential areas in relation to health has been based on large scale and aggregated population data. In the Netherlands, Maas, et al. (2006) showed that the perception of general health was positively related to people's living environment, measured as the percentage of green space within a 3-kilometre radius, and that the relation was stronger for lower socioeconomic groups. Maas, et al., (2008) found that «*less green space in people's living environment coincided with feelings of loneliness and with perceived shortage of social support*». Consequently, having a certain amount of well-distributed green areas is likely to be a precondition for social sustainability. It has subsequently been shown that areas with low levels of green space have more self-reported mental distress and greater rates of anxiety and depression (Maas, et al., 2009; van den Berg, et al., 2010). The Dutch researchers concluded that green space seems to be more than just a luxury, and should play a more central role in spatial planning.

None of the studies referred above give any recommendations for what kinds of environmental qualities or characteristics are the most valuable and most relevant to making comparisons with the present findings. They are mostly studying quantities, not qualities related to peoples' environmental perception. Qualities are related to the needs of people regarding activities and experiences in the city's green spaces. Do nearby green spaces offer appropriate opportunities, or affordances to meet the needs? In the present paper environmental perceptual criteria (Grahn, et al., 2010) are being used to study people's satisfaction with

their living environment. Satisfaction with the living environment is an important determinant of individual health and well-being (e.g., Taylor, Repetti and Seeman,1997; Oswald, et al., 2007), and thus a vital aspect to consider in the contemporary discourse on urban densification. Research in the field show that large recreation areas outside but close to the city are restorative and valuable for health and well-being (e.g. Nilsson, et al., 2011), however there is not the same agreement on the need for large parks in cities. According to Grahn (2012), some developers try to argue that quality may be more important than quantity, thus implicitly suggesting that park size should be given low priority. The problem is, however, that some valuable qualities cannot coexist in the same limited space (e.g., an outdoor environment that is serene but at the same time has space for groups to come together for play and fun). Thus, including a rich variety of recreational qualities requires large parks or other kinds of green space. Moreover, the attraction of a park is closely associated with its size (Grahn and Berggren-Bärring, 1995; Berggren-Bärring and Grahn, 1995a; 1995b). Research focusing on the association between recreational qualities in the neighbourhood landscape in relation to health is highly relevant to consider in the current discussion on densification.

Restorative health effects are harder to achieve in urban than in natural environments, something that has long been known within the field of environmental psychology (Kaplan and Kaplan, 1989; Ulrich, et al., 1991). Kaplan and Kaplan (1989) pointed out that impressions of nature can improve people's attention capacity, thereby improving their well-being. Certain biotopes and habitats seem to have been of great importance for reducing stress levels during human evolution (Coss, 1991; Ulrich, 1993). In a clinical setting, Diette, et al. (2003) found that patients undergoing a bronchoscopy who were shown pictures of nature accompanied by natural sounds (birdsong) had significantly less pain than did those in the control group. Even though patients in the intervention group had more invasive procedures, they did not require more medication. When people are stressed or ailing or are in pressed situations, the availability of natural environments seems to be very important (Grahn, et al., 2010). If people can visit environments with certain characteristics, their blood pressure, heart rate, etc., can return to normal more quickly (Hartig, 1993; Ottosson and Grahn, 2006).

We can also look at epidemiological studies of health conducted in large populations. Epidemiologists have studied the health effects of a wide range of environmental exposures in neighbourhoods. Results show the association between high-density living and mental illness, children's health, respiratory disease, heart attack, cancer and human happiness, thus providing evidence showing that one significant health issue is the adverse mental health consequences of increasing urban density (Recsei, 2013). Another finding is that air pollution is associated with respiratory and cardiovascular diseases, as well as with overall mortality (WHO,

2006; Pope, Ezzati and Dockery, 2009). Additionally, exposure to traffic noise is clearly associated with annoyance and disturbance of daily activities such as rest and sleep (Björk, et al., 2006). Noise has also been linked to hypertension, an important risk factor for cardiovascular diseases (Bodin, et al., 2009). Beyond these more commonly known effects of the physical environment, neighbourhood social interaction patterns, social cohesion (Wilkinson, 1996), social capital (Giordano, Björk and Lindström, 2012), and a shared sense of coherence and safety may have a decisive influence on health (Taylor, Repetti and Seeman, 1997; Oswald, et al., 2007). This supports the notion that densification can only be accepted if green elements are developed and maintained in order to buffer against likely adverse effects of the densification strategy.

Having access to natural environments with characteristics that promote mental recreation and physical activity near one's home is emerging as a potentially powerful structural intervention for mitigating socioeconomic differences in health (Maas, et al., 2006; Maas, et al., 2009; Nutsford, Pearson and Kingham, 2013). An extensive observational population study in England (n = 40,813,236) showed that populations exposed to the greenest environments also have the lowest levels of health inequality (premature mortality), and that differences in premature mortality as a function of the amount of neighbourhood green areas are greatest among the lowest income group. In the highest income group, the population with the lowest access to green areas has two times higher premature mortality, whereas in the lowest income group the population with the lowest access to green areas has four times higher premature mortality (Mitchel and Popham, 2008).

