reviewed paper

The Value of Green Infrastructure in Urban Quality of Life

Karsten Rusche

(Dr. Karsten Rusche, ILS - Research Insitute for Regional and Urban Development, Bruederweg 22-24, 44135 Dortmund, karsten.rusche@ils-forschung.de)

1 ABSTRACT

High quality environments have an important role to play in building competitive cities and regions and in contributing to quality of life for both communities and employees. Green Infrastructure – defined as a network of multifunctional open spaces, parks, trees and woodlands – is a valuable part of the urban economy but, as urbanization increases, public and private green spaces are being lost to housing and commercial developments.

Economic investment decisions are shaped by a variety of factors including transport infrastructure, access to skilled labor and proximity to markets or supply chains. However these decisions are also influenced by perceptions of the area or regional 'image' as an attractive, prosperous setting for living, working and therefore investing in. Regions suffering from post industrial decline can suffer from a negative image which is difficult to shake off. One opportunity to reshape these regions is to enhance investments in green infrastructure. Green infrastructure can be seen as a certain type of regional amenity. It delivers various benefits for the inhabitants like ambient air quality, biodiversity, recreation facilities and so on.

The approach of this paper is to measure the willingness to pay of people for the amenity "green" in urban areas. This is done by integrating a GIS-based coding system for the quality and quantity of green infrastructure into the methodological concept of quality of life. In recent research papers the quality of life in urban areas is assessed by various variables and indicators. But especially the green spaces are lacking a conceptual measurement on the regional scale. By using data sets on the scale of European urban areas a way for valuing the benefits of urban green infrastructure is developed. It is mainly based on a regression setting that uses standard quality of life variables, but augments the analysis by, adding indicators for the accessibility of urban green infrastructure (based on distances).

This academic work spins off from the INTERREG IVb project "VALUE". It aims at establishing a way how to target green infrastructure investments at the city and regional scale to deliver the greatest economic benefits while ensuring that high quality green infrastructure is protected.

2 INTRODUCTION

The word "green" is currently very popular in public and academic discussion. Not only when considering the ecological aspects of carbon free - strategies, but also in the sense of acting responsible with the resources of nature. Regarding the field of urban economics, the term "green" is also becoming more and more important. This is, because the competition between urban regions is fostering with the ongoing increase in urbanization and globalization. Cities compete not only for capital but also for people and their knowledge. Especially in highly developed, service sector depending countries this part of regional competition is more and more not only met by just being attractive concerning hard economic factors. City planners are becoming aware of the triggering role of "liveability" of cities (Department for Communities and Local Government 2006), i.e. the composition of soft local factors of a city region that attracts high potentials to live and work in a certain place. Combining the hard and soft local factors one can speak of "Quality of Life" as a main aspect of intercity competition.

An often neglected aspect in this context is the importance of a high quality green infrastructure - defined as a network of multifunctional open spaces, parks, trees and woodlands - as a significant component of the amenity setting of an urban area.

Economic research has a long tradition in assessing the value of green spaces in urban areas. But the body of literature operates mainly the local - intracity - scale. A wide range of analyses worked on shedding light on the relationship between utility, willingness to pay and the development of open urban spaces. Results differ quite significantly depending on the spatial scale and the methods used. The aims of research within the literature are almost alike, but the techniques in determining the impact of the economic value of green infrastructure are changing rapidly. Referring to the two most used approaches on the local level - stated preference analysis by survey techniques and revealed preference analysis by hedonic pricing models (HPM)

- the past few years have speeded up the development of new empirical assessments. In both cases major catalysts for this were the growing use of GIS and the availability of geo-referenced data (Anselin/Lozano-Gracia 2008, Cohen/Coughlin 2008). So, it is well known for a single city that people do pay (in terms of house prices) for a greener neighborhood, a nice green view or a well structured green infrastructure. But the way in which the "greenness" affects the competition between cities on a regional scale is not yet well explored. When focusing on the more aggregated spatial level of city regions instead of neighbourhoods, the available methods and empirical assessments become much fewer.

Accordingly, this research paper investigates the relationship between regional quality of life and the composition of urban green infrastructures for European cities. It does so by combining the well-defined methodological concept of QoL with a GIS approach for the coding scheme of quality of urban green as a part of urban infrastructure. The main rationale behind the subsequent analysis is: when people and firms value a certain quality and quantity of green open spaces, it will be capitalized in local prices and wages.

