CRITICAL SUCCESS FACTORS IN PLANNING AND MANAGEMENT OF URBAN GREEN SPACES IN EUROPE

Tüzin Baycan-Levent
Department of Urban and Regional Planning
Istanbul Technical University
Istanbul
Turkey
Tuzin.baycanlevent@itu.edu.tr

Peter Nijkamp
Department of Spatial Economics
Free University
Amsterdam
The Netherlands
pnijkamp@feweb.vu.nl

Abstract

This paper focuses the attention on the importance of urban green areas in the context of urban sustainability policy. Special attention is given to the conditions that are responsible for successful urban green space planning. Based on a systematic extensive data base on relevant attributes of urban green in 23 European cities, our study aims to identify the critical success factors for the effective provision and maintenance of green spaces in the city, by using a multidimensional principal component analysis. By means of this comparative analysis, it is possible to specify transferable policy lessons on urban green spaces.

1. Sustainability in an Urban World

In recent years we have witnessed an avalanche of new terms and concepts that focus on the urban role in the general sustainability movement (see e.g., Brandon and Lombardi 2005; Breheny 1992; Capello et al. 1999; Priemus 1999; Swanwick et al. 2003). A few examples are: eco-city, zero-emission city, liveable city, resourceful city, sustainable city, environmental city, car-free city, green city or garden city. All such concepts serve to express the idea that in the search for effective sustainability initiatives the city is a key player, an idea which should not come as a surprise, as cities in almost all countries house the majority of the population and economic activity

Our world is becoming increasingly urbanized – with all the advantages and disadvantages that go with it. The geography of the twentieth century exhibits an intensified trend toward an urban way of life in modern society. Despite suburbanization – and sometimes de-urbanization tendencies – the city remains the nucleus of a developed economy. It is undoubtedly true that the economies of density and scale are decisive factors for city formation. Clearly, there are also dis-economies as witnessed by congestion, environmental decay and so forth. Nevertheless, the positive features of the city still appear to be a dominant force, as the city is an extremely efficiently organized geographical entity (see also Glaeser 1999).

This perspective applies in particular to the use of public utilities such as water, telecommunications, electricity and energy in general. Also, the agglomeration advantages of a city make it possible to adopt new forms of environmental waste management and renewable energy policies which otherwise would not be feasible.

This background has led to the notion of a sustainable city, a concept which refers to the potential of urban agglomeration to ensure an environmentally benign development of a city through focused environmental resource, and energy initiatives which stimulate a balance between economic progress, social equity and environmental quality (see Capello et al. 1999).

Since the early 1960s, when Rachel Carson's 'The Silent Spring' attracted world-wide attention, there has been an ever-increasing awareness of the extensive damage to the environment caused by various forms of pollution. An avalanche of literature has been published since the 1980s on the pervasiveness of environmental decay ranging from local to even global scales and culminating in the widely cited Brundtland Report (WCED 1987). Sustainable development has clearly taken on a global dimension, but in recent years it has increasingly been acknowledged that there is a close mutual interaction between local and global processes. Localities (e.g., cities, villages) are open spatial economic and ecological systems impacting on their surroundings and on the earth as a

whole. The recognition that much of the sustainability debate has an urban orientation is also based on the fact that cities are large consumers of natural resources and major producers of pollution and waste. For example, the cities in OECD countries consume approximately 60 to 80 percent of total energy demand (see OECD 1995). The role of localities is even more pronounced, when we recognize that cities are also the major sources of new technology, economic growth and new environmental initiatives. Consequently, the role of the city is increasingly that of an animator and coordinator of creative quality-of-life strategies. And this role is likely to be reinforced in the future (Gibbs 1994; Girardet 1992b).

Sustainable development has become one of the touchstones of urban policy in the past years. And consequently, the notion of a sustainable city has in the past decade gained much popularity in many countries (see e.g., Nijkamp and Perrels 1994; Haughton and Hunter 1994; Selman 1996). There is at present considerable analytical and political interest in the success conditions for a sustainable city. The urban focus in the present sustainability debate is largely caused by the fact that (large) cities are the major users of nature's scarce resources and the major causes of environmental decay (cf. Girardet 1992a). At the same time, cities are able – as a result of scale advantages – to create more efficient energy savings conditions and related environmental quality improvements (Capello 1998). Furthermore, it ought to be recognized that the sphere of influence of cities – in terms of spatial interaction of persons, goods, environmental impacts and resource use – extends far beyond their own territory; the potential of cities to shape attractive quality of life conditions in areas under stress means that cities are sometimes regarded as islands of opportunities in seas of decay (cf. van Geenhuizen and Nijkamp 1997). A currently popular concept in this context is that of an ecological footprint, which refers to the fact that the environmental burden of a city – through use of scarce inputs and through pollution emission – may have a formidable geographical coverage. Thus, the environmental carrying capacity of a city would ideally have to be placed in a much wider spatial setting (see Archibugi 1997; Nijkamp et al. 2004; Rees 1992; Wackernagel and Rees 1996).