Björk and colleagues published a study focusing on the qualities of urban green spaces near residents' homes (Björk, et al., 2008). They also found effects relating to residents' socio economy. They aimed at researching the impact of green exposure, defined as a variety of sensory dimensions/characteristics, in a study of semi-urban and rural areas in the Skåne region, southern Sweden. Five characteristics – *serene, nature, species-richness, space* and *culture* – were elaborated in GIS based on GIS data from the county administration (e.g. biotope values, nature protection, cultural values, noise impact etc.), and Corine land cover data (Corine, 1995). A total of 37 distinct variables were collected and used for the classification of the five characteristics (Skärbäck, et al., 2012). Since the county administration did not have sufficient relevant urban data for classification of any of the characteristics, the four largest Cities in Skåne were excluded from the study. Data on health and well-being, including a question on neighbourhood satisfaction, were obtained for the population of the region of Skåne from a public health survey in 2004 (n = 24,819 respondents in rural and semi-urban areas). Statistical analyses were then conducted on the rural and semi-urban respondents' responses. The location of the respondents' homes was defined using

GIS coordinates (Björk, et al., 2008). The results show that the number of characteristics within 300 m from home was strongly associated with neighbourhood satisfaction, and this was especially marked among tenants.

Interview studies have revealed that the larger the park is, the more room there is for different qualities and the more popular the park is (Grahn and Berggren-Bärring, 1995; Grahn,Stigsdotter and Berggren-Bärring, 2005). One relevant question is to what extent improving park quality can balance limiting park size. All these questions cannot be answered in one study. The present paper will therefore focus on the issue of ensuring valuable outdoor qualities for well-being in the context of densification of cities and rural areas. The policy of urban densification aims at minimizing transport, carbon dioxide emissions and climate effects, but it may also result in reduced environmental qualities for people if it is pursued at the expense of neighbourhood park qualities. The concept of sustainable development also includes social aspects, health and well-being. If densification results in smaller parks then this could thus impose a threat on sustainability.

In this paper we want to compare available data from urban Malmö on people's satisfaction with their environment as a function of the variety of outdoor qualities close to home, with a geographical pattern based on the population's socio-economy. This may lead the way to better understanding of potential adverse effects of densification as well as possibilities to provide measures against segregation. We hypothesized that the association between outdoor qualities such as serenity in the landscape and satisfaction with the neighbourhood would act as driving forces for the attractiveness of the local area and thus contributing to socioeconomic segregation. The main research question is the following: How can defined green qualities in urban neighborhoods contribute to satisfaction and well-being among its inhabitants? And furthermore: How can the results be related to socioeconomic segregation? Such issues will become more urgent with increased urban densification.

Definitions of perceived characteristics of green neighbourhood environments

A number of studies have shown that some properties in the outdoor environment are of great importance to human health and well-being, and through statistical factor analysis these properties have been grouped into eight distinct characteristics that can be expected to have salutogenic (well-being/health promoting) effects (table 1; see also, e.g., Grahn and Stigsdotter, 2010; Adevi and Grahn, 2012). Serenity has been suggested to be the most important characteristic for well-being (Grahn and Stigsdotter, 2010), specifically with regard to recovery from stress (e.g., Grahn and Stigsdotter, 2010; Grahn and van den Bosch, 2014; Annerstedt, et al., 2012; 2013).

People's satisfaction with their neighbourhood has been shown to be particularly closely associated with their perception of serenity and cultural history within a 5–10 minute walk from home (de Jong, et al., 2012). These associations were more marked among tenants than among house-owners. Other studies have shown that people's perception of whether their sound environment is soothing and restful is closely associated with their health and well-being (Andringa and Lanser, 2013.)

Based on a number of interview studies conducted from 1985 to 2012, eight perceived characteristics of green neighbourhood environments are defined as being important for well-being (Grahn and Stigsdotter, 2010; Adevi and Grahn, 2012). The characteristics are *serene, nature, species-richness, space, prospect, refuge, social and culture*[1] (see table 1).

Table 1
Eight characteristics that meet recreational needs (from: Grahn and Stigsdotter, 2010).

1. Serene	A place of peace, silence and care. Sounds of wind, water, birds and insects. No rubbish, no weeds, no disturbing people.
2. Nature	A place of fascination with nature. Plants seem self-sown.
3. Species-richness	A place rich in species. A room offering a variety of wild species of animals and plants.
4. Space	A room offering a restful feeling of «entering another world», a coherent whole, like a beech forest.
5. Prospect	Views of the landscape. A green open place allowing vistas and stays.
6. Refuge	A place of imagination. An enclosed, safe and secluded place where you can relax and be yourself; let your children play freely.
7. Social	A meeting place for festivity and pleasure.
8. Culture	The essence of human culture: A historical place offering fascination with the course of time.

The characteristics are defined as perceived affordances, that is, as a feeling of whether or not the environment provides and supports desired experiences, rest and/or activities (Grahn, et al., 2010), not as specific concrete physical properties. Perceptions and preferences do not seem to vary a great deal among people (Gyllin and Grahn, 2005; Real, Arce and Sabucedo, 2000; Falk and Balling, 2010; Edwards, et al., 2011), although some differences with respect to education and country of origin were noted in a previous study (de Jong, et al., 2012). The differences are to a certain extent individual, depending in part on people's early experiences (Adevi and Grahn 2012), thus what kind of landscape objects are associated with, for example, serenity may differ. This has to be considered when evaluating the results.