In the concept of regional quality of life it is assumed that in a theoretical situation of spatial equilibrium all people have sorted themselves among all regions regarding their individual utility functions, according to the maximization of individual utilities (Blomquist 2006). In this utility function there are not only regional economical characteristics like income but also regional sets of amenities like nature, climate, culture and the amount of parks and other open spaces. So, when focusing on the impact of green investments on the regional scale, the strength of the relative impact of urban landscapes on the quality of life has to be assessed (Hand et.al. 2008).

Concerning QoL, economic theory concludes that amenities can be seen as attractors of people. So, in relation to some reference location people are willing to forgo a certain amount of real wage when they are localizing in a region with high quality of life. In addition they will be willing to pay a higher price for housing to have access to the regional housing market. On the one hand the housing prices will be higher in "nicer" places compared to regions with lower amounts of quality of life. On the other hand firms that offer jobs in the high valued regions will have to pay less to attract employees, because the region has a high net value of its own. So the hourly wages will be relatively low in these places after correcting for the higher prices of property.

3 QUALITY OF LIFE APPROACH

This section explains how the measurement of QoL is derived conceptually. It is based on the main literature (Chen/Rosenthal 2008, Gabriel/Rosenthal 2004, Büttner/Ebertz 2009, Blomquist 2006) which in core developes further ideas of Rosen (1979) and Roback (1982). The explanations are hold in brevity because more distinct and stepwise information can be drawn out of the cited literature.

Two sectors are being distinguished: households and firms. As mentioned above, firms maximise profits as households maximise utility. In functional form this is:

(1) $$u = u\ (w_i, r_i^H \,|A_i)$$

U is the households indirect utility function, where u is utility, w is the wage, rH the residential rent and A is a vector of local attributes aki in region i.

(2) $$\pi = \pi(w_i, r_i^B \,|A_i) = xp - xc(w_i, r_i^B \,|A_i)$$

Π is the profit function. Here rB is the commercial or industrial rate of rent, x is the amount of output, p is the commodity price and c(.) is the unit cost function.

When considering a spatial equilibrium and competitive markets, all firms face the same profit (=zero) and all households have the same utility:

(3) $$u\ (w_i, r_i^H \,|A_i) = \bar{u}$$

(4) $$\pi(w_i, r_i^B \,|A_i) = \bar{\pi}$$

When focusing on the relevance of local attributes for the QoL, the question of research is how the utility function reacts on a small change in a local amenity. This effect is mirrored by two components: the amount of wage a household is willing to forgo to consume a marginal amount of a certain amenity j and the willingness to pay for higher housing rents:

(5) $u_j/u_w = L^* \cdot dr/da_j - dw/da_j$

Equation 5 relates a growing utility to amenity effects of wages and housing prices. It can be divided into the effect the house price change and the wage reaction due to an isolated increase in amenity j. L* on the right hand side is the housing demand of the household and can be normalized to 1 for simplicity. In addition to that the relation on the left hand side can be rephrased for easier use into ip_j^h, the implicit price a household is willing to pay for a certain amenity j.

Once the HPM setup is defined and results of the estimations are available, some further steps of transformation follow up. The values of the regression coefficients do not yet mirror implicit prices; they rather belong to Euros per square meter and Euros per hour. So in order to attain implicit prices belonging to a monthly household budget, the coefficients have to be recalculated. Therefore some equal basis has to be taken into account, for example the average monthly expenditure on housing or the average monthly salary in the super ordinate region. Using this centre reference, all regression coefficients have to be rebased (Blomquist 2006, Buettner/Ebertz 2009). These rebased figures are then aggregated to the QoL as in (6).

The regional QoL is then the sum of all implicit prices of amenities multiplied by their local amounts.

(6) $QoL_i = \sum_{j=1}^{k} ip_j^h \cdot a_{i,j}.$

One important note has to be made: In this paper the main aim is not the calculation of a QoL index to rank cities. The interest lies in the coefficient estimates for the green variable in the empirical approach that is derived by using the conceptual framework of QoL. Therefore the analysis stops by using the relationship presented in equation 5. The weighted summation of equation 6 is left out on purpose.