It has rightly been argued in the literature that urban sustainable development is not only a matter of environmental quality control. The city is essentially the result of three main intersecting forces, viz. social, environmental and economic forces, which are interlinked, giving rise to positive and negative factors (see Camagni 1998). Urban sustainability goals are thus related to the maximization of positive factors stemming from the interaction of these three elements (e.g., a high quality of the labour market, increasing returns in energy use, economies of density in pollution control etc.) and the

minimization of negative factors (e.g., traffic congestion, air, water and soil pollution). Thus, sustainable cities are not only characterized by a clean environment, but have a much richer socio-economic and environmental scope.

There is an increasing awareness that urban environmental quality is highly favoured by the availability of accessible protected and well maintained urban green spaces (parks, green provisions etc). This has sometimes been a neglected issue in the urban planning literature, especially from the perspective of a quantitative comparative study. The present paper aims to investigate and compare – by means of principal component analysis – the current state and availability of urban green spaces in several cities in Europe and to draw transferable lessons on current management practices on urban green in these European cities. This is an important challenge, as the full potential of green spaces in the cities is often not fully recognized, so that maintenance and design initiatives in urban green may be sub-optimal. The identification of best practices and policy lessons may provide effective guidance for society and planning agencies to improve the sustainability of cities through a dedicated green space strategy.

The paper is organized as follows. After an overview of issues related to planning and maintenance of urban green (Section 2), we will describe the data base of our comparative study (Section 3). Then we will offer the results of a principal component analysis applied to our data set, followed by policy interpretations and conclusions. The study will be concluded with some general planning lessons.

2. Issues in Urban Green Space Planning

In the past decades urban sprawl and urban land use intensification have caused a significant loss in natural and green areas (EEA 2002). In many urban areas the creation of new public green spaces has not kept pace with the growth of the built-up areas (Pauleit 2003). In addition, the information on the provision and quality of urban green space is rather limited, while policy and planning on urban green is rather fragmented in most cities (Pauleit 2003; Pauleit et al. 2003; Scottish Executive 2001; Szulczewska and Kaliszuk 2003). In many cases, we do observe lack of project rationalization for green spaces, weak management and implementation structures and limited funding possibilities (De Sousa 2003; DTLR 2001; Pauleit 2003; Scottish Executive 2001; Tyrväinen and Väänänen 1998).

Fortunately, in recent years several urban sustainability initiatives have made a serious attempt to offer a more rigourous basis for urban green space planning, witness such initiatives and concepts as: urban planning with nature, garden city planning, brownfield-greenfield planning, urban green networks design (or urban green

connectivity planning), urban greenstructure planning, urban landscape ecology planning, and so forth (Beer et al. 1993; Breuste et al. 1998; De Sousa 2003; DTLR 2001; Goode 1998; Jim 2004; MacHarg 1971; Pauleit et al. 2003; Roelofs 1999; Scottish Executive 2001; Swanwick et al. 2003; Szulczewska and Kaliszuk 2003; Tjallingii 2003). Furthermore, the benefits of urban green spaces have been highlighted in a more rational and convincing way, by creating a distinction and systematic typology of benefits into social, economic, ecological and community planning benefits (see for an overview also Baycan Levent and Nijkamp 2006).

This paper addresses professionals and managers of urban parks and green spaces in the city. It has broadly been recognized in the history of human settlements that the availability and quality of urban green contributes to the quality of life of residents of cities, while high quality green spaces also act as an attraction force for visitors. Unfortunately, many cities have over the past decades neglected the management and socio-economic potential of green spaces. Consequently, there is a widespread need for good practices of urban green management, in particular on the basis of a solid comparative study focusing on critical aspects of use, management and maintenance of such areas. Therefore, the main goal of the present study is to offer a proper understanding of key elements of urban green in various cities in Europe, to develop a quantitative methodology for comparative analysis of use and management practices (including local responsibility) of urban green space and parks in various European cities, and to derive transferable lessons – based on a comparative statistical analysis (viz., principal component analysis) of various management practices in cities in Europe – for policy makers and practitioners involved with sustainable city tasks. We will first offer a concise introduction into urban green space issues.