1 Some of the terms used to designate the eight concepts have been partly changed (Grahn, Stigsdotter and Berggren-Bärring, 2005). Nature was called wild, prospect was the common, refuge was the pleasure garden, social was centre/festive. Their definitions, however, have not been changed.

The characteristics *serene, refuge* and *nature* are of particular value for stress reduction, and the characteristic *social* is most often negatively correlated with stress reduction (Grahn and Stigsdotter, 2010; Ottosson and Grahn, 2008).

Material and methods

In order to study the associations between people's satisfaction with their neighbourhood on the one hand, and environmental qualities in their surrounding neighbourhood on the other, two investigations were conducted in urban Malmö and the results were then compared to the previous findings in Björk, et al. (2008). The factors included in all three studies are identical in terms of the perceived environmental characteristics, but differs in scale. The two studies in Malmö concerns urban landscapes and the study conducted by Björk and colleagues the rural/semi-urban landscape.

Study of outdoor qualities in urban Malmö with 2004 public health data

Malmö's outdoor qualities were associated with data from of the 2004 Skåne Region public health survey. The green qualities were elaborated from datasets provided by the Malmö city planning, park management and environment department in 2010. Using GIS, the presence/absence of each of the eight characteristics (*serene, nature, species-richness, space, prospect, refuge, social* and *culture*) within 300 m of each respondent's home was calculated. However, only the five characteristics *serene, nature, species-richness, space* and *culture* were used to compare with the regional study (Björk, et al., 2008).

First, a pilot study was carried out for a North-East area of Malmö. The characteristics were first inventoried and classified outdoors in fields by the researchers involved. We describe this as a first intuitive and discerning classification method. Second, we compared this inventory classification with maps based on parameters from datasets provided by the relevant city departments. Different combinations of variables were tested and compared with the inventory classification. When the correspondence between the GIS maps and the inventory classification was considered satisfactory, the final combination of GIS variables for classifying each characteristic was applied for the whole of the greater Malmö urban area.

Data on health, well-being and neighbourhood satisfaction on outdoor qualities in Malmö (as well as for the regional Skåne study in Björk, et al., 2008), were obtained from a public health survey in 2004 (n = 3,060 respondents in the study of urban Malmö and n= 24,819 respondents in rural and semi-urban areas (Ibid.)). The data used from the survey concerned a question about neighbourhood satisfaction.

Study of the characteristic *serene* in urban Malmö with 2008 public health data

A survey was conducted that had focus on the characteristic serene. Due to our background research the characteristic *serene* is among the most important, and also threatened sensory dimensions when cities get densified. In the 2008 public health survey respondents answered questions concerning to what extent they perceive the five characteristics *serene, nature, species-richness, space* and *culture* within a 5–10 minute walk from home – see also de Jong, et al. (2012) for further explanations of the database. In this second study of urban Malmö (n = 2.946) respondents' answers were used to classify the five characteristics in a regression analysis with objective and distinct variables observed within 300 m from the respondents' homes. Thus this classification method is based on the respondents' own experiences of perception, not by external experts intuitively.

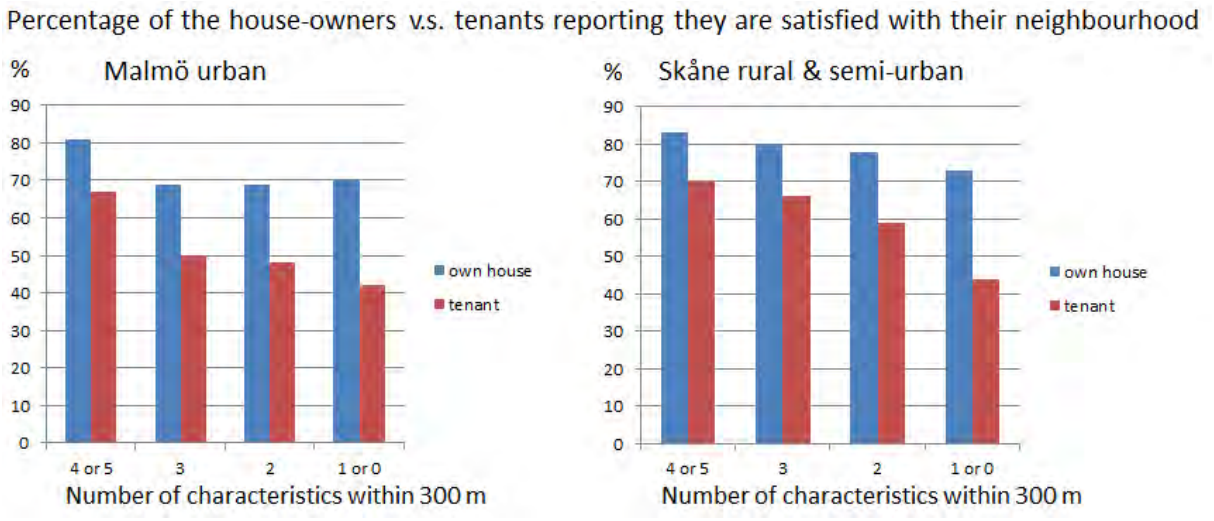
Data for our second urban Malmö study: Each participant of the public health surveys in 2004 and 2008 was georeferenced at his or her residence using GIS coordinates, and the characteristics of the neighbourhood within 300 meters from the residence were assessed. Statistical analyses based on multivariable logistic regression with adjustment for individual-level socioeconomic factors were conducted for the association between assessed green characteristics and self-reported neighbourhood satisfaction among the survey participants.