Empirical Measures

The empirical assessment of the QoL is based on a regression approach. In contrast to stated preference techniques these estimations are solely based on revealed preference analysis, mainly the (spatial) hedonic pricing model. Generally speaking, the HPM deduces information of qualitative and environmental goods characteristics from market data. The information that is used in the empirical work can therefore be divided into two subsets (Gyourko/Tracy 1991, Blomquist et. al. 1988): Structural (individual) traits versus local amenity attributes for housing (wage) equations. In the most straightforward form the estimation of each form of regional quality is calculated in a hedonic regression, which analyses the impact of local attributes and local amenities on the respective price or wage variable (Chen/Rosenthal 2008):

(9) $w_{i,s} = \alpha + \sum_{j=1}^{k} \beta_j \cdot a_{ij} + \gamma I_s + \varepsilon_{i,s}$

(10) $p_{i,s} = \varphi + \sum_{j=1}^{k} \theta_j \cdot a_{ij} + \sigma C_s + u_{i,s}$

In a housing equation, for example, the monthly rent per square meter of housing (p) is set in relation to housing characteristics C (number of rooms, age, garage, lot size, living space) and a variety of regional variables/amenities a (socio-economic and environmental data). The wage regression refers to hourly wages w in relation to individual characteristics I (age, education, family status) and the local amenities a (Gabriel/Rosenthal 2004).

Because in this research paper the focus lies on the regional scale, this standard sets of data cannot be applied. Here, for every city under study we use an average price per square meter housing. So there are no housing attributes that can be referred to. The analysis therefore comprises data on regional socio-economic conditions and regional amenities.

3.1 Functional form

In the empirical literature on hedonic pricing models there is a wide range of different functional forms that are used. The most common equations are log-linear or log-log specifications of the relationship between the prices/wages and the exogenous variables. This is because of the ease of interpretation of the referring coefficients as differentiates or elasticities. But as these forms narrow the way of interpreting results and the optimisation of the estimation efficiency, many authors also use a Box-Cox power transformation which exact specification is mathematically determined in a Box-Cox maximum-likelihood search (Blomquist 2006, Tyrväinen/Miettinen 2000).

3.2 Green infrastructure

Most research on the QoL lack a precise and detailed implementation of quantities and qualities of green infrastructure. Research on QoL uses a wide range of amenity variables for regional description (Blomquist 1988, Gyourko/Tracy 1991). But in these publications the main focus is on air pollution as a driver of quality of life. The more recent analyses add only weak assessments of green infrastructure on the regional scale, i.e. number of Superfund Sites or the area share of forest and water (Blomquist 2006, Buettner/Ebertz 2009).

A contrast to this low presence of green space variables is the discussion of its theoretical impact on the regional quality of life. Green investments can be interpreted as investments in an upslope of the comparative advantage of a region (Crompton 2001). This is because green open spaces in urban areas have an effect not only on the small scale quality of place, but also on the wider perception of a good place to life (Andrews 2001). Through this channel a development of green open spaces should affect the regional attractiveness for people and firms relative to other places (Baycan-Levent/Vreeker/Nijkamp 2004).

So one important addition that has to be made to the research on QoL is in how far green investments have an effect on the regional willingness to pay in form of significant implicit prices (Tyrväinen/Miettinen 2000). In the literature on HPM on a local scale there is a huge number of papers that deals with the value of open space (for example McConnell/Walls 2005 as a review). Especially the ways of encoding qualities and quantities of green infrastructure in these analyses can be transferable to the regional/city level research approach. With the growing usability of GIS software and the availability of geo-referenced data the small scale HPM analyses concentrated on adding this information to the conventional approaches. For example, Goeghegan/Wainger/Bockstael (1997) use GIS information to a broader extend. Here it was a particular research interest to encode quantities and qualities of open space. Regarding quantity of green infrastructure an easy assessment is the use of simple distance measures of the relative proximity of open spaces (Cho/Bowker/Park 2006). This quantity can be measured in meters of linear distance to the next park. An extension in the variety of parks types was suggested by Cho/Poudyal/Roberts 2008 (evergreen forest patch, deciduous forest patch, mixed species forest patch). Additional measures of quantity are the number of forest patches in a certain radius or the average patch size.

In summary it can be stated that there are some interesting approaches in the empirical literature concerning green investments. But all of them are rather on a more local than a regional scale or do not use the variety of possible GIS-based information on green open spaces for the analysis of quality of life. The only paper that investigates similar effects focuses on the role of forests (Hand et. al. 2008). The ambition of this paper is, in contrast to that, oriented at green networks, where intra-urban forests are only one component of a city's green. For the aim of this paper it is necessary to integrate contemporary measures of qualities and quantities of green open spaces into the concept of regional urban QoL.