The large-scale urbanization trend has prompted the need for proper access to urban environmental quality resembling the countryside or – as a substitute on a daily basis – to urban landscapes in the form of parks and urban green. Given the intensity of use of such public amenities in densely populated towns, such areas are subjected to a permanent threat of quality decay and dereliction, if not properly managed and maintained, rather than being attractive, clean and safe places to enjoy. Therefore, sufficient efforts from the side of urban decision-makers and the public at large are needed to guarantee a desired provision and upkeep of green amenities in the cities. Nowadays, the awareness is growing that effective maintenance, coordinated management, public participation, and user responsibility for secure and attractive green spaces are a *sine qua non* for a balanced contribution or urban green to sustainability of cities. In this context several important issues are emerging:

- what is an appropriate definition of urban green space?
- what is the relationship between socio-demographic indicators of cities and the provision with urban green?
- how is the quality of green spaces in the city perceived by the residents and/or the users?
- which efforts are expected from the side of public officials and policy makers for urban sustainability including green spaces?
- which are the key factors for a proper management of urban green?

In a previous study, urban green space has been defined as: "*public and private open spaces in urban areas, primarily covered by vegetation, which are directly (e.g., active or passive recreation) or indirectly (e.g., positive influence on the urban environment) available for the users*" (see Baycan Levent and Nijkamp 2005, p. 67). This definition is rather broad and may incorporate a variety of public green areas in the city. Urban green does not only have a quantitative dimension (such as size, user capacity), but also a qualitative dimension (such as quality of maintenance, biological diversity, diversity in flora and fauna). It should be noted that in most cities in Europe a satisfactory information system with relevant data on such features of urban green is usually lacking. Furthermore, many green spaces in the city were not deliberately planned, but emerged out of historical and topographical causes in an evolutionary manner, but nowadays they all serve to reconcile the needs for natural and man-made environments in the city.

The access to urban green is, of course, an important policy issue. Two factors play in particular a role here, viz. the density of urban residents in areas adjacent to the green area concerned and the distance from residential areas to the green spaces in the city. Thus, the socio-economic function of open green spaces or green belts in urban areas depends on locational and demographic characteristics of the residents of the city and the visitors of these areas.

Urban quality of life is nowadays seen as an important determinant of residential location in many cities. Clearly, public managers have a great responsibility for the upkeep of public environmental amenities, but also residents and visitors share a common concern to make urban green an attractive and safe place for recreation, social contacts, environmental satisfaction or sports. To study the appreciation of residents or visitors for green spaces in the city, appropriate assessment techniques (such as contingent valuation methods or conjoint analysis methods) can be deployed.

Care for urban sustainability, with a particular view to the maintenance of green spaces in the city, has to take account of various caveats in the provision or upkeep of

urban green, such as the high-use intensity of parks near the city center, rapid decay in quality caused by vandalism or littering, or different views on architectural design of urban green due to a multiplicity of sometimes conflicting use functions. Thus, different expectations may create different perceptions of the quality of urban green.

A proper management of urban green spaces is fraught with many problems related to the demarcation of responsibilities, lack of coordination between different stakeholders, lack of awareness of the critical importance of urban green for the well-being of residents, conflicting use values attached by residents and visitors to various functions of urban green, etc. Therefore, there is not a simple panacea that can be used to create success stories for urban green policy. Rather, there may be a variety of good practices that – on the basis of comparative analysis – may lead to useful and transferable policy lessons and/or effective coherent management strategies. In the sequel of this paper, we will present a comparative quantitative study on green policy in European cities, with the aim to extract generalizable findings for urban green policy.

3. The Data Base

The cities reviewed and analyzed in our comparative study on the provision and maintenance of urban green spaces in Europe were selected by a broadly composed research team and extended with several other cities which were regarded as relevant for the project purposes and whose officials wanted to cooperate[1]. The selection criteria were based on geographical coverage and city size, while additional criteria were based on a manageable number of cities to be examined and availability of (standardized) data on urban green. At the end, a total of 23 cities from 15 European countries was included in our comparative analysis (see Table 1), with the aim to use benchmarks for drawing transferable lessons on good planning practices for urban green spaces in Europe.