Data used from Statistic Sweden and the municipality

We also investigated spatial colocation between green characteristics and socioeconomic situation in the urban study of Malmö. As an area-level socioeconomic indicator in this study we used average household income in different statistical areas of Malmö available from the municipality (The City of Malmö and Statistic Sweden of 2010), also published in the major local newspaper in Skåne on the 24th of March 2012 – figure 8 (Sydsvenskan, 2012).

Result and analyses

Below are the results presented from the two urban studies in Malmö which are analysed and compared with the previous rural/semi-urban regional study. The beneficial effect, measured as «neighbourhood satisfaction», of having characteristics of green neighbourhood environments within 300 m from home was analysed in the regional study of Skåne (Björk, et al., 2008) and in this paper after adjustment for individual socioeconomic factors using logistic regression. Both studies show a similar result that the beneficial effect of having several of the five characteristics – *serene, nature, species-richness, space* and *culture* («the more the better») – within 300 m from home was seen among tenants, but not so clear among house owners (figure 1).



In the regional study by Björk, et al. (2008) the number of recreational values elaborated from GIS data close to the residence (< 300 metres) was positively correlated with neighbourhood satisfaction ($p < 0.001$). The overall neighbourhood satisfaction was highest among house-owners, but the association with the number of recreational values was much more marked for tenants (figure 1). For house-owners, *serene* (OR[2] 1.4, 95 % CI[3] 1.1–1.6) and *nature* (OR 1.4; 95 % CI 1.1–1.8) within 300 metres had the strongest impact on neighbourhood satisfaction in the multivariable regression analyses, whereas *serene* (OR 1.7; 95 % CI 1.3–2.3) and *species-richness* (OR 1.4; 95 % CI 1.2–1.7) were the most important recreational values for tenants. The association between neighbourhood greenness and satisfaction among tenants is salient. When all five characteristics are present within 300 m from home, 70 % of tenants are satisfied with their neighbourhood, whereas below 50 % are satisfied when only one or no characteristics are present. The corresponding association among house-owners is less marked, 83 % vs. 74 %. Consequently, house-owners seem to be rather satisfied with having their own garden, while tenants' being more dependent on having good natural environments or parks within 300 m from home.

Our first Malmö study of outdoor qualities and 2004 public health data shows similar result as Björk, et al. (2008), also using 2004 data, which is remarkable since the two studies work with quite different landscape data and scale (urban Malmö vs. rural/semi-urban Skåne). To facilitate a comparison of the result, see figure 2.

Although the two studies, urban vs. rural/semi-urban, focus on different areas, scales and landscape types, which require different classification

Figure 1
The relation between the number of recreational value characteristics (0–5) of the natural environment within 300 m distance from the residence and the percentage of respondents reporting high neighbourhood satisfaction in the Malmö urban areas, compared to the previous study in Skåne rural/semi-urban areas (adapted from Björk ,et al., 2008).

2 OR = Odds ratio: i.e. the odds of neighborhood satisfaction were 1.4 times higher if serenity within 300 m was present.

3 CI = 95 % confidence interval reflecting the statistical error margin.

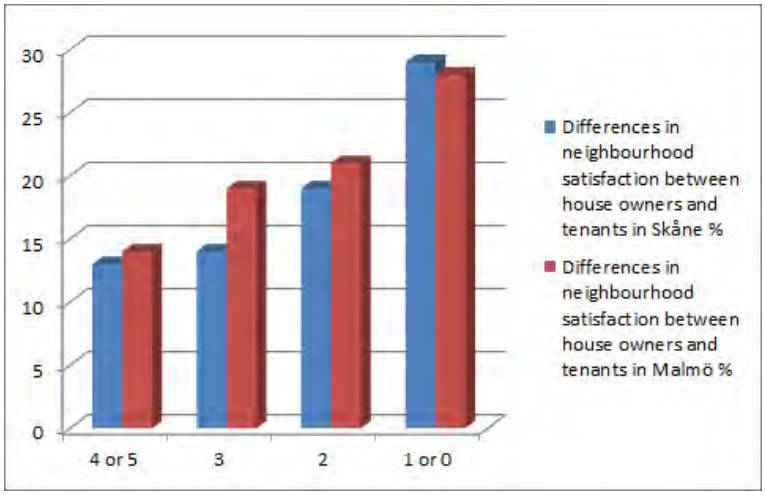


Figure 2
Difference in neighbourhood satisfaction between house-owners and tenants when different numbers of valuable qualities/characteristics are present within 300 m.

of perceived characteristics, the diagrams are indeed very similar. The proportion of respondents reporting satisfaction with their neighbourhood was lower the fewer characteristics that were present within 300 m from home, and this was more significant for people living in a flat than for those living in their own house. This shows a tendency in which the number of landscape and/or park qualities is of great importance to neighbourhood satisfaction, especially among people living in flats.

Figure 2 shows that in this urban area, Malmö, the difference increase more than in rural Skåne already at a reduction from 4–5 to 3 characteristics in the neighbourhood.