3.3 Data

To analyse the effect of green infrastructure on European urban areas' QoL, four different data sets are combined: two for the socio-economic variables for city regions, two for the indicator for regional greenness.

To get information on housing values in European cities, the Urban Audit data set is used. It is a data collection of more than 300 cities that consists of a huge variety of data on several topics (European Communities 2004). Here, housing prices per square meter and rents per square meter are selected as information about the average housing price in a city. The housing prices were recalculated to mirror n imputed monthly rent by using a discount rate of 7.85 percent together with information on the average size of a house in these cities. Than the data on apartment and house prices were averaged to get an idea of the overall housing value for a certain city (Blomquist 2006). Data was available for city regions as administrative regions and larger urban zones as functional economic areas. From a theoretical point of view the data for the functional regions is the most appropriate in many cases (Rusche 2010), but as this research focuses on the QoL in the dense urban fabric of cities, the regional data is taken from the city regions.

In addition, also data on the gross national product for the NUTS-3 region that belongs to each city and information about the population density were taken from the Urban Audit (UA). The economic variable of GNP captures the relative productivity of a city region in the European context and the population density covers the housing market conditions. As the UA is a quite new data source, its theoretical data richness suffers from a lack of complete data for all cities. So, concerning amenity variables, the Urban Audit promises a lot of information on, for example, crime and environmental statistics. But when employing this data, the sample sizes decrease to fewer than one hundred cities.

To give further indication on the overall endowment with public amenities, the variable "settlement" from the ESPON data is used. It ranges from 1 to 9, indicating the degree of centrality of a city. Regarding the amenity set up of cities, the assumption is made, that the more central a city is, the more it is endowed with public infrastructure (museums, theatres, public transport, universities, etc.). So this variable should capture the non-economic amenities arising from the city status. The second variable that is taken from the ESPON data is Coast. This is a binary variable indicating whether the NUTS-3 region of a city has a coast line or not. This stands for the touristic and recreational amenity values of city that are not captured by local green infrastructure.

One important drawback in European statistics has to be mentioned: there is no low scale information on regional wages. Therefore the regression approach can only rely on the housing price equations. As the standard QoL approach uses information on house prices and wages, this analysis suffers from a lack of information. But nevertheless, other studies already used the QoL concept by just focusing on the house prices (Buettner/Ebertz 2009), but here the wage equations showed to be insignificant). For the purpose of this research, only housing value regressions can be conducted.

4 URBAN GREENNESS

For the GIS-based analysis , the CORINE Land Cover 2000 (CLC2000) data set was combined with the dataset on "green urban areas within urban morphological zone" (GUA). Both datasets base upon the IMAGE2000 remote sensing dataset which is made from Landsat-7 ETM images taken in 1999-2001 (QUELLE: DLR http://www.corine.dfd.dlr.de/projektinfo_de.html; EEA http://www.eea.europa.eu/data-and-maps/data/green-urban-areas-within-urban-morphological-zones-2000-version-12-2005) The CLC2000 covers several types of land uses for all European cities, but is on a relatively rough resolution of 1:100.000 (QUELLE: DLR). The GUA data only includes information on green urban spaces, but is on a higher detailed resolution of 1:50.000 (QUELLE: EEA). In combining these two geodatasets, the regional structure of urban green infrastructure can be covered in detail.

One important innovation in the analysis conducted here is the coding scheme of green infrastructure. Based on the definition of urban green spaces as a network infrastructure, a GIS-based indicator was developed. It builds on a 300 meter buffer around the green urban spaces that can be identified by a union of the CLC2000 and the GUA. The buffer is related to the settlement area of the urban fabric that can be accessed by linear distance.

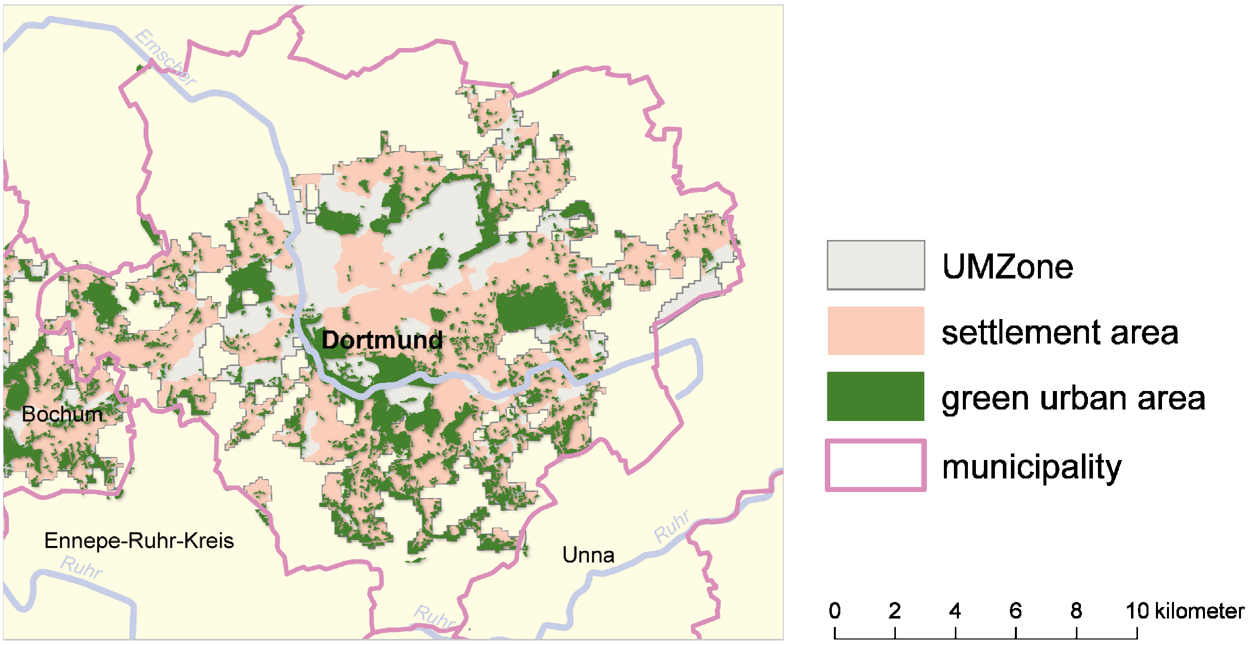

Fig. 1: Elements of Urban Greenness. Own calculations, map source: Urban Audit, CORINE Land Cover 2000, Green Urban Areas.

Figure 1 gives an idea of the approach for the city of Dortmund in Germany. For all cities that remain in the data set, the GIS indicator is calculated as follows:

$$\text{„Greenness“} = \frac{\text{settlement area within a 300m radius („as the crow flies“) around urban green spaces}}{\text{total urban settlement area}}$$

The main motivation for this kind of accessibility indicator is to get a more sophisticated picture of the regional setting of green urban spaces. By using a walking distance (approx. 15 minutes) buffer around urban green spaces, the greenness indicator measures the amount of settlement area, which lies within an adequate distance for the local inhabitants. So the quality of the green spaces as an infrastructure that is used by people comes in the fore. To get an idea of the relevance of this greenness indicator, it is contrasted with a standard ratio (share of green areas to share of settlement areas) and also taken into calculation.

Variable	Dimension	classification	Mean
Average housing rents	Euro	socio-economic / endogenous	818
GNP (Nuts-3) per capita	Euro	socio-economic / structural	26.657
Population Density	people per square kilometer	socio-economic / structural	2.620
Settlement	1 - 9 classification	amenity	4,951
Coast	0 - no coast, 1 - coast	amenity	
Greenness	percentage points	amenity	77,23

Table 1: Variable description

The implementation of the GIS approach cuts back the sample size further. This is because the GUA statistic is only available for Urban Morphological Zones. They are defined as connected settlement areas of more than 100.000 inhabitants (European Environment Agency 2007). So, some small cities with a diverse settlement structure are not covered by the GUA. The overall sample size consists of 142 European cities in several countries (Figure 2).

Fig. 2: Sample of European cities

5 EMPIRICAL RESULTS

The regressions base on the standard linear form. This is supported by the results of a box-cox search, which indicates on the linear equation as the best fitting functional form. The results show a high explanatory power and are - by means of a Reset-test and tests for normality - suitable for an OLS approach. The standard errors and p-value are calculated using a heteroscedasticity and autocorrelation consistent procedure.

The empirical results show two interesting aspects.