The results in the light of *serene*

Some characteristics are particularly sought after and sensitive to disturbances, thus they require a certain amount of space and should be discussed with particular care before densification. One of these, and the most sought after quality, is *serene* (Grahn and van den Bosch, 2014). As stated in the background (e.g. Grahn and Stigsdotter, 2010; Grahn and van den Bosch, 2014) *serene* is important for stress reduction and how satisfied people are with their neighbourhood. Therefore it is interesting to look deeper into the results for the characteristic *serene*, first from the Skåne study by Björk, et al. (2008) (figure 3), and then from the Malmö studies presented in this paper.

One of the criteria we have established for *serenity* in rural and semi-urban areas is «silence». The western and southern part of the Skåne Region consists mainly of arable land and cities. This explains the white corridors through the blue landscapes in the east and north that fulfil the GIS-classified criteria for *serenity*. In the urbanized south-west corner, however, with many roads railroads and airports silence is almost absent when using this stringent definition. The case study, Malmö, is situated in this part of Skåne. Hence, there are not many *serene* areas attached to the city.

As for the regional study, it is interesting to look more closely at the characteristic serene to see how it differs over the city area (figure 4). The

Figure 3
Serene classified from certain land use types, protected qualities, noise, etc. The four big cities Malmö, Lund, Helsingborg and Kristianstad were excluded from this study, thus the map is white where the cities are located (Adapted from Skärbäck, et al., 2012).

reason why house-owners' satisfaction with their neighbourhood does not decrease with the decreasing number of characteristics in the immediate surroundings is probably because they own a garden. Figure 4 shows the *serenity* in the west and the east of Malmö, where separate, privately owned houses with gardens dominate. The yellow colour on the central downtown is dominated by multi-storey houses from older periods to modern time. In the Western part of that axis, there are also large parks from the 1920s and 1930s giving Malmö the epithet «The city of parks». The Northern part of this axis is the old town, where the blocks are closed to the streets and their backyards are free from traffic noise. These backyards are also mostly locked and open only to tenants, ensuring a feeling of safety for their homes, but criticized by others as «gated cities». The downtown attracts many casual and temporary visitors to offices, cafes, restaurants and pedestrian streets for shopping. The car traffic is limited, and the entire impression is that this part of Malmö is perceived as safe, with *serene* places for the people living there.

The black corridors east of this central axis (figure 5) are streets with heavy traffic (*Nobelvägen*), a railroad and the «Inner ring» road. In our classification, we have excluded areas with traffic noise over 55 dB (A) 24 h.

Notice that the GIS classification of characteristics in these two studies are based on intuitive expert elaborations of distinct variables in which alternative maps have gradually been produced and compared with field study experiences. One pitfall of this method is the issue of interpreting

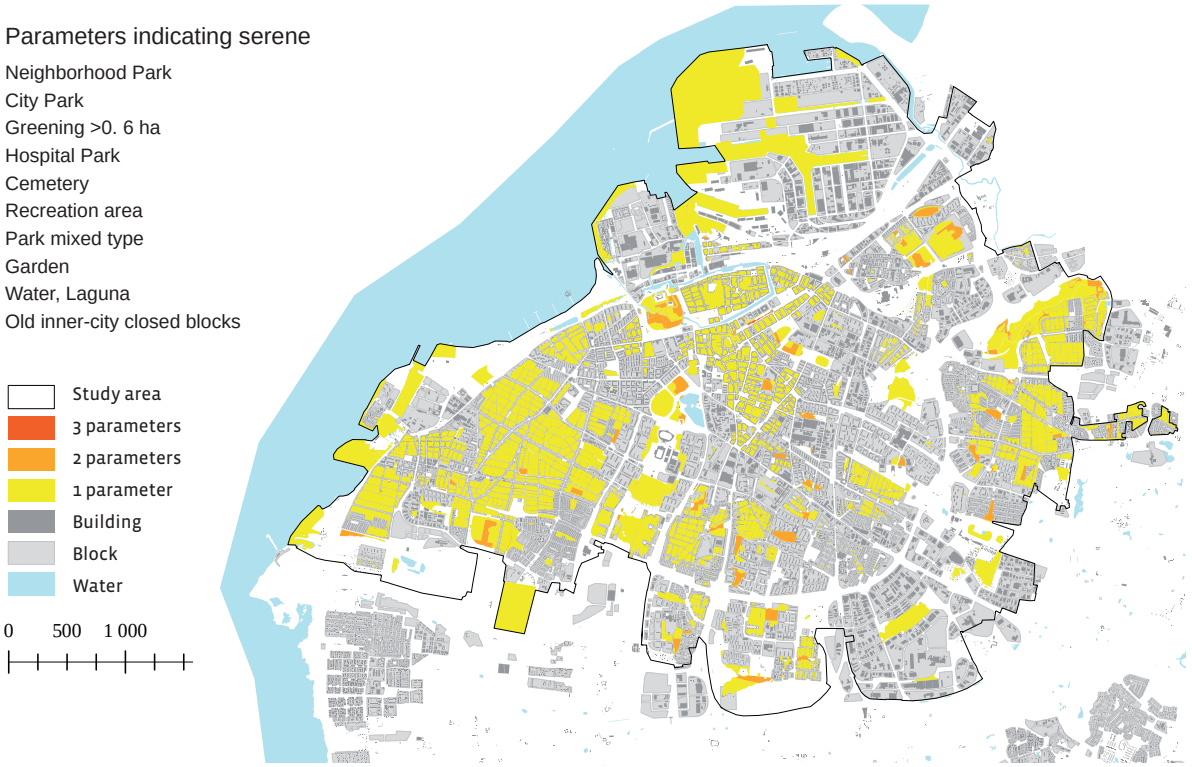


Figure 4
Serene areas in Malmö

Figure 5
Traffic noise > 55 dB (A) in Malmö.
(*Adapted from statistics of Malmö Municipality*).

and combining objective data so that they correspond to common perceptions of nature characteristics.