First, the GIS approach for the greenness indicator proves to be a powerful and efficient way of mirroring the network structure of urban green spaces. When comparing Model 1 and 2 - which only differ in the way the green infrastructure is calculated - it becomes obvious, that the influence of GI is rather more complex. By just putting the ratio of green area to settlement area into account, the regression model 1 indicates, that urban green has no significant impact on housing prices. It would therefore not be seen as a component of regional quality of life and compatibility. But, in contrast, by encoding the accessibility of GI, model 2 clearly point out, that urban greenness does indeed have a significant impact on the regional housing markets.

N = 141 cities					
	coefficient	standard error	z-value	p-value	
(intercept)	5081.000	1167.200	4.353	0.000	***
GDP_Nuts	0.198	0.027	7.429	0.000	***
population density	0.243	0.165	1.477	0.140	
share of green	4.012	13.371	0.300	0.764	
settlement structure	-152.100	85.037	-1.788	0.074	.
coast line	984.500	589.850	1.669	0.095	.
D Belgium	-9041.000	695.200	-13.005	0.000	***
D Denmark	-1935.000	2420.200	-0.800	0.424	
D Estonia	-3064.000	622.840	-4.919	0.000	***
D Spain	884.700	768.320	1.151	0.250	
D Hungary	-1599.000	878.800	-1.820	0.069	.
D Romania	-3917.000	967.190	-4.050	0.000	***
D Sweden	1373.000	3821.800	0.359	0.719	
D Slovakia	-1202.000	1738.100	-0.692	0.489	

Signif. Codes	0	‘***’	0.001	‘**’	
	0.01	‘*’	0.05	‘.’	
[1]	HC consisent standard errors				
Adjusted R²	0.7213				
F-statistic:	29.07	on 13	and 128	DF,	
			p-value:	0.000	

Model 1: Housing price regression - Green Ratio

The information on the settlement structure and the connection to a coastline prove to be not significant, but they stabilize the result and together with the whole set of variables they fit in the model as a whole - as the F-statistic indicates. While the dummy variables capture effects of country-specific differences, the results for the variables GDP and population density as standard data show the expected impact on regional QoL: the more income is generated and the more dense a city is, the more it is valued by the average house renter.

N = 141 cities					
	coefficient	standard error	z-value	p-value	
(intercept)	1460.700	1649.000	0.886	0.376	
GDP_Nuts	0.191	0.026	7.438	0.000	***
population density	0.325	0.158	2.058	0.040	*
urban greenness	46.960	16.858	2.786	0.005	**
settlement structure	-139.680	83.692	-1.669	0.095	.
coast line	1226.500	540.110	2.271	0.023	*
D Belgium	-9033.900	552.880	-16.340	0.000	***
D Denmark	-1784.300	2868.600	-0.622	0.534	
D Estonia	-3095.300	577.680	-5.358	0.000	***
D Spain	865.160	787.990	1.098	0.272	
D Hungary	-1449.800	790.840	-1.833	0.067	.
D Romania	-4010.900	966.680	-4.149	0.000	***
D Sweden	803.910	3351.500	0.240	0.810	
D Slovakia	-1240.300	2360.600	-0.525	0.599	

Signif. Codes	0	'***'	0.001	'**'	
	0.01	'*'	0.05	'.'	
[1]	HC consisent standard errors				
Adjusted R^2	0.7363				
F-statistic:	31.29	on 13	and 128	DF,	
			p-value:	0.000	

Model 2: Housing price regression - Greenness

Urban Greenness, as the centre of this analysis, is identified as an amenity that is valued by inhabitants of European city regions. In relation to the "other" influences the impact seems relatively moderate, as a change in the greenness by one percentage point raises the average housing price by 46,96 EUR.

Nevertheless, the impact is in its amplitude comparable to the other structural variables. As easily can be assessed by the coefficients of the dummy variables, the fairly straightforward regression setting could be augmented with more detailed variables.

6 CONCLUSIONS

The major conclusion for the analysis of the QoL aspects of urban green infrastructure is very important. Green urban spaces are not only valued on a local scale as other studies showed. It also is a component of regional quality of life levels of European cities.

Therefore, city planners should be aware of the fact, that reusing green spaces for residential or business purposes is not always the right answer. To foster the relative position of a city in the interurban competition it is not only the quality for businesses that has impacts on the liveability of cities. Green infrastructure as a network of places to use for leisure, recreation or just to look at impacts on the perception of city of being "green" or "red" (e.g. dominated by urban fabric). So, when thinking of a planning concept for a competitive city, it should always be kept in mind, that green is an amenity.