The study of Malmö with public health data from 2008 gives a possibility to evaluate how well the intuitive expert classification corresponds to common perceptions of the restorative characteristics. As already mentioned, the classification of the characteristic serene in the second study of Malmö comes from a regression analysis of the respondents answers in the 2008 questionnaire. One result from this regression analysis is presented in figure 6, showing the expected likelihood that people in different areas will perceive certain characteristics.

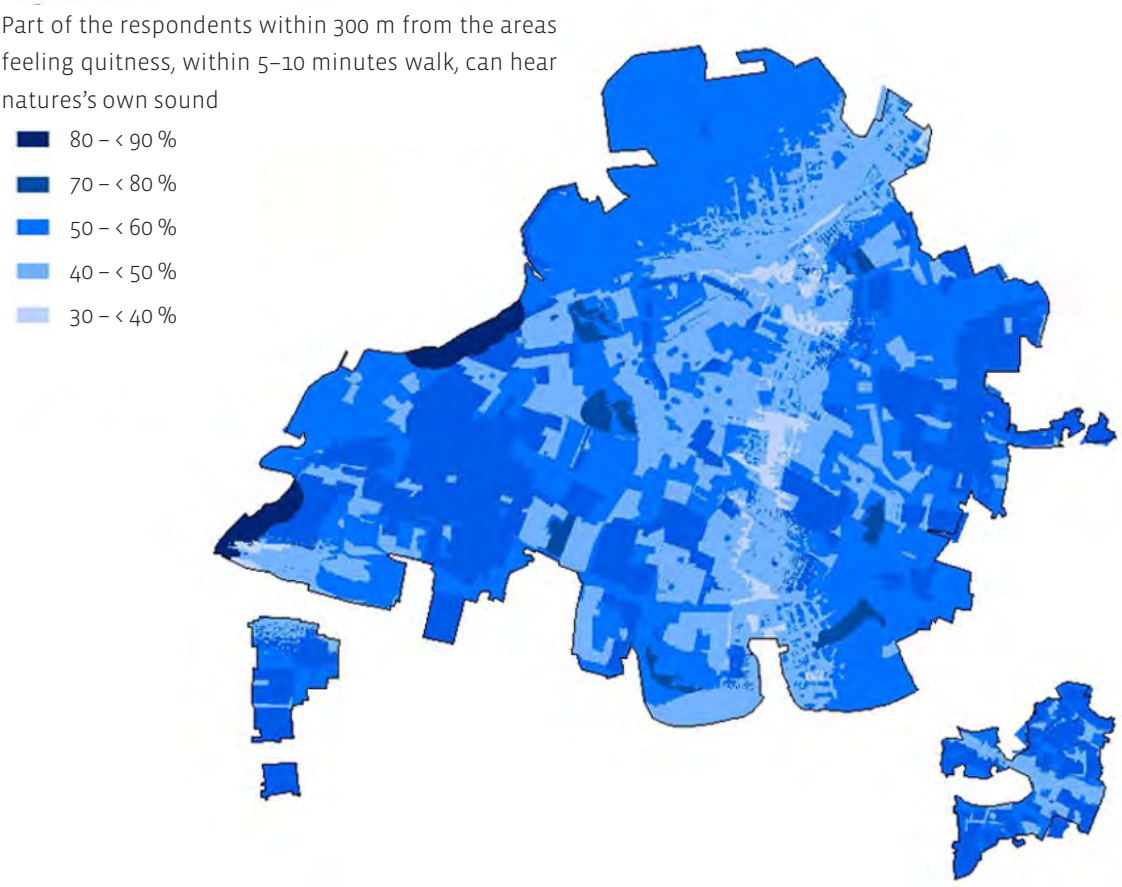


Figure 6
Classification of serenity in Malmö using regression analysis on the answers from the 2008 health survey and objective landscape parameters.

As seen from the regression analysis for the characteristic serene in figure 6, the result of respondents' perceptions generally show a pattern similar to the intuitive expert estimation in figure 4. Comparing figure 6 with figure 5 also shows rather clearly that traffic noise is largely associated with a low feeling of serenity.

However, there are also another observation of difference between west and east, that is the frequency and size of social green values. To explore this explanation, we can compare with an extra map (figure 7) showing the distinct variables parks, recreation areas, cemeteries, hospital parks,

Figure 7
The variables parks, recreation areas, cemetery, hospital parks, gardens and lagoon. Excluded is noise > 55 dB (A).

gardens and lagoons combined. For example the three large parks *Pildammsparken*, *Kungsparken* and *Slottsparken*, together nearly 100 ha, can be seen at the central west of Malmö as dark blue areas in figure 6 and green in figure 7. The saying that Malmö is «the city of parks» comes to a large extent from them. No such greenings exist in the central eastern axis of Malmö, the same area that shows low serenity, except from two large cemeteries in that area.

A comparison with socioeconomic data from the city of Malmö and Statistic Sweden 2010,shown in a figure in *Sydsvenskan*, Malmö daily newspaper (Sydsvenskan 2012-03-24) (figure 8) also gives other interesting observations illustrating differences between the western, middle and eastern parts of Malmö, differences characterized as «The city that is tearing apart».