Further research has to focus in a more detailed and structured coding of urban greenness. For example, the types of different green spaces could be differentiated further and then be implemented in to the QoL analysis. The second and equal important issue is the use of a broader indicator set for European city structures and amenities. The ongoing improvements in the Urban Audit seem very promising in this direction.

7 REFERENCES

Andrews, Clinton J. 2001. "Analysing quality-of-place." Environment and Planning B: Planning and Design, 28: 201–217.
Anselin, Luc, and Nancy Lozano-Gracia. 2008. "Errors in variables and spatial effects in hedonic hous price models of ambient air quality." Empirical Economics, 34: 5–34.
Baycan-Levent, Tüzin, Ron Vreeker, and Peter Nijkamp, ed. 2004. "Multidimensional Evaluation of Urban Green Spaces: A Comparative Study on European Cities.".
Blomquist, Glenn C. 2006. "Measuring Quality of Life." In: A companion to urban economics. ed. Richard J. Arnott and Daniel P. McMillen, 483–501, Malden, Mass.: Blackwell.
Blomquist, Glenn C., Mark C. Berger, and John P. Hoehn. 1988. "New Estimates of Quality of Life in Urban Areas." American Economic Review, 78: 89–107.
Buettner, Thiess, and Alexander Ebertz. 2009. "Quality of life in the regions. Results for German counties." The annals of regional science, 43(1): 89–112.
Chen, Yong, and Stuart S. Rosenthal. 2008. "Local amenities and life-cycle migration: Do people move for jobs or fun?" Journal of Urban Economics, 64: 5119–5537.
Cho, Seong-Hoon, J. M. Bowker, and William M. Park. 2006. "Measuring the Contribution of Water and Green Space Amenities to Housing Values: An Application and Comparison of Spatially Weighted Hedonic Models." Journal of Agricultural and Resource Economics, 31(3): 485–507.
Cho, Seong-Hoon, Neelam C. Poudyal, and Roland K. Roberts. 2008. "Spatial analysis of the amenity value of green open space." Ecological Economics, 66: 403–416.
Cohen, Jeffrey P., and Cletus C. Coughlin. 2008. "Spatial Hedonic Models of Airport Noise, Proximity, and Housing Prices." Journal of Regional Science, 48(5): 859–878.
Crompton, John L. 2001. "The impact of Parks on Property Values: A Review of the Empirical Evidence." Journal of Leisure Research, 33(1): 1–31.
Department for Communities and Local Government, ed. 2006. "State of the English Cities. Liveability in English Cities.".
European Communities, ed. 2004. "Urban Audit. Methodological Handbook.".
European Environment Agency, ed. 2007. "Urban Morphplogical Zones 2000. definition and procedural steps.".
Gabriel, Stuart A., and Stuart S. Rosenthal. 2004. "Quality of the Business Environment versus Quality of Life: Do Firms and Households like the same Cities?" The Review of Economics and Statistics, 86(1): 438–444.
Geoghegan, Jacqueline, Lisa A. Wainger, and Nancy E. Bockstael. 1997. "Spatial landscape indices in a hedonic framework: an ecological economics analysis using GIS." Ecological Economics, 23: 251–264.
Gyourko, Joseph, and Joseph Tracy. 1991. "The Structure of Local Public Finance and the Quality of Life." Journal of Political Economy, 99(4): 774–806.
Hand, Michael S., Jennifer A. Thacher, Daniel W. McCollum, and Robert P. Berrens. 2008.
Intra-regional amenities, wages, and home prices. The role of forests in Southwest.
McConnell, Virginia, and Margaret Walls, ed. 2005. "The Value of Open Space: Evicence from Studies od Nonmarket Benefits.".
Roback, Jennifer. 1982. "Wages, Rents, and the Quality of Life." Journal of Political Economy, 90(6): 1257–1278.
Rosen, Sherwin. 1979. "Wage-Based Indexes of Urban Quality of Life." In: Current Issues in Urban Economics. ed. P. Mieszkowski, 74–104, Baltimore: John Hopkins University Press.
Rusche, Karsten. 2010. "Quality of life in the regions. An exploratory spatial data analysis for West German labor markets." Jahrbuch für Regionalwissenschaft / Review of Regional Research, 30(1): 1–22.
Tyrväinen, Liisa, and Antti Miettinen. 2000. "Property prices and urban forest amenities." Journal of environmental economics and management, 39(2): 205–223.