The close association between low income, high noise levels and low *serenity* is striking: The maps together show how Malmö consists of two separate cities; one in the west and one in the east. The western part not only has the highest incomes, but also the best park availability and modest noise problems, whereas the eastern central part is poorer, lacking in parks and suffers from high noise levels.

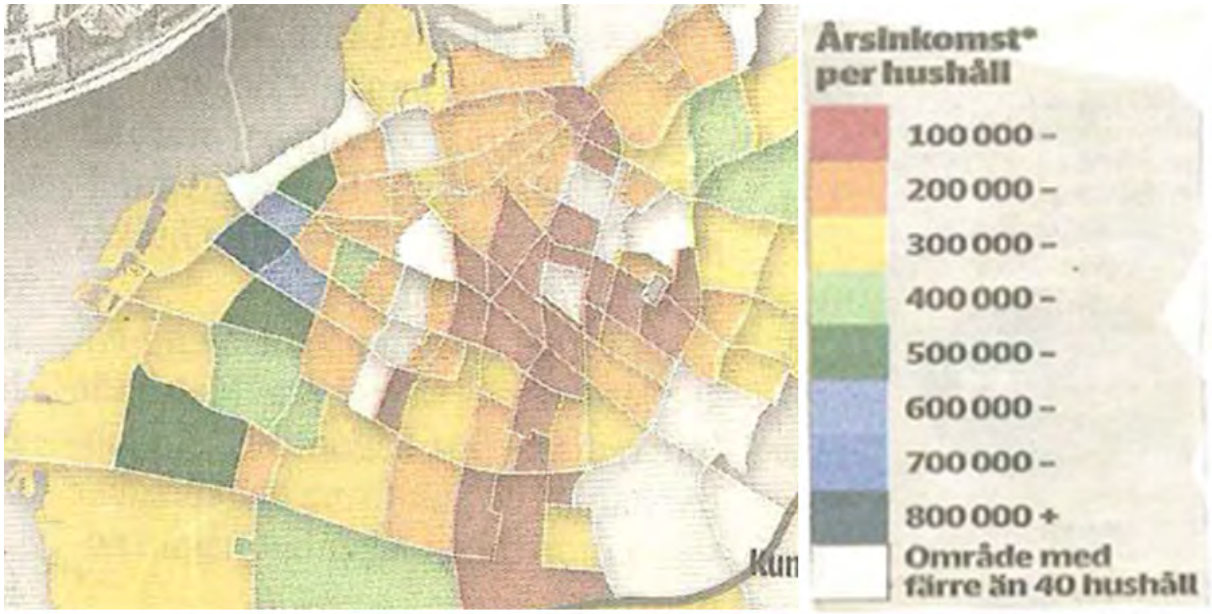


Figure 8
Annual average income (SEK) («årsinkomst per hushåll») of the households in defined city districts of Malmö. Graphic: Johan Strömbeck and Krister Cronqvist (Sydsvenskan, 2012, pp. A8–A9).

Discussion

The analysed studies clearly show that there is a strong association between how people perceive certain outdoor environmental qualities and how satisfied they are with their neighbourhood. Another important result is the clear association between differences in outdoor environmental qualities and household income, revealing the segregation in Malmö. In our search for other studies on how health and well-being are associated with densification, we found very little. But there are some exceptions. In our study, we have found that the size of the green space is important because the more characteristics for mental well-being there are the better. However, some characteristics do not fit together, e.g. the social may disturb the serene, so the larger green space, the more room for different characteristics. Equivalent results obtained by Kristensson (2003) show that there is no room for several outdoor physical activities on the same place, thus green spaces that are too small do not have room for multiple-use of certain activities. A conclusion is for several characteristics the larger the green space, the larger potential.

Our finding of the close association between low income and low serenity in Malmö has a parallel in a study of Southern California, were the spatial distribution of public recreational programs was investigated (Dahmann, et al., 2010). The researchers found that more than half of all recreation programs take place away from a formal park site, and that cities characterized by low household incomes, low fiscal capacity, minority populations, and multi-family housing are disadvantaged with respect to provision of recreation. Their conclusion was that such disparities might increase health risks among populations in such communities. They argued that urban planners and public health advocates

should enhance recreation programs in lower-income non-white communities (Ibid.). As we have shown for Malmö, such low income districts have a low green space standard with low serenity (figure 6–8), and thus we believe the Southern California study confirms our conclusion that people's recreational activity is highly dependent on having a car for «recreational commuting», and that this is particularly true for low income urban areas with a low park standard. People in such areas are in a «lose-lose» rather than «win-win» situation.

One main question to discuss in this paper is how the interpretation of the data relates to current densification trends in Malmö. Although Malmö has a rather rapidly increasing population, it still has only about 4,000 inhabitants/square kilometre, whereas Copenhagen is 2–3 times denser. The latest residential areas were developed in Malmö Harbour and at the urban fringe east and south of the city. New dwellings, however, are now being planned in the central eastern parts of Malmö, where the *serenity* is currently very low according to our data and results. Seven blocks of former industries are to be developed for housing in the *Sorgenfri* area, but none of the blocks, around 7 hectares, are planned to be park. Only a conspicuously small space is planned to be park, not representative for Malmö's tradition and reputation of being «the city of parks».

Now to the question on how we can apply the present findings to our understanding of possible effects of densification focusing on green space and public health, and suggestions about how the city needs to be developed according to green infrastructure beneficial for promoting public health. Our studies of neighbourhood satisfaction in Skåne and Malmö are in line with the result from the comparison of the level of local green space in residential areas in the Netherlands, that the perception of general health was positively related to people's percentage of green space (Maas, et al., 2006). Despite the fact that the Dutch study work with 3 kilometre radius and our studies in Skåne and Malmö work with 300 m radius, our material also indicates an association between serenity and household income. Our results are also in line with Mitchell and Popham's (2008) findings in England. Our result of low feeling of serenity in the low income areas of Malmö may be in line with the finding in Maas, et al. (2008) of loneliness and perceived shortage of social supporting less green space areas. This connection, however, ought to be studied further in the future. Nevertheless our conclusion is that, having a certain amount of well-distributed green areas is a precondition for social sustainability. We agree with the Dutch researchers' conclusion that green space is more than just a luxury and that it should play a more central role in spatial planning. And we can add to that recommendation that the more space for different characteristics, the better.

Our analysed studies together provide important input for the current

debate on the effects of global warming and the densification trend in urban planning. We are supposed to live more densely in cities to minimize commuting distance to our workplaces, but if we do not have enough parks that are well distributed and close to housing areas, there may be a need to commute to distant recreation areas and weekend houses. Gullberg, Höjer and Pettersson (2007) come to the same conclusion. Looking at the map of household income, it is clear that Malmö is a segregated city and that this segregation is closely associated with large-scale differences in outdoor environmental qualities. This divergence in outdoor environmental qualities for different income groups has most likely developed hand in hand over a long period of time. But there is no reason for it to be permanent. It is well known that city centres can change locations in a city. Popular locations come and go. Historically, the Värnhem square in Malmö was a highly desirable area, whereas it is now associated with the lower levels of well-being characterizing eastern Malmö of today.

The present study may be an important contribution to the contemporary debate concerning Malmö: How can we enable immigrants coming to Malmö, many of whom find their homes in the southern and eastern parts of the town, to integrate into Swedish society? One road ahead towards a possible solution would be to try to increase the level of attraction in the southern and eastern areas so that older inhabitants and the young Swedish population will want to live their lives there and integrate with newcomers. As suggested by the current study results, neighbourhood satisfaction and thereby attraction would most likely increase through investment in new large parks in these areas, on the same scale as the investment in large parks made in the early 20th century. During the depression years, establishment of those parks was funded by labour market subsidies. Similar investments today would probably have positive effects on the city's unemployment rate. Reducing traffic noise, especially from the railroad, would be another measure to increase serenity, neighbourhood satisfaction and attraction values.

Many people are aware of the value of greening in their environment, and prioritize that when choosing a new home. But, some argue against measures to improve the housing standard because such improvements may speed up gentrification. However, improvement of the outdoor environment does not always raise living costs, because the rent level (in Swedish *bruksvärdeshyra*) in Sweden is regulated and almost entirely based on interior qualities, not outdoor qualities, e.g., the eight characteristics. The downside of this way of setting rent levels is that developers and investors calculate real estate densification to be more profitable than improving the green qualities. Therefore in Sweden the incentive is low to invest in rental housing. Also because the banking valuation and thus banks' money lending to rental property developers is a function of rental income, the housing developers resist ambitions

to improve outdoor qualities. This is not the case on the market for condominiums (in Swedish *bostadsrätter*), where the free market price is to larger extent a function of outdoor qualities, and the banking valuation related to the market price results in greater profit for developers. Thus, having a large percentage of condominiums may lead to gentrification. Too few new rental dwelling areas are being built, but instead more and more condominiums. One consequence of this is that low-income families have difficulties finding a rental flat, while the supply of rather high-price condominiums is sufficient.

Jennifer, Byrne and Newell (2014) also comment on this economic issue. They call it a paradox that creation of new green space to make neighbourhoods healthier and more aesthetically attractive, also can increase housing costs leading to gentrification and a displacement of the very residents the green space strategies were designed to benefit. Their message is that urban planners, designers, and ecologists need to focus on urban green space strategies that are «just green enough» (Ibid.). For us the conclusion «just green enough» sounds too pessimistic. If we only use the quantity of greening, as most of the studies we have referenced do, it may be relevant to limit the discussion to quantities. But we have tried to elaborate qualities through our specification of the eight characteristics for mental well-being. With these characteristics in mind, we believe landscape designers can create green spaces that meet the needs of residents without risking either gentrification or segregation.

Need for further research

There is an urgent need for further research to identify the kinds of green space qualities or environmental perceptions and characteristics that are most valuable to create when densifying cities. Having one's own house with a garden is not sustainable by definition, neither from an environmental nor from an economical perspective. However, what about the social perspective? A garden may unify the house owner's family and friends, and their satisfaction may promote well-being and good health. But too many single-family houses require a great deal of space that could instead be used for multi-storey buildings and public parks. To further study these issues, research has to show how different landscape qualities promote health and well-being as well as how people's preferences relate to certain outdoor qualities. This issue will become more urgent as densification increases. To minimize gentrification when investing in new parks in an old area, while maximizing integration, there is a need for research on how we can find the proper balance between different housing types and different park qualities.

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