For each of these cities an extensive data collection and information gathering activity had to be organized in order to create a standardized, but unique set of data on attributes, managerial practices and policy impediments regarding urban green space planning in all these cities. The data and information base – necessary for a systematic assessment and evaluation of green policies in European cities – was collected by and obtained from a varied set of relevant departments, agencies, experts and civil servants of municipalities in these relevant cities. The data were cross-checked and critically reviewed by a broadly composed research management committee.

[1] The case study research was undertaken by a broadly composed consortium and was part of an EU sponsored research project on urban green spaces, called URGE.

Table 1. Cities in the urban green sample

Metropolises Population: 1,000,000+	**Big cities Population: 500,000-1,000,000**	**Medium-sized cities Population: 100,000-500,000**
Berlin	Birmingham	Antwerp
Budapest	Cracow	Bern
Istanbul	Genoa	Edinburgh
Vienna	Helsinki	Espoo
Warsaw	Lodz	Leipzig
	Malaga	Ljubljana
	Marseilles	Montpellier
	Turin	Salzburg
		Sarajevo
		Zurich

The data base and information system used for our comparative analysis centered around a systematic typological approach which guided the data collection process. At the end, 7 clusters of relevant variables were distinguished containing in total 28 items. The type of data collected and used in our comparative study are concisely represented in Table 2.

Table 2. Data base on urban green

General profile of the city:
- administrative area
- built-up area
- population
- density (gross and net)
- land use (residential, industrial, agricultural and green areas, forest, water surfaces) (as total area and proportion with respect to total area)

Quantity and availability of urban green spaces:
- proportion of green spaces with respect to total area (%)
- proportion of green spaces per 1000 inhabitants (m^2)

Importance of urban green spaces:
- importance of urban green spaces to the city compared to other functions

Changes in urban green spaces:
- recent changes in the total area of green spaces in the last 10 years

Financing of urban green spaces:
- changes in the budget for greenery in the last 2 years

Planning of urban green spaces:
- existence of special planning instruments for urban green spaces
- number of responsible departments for the planning of urban green spaces
- citizen participation

Level of performance:
- success level of urban green space policy in light of the objectives of a city

In conclusion, after a time-consuming data collection process, with all cities actively involved, it was possible to create a data base on all relevant facets of urban green space in Europe, leading to a unique data base matrix (23x28). This data system will be statistically analyzed in Section 4.

4. Principal Component Analysis of Urban Green Data

Our multidimensional data matrix contains a great variety of several – sometimes partly correlated – variables measured in different dimensions. A powerful and often deployed statistical technique to reduce the high dimensionality of such a data set and to extract some key forces that are decisive for the structure and numerical representation of our data matrix is Principal Component Analysis (PCA). PCA is able to summarize the basic features of such a complex data set by transforming it to a more concise set of independent factors that still encapsulate (almost) all information. To achieve this lower dimensionality, PCA uses a linear statistical transformation of the data set, such that the highest variance by any projection of the data is related to the first coordinate (called the first principal component), the second highest variant to the second coordinate, etc.

The results of our PCA are rather straightforward and demonstrate that the 28 variables contain much redundancy and that from the total of 28 variables there are mainly 9 variables that are decisive for the data pattern concerned. These 9 variables can essentially be summarized in 5 principal components (PCs), which altogether explain already 88.96 percent of the total variance in the sample. These results are briefly summarized in Table 3. Technical details on the statistical results of the PCA can be found in the Annex.

Table 3. Empirical results: variables used in PCA

PC1	**Quantity of green spaces**
PC1-1	Proportion of green spaces with respect to total area (%)
PC1-2	Proportion of residential areas with respect to total area (%)
PC1-3	Proportion of forest with respect to total area (%)
PC2	**Participatory planning**
PC2-1	Number of responsible departments for the planning of urban green spaces
PC2-2	Experience with citizen participation
PC3	**Performance level**
PC3-1	Recent changes in the total area of green spaces in the last 10 years
PC3-2	Success level of urban green space policy in light of the objectives of a city
PC4	**Built-up level**
PC4-1	Proportion of built-up area with respect to total area (%)
PC5	**Availability of green spaces**
PC5-1	Proportion of green spaces per 1000 inhabitants (m^2)

The PCA results encapsulate interesting features (see Annex). In particular, the following findings are noteworthy:

- there is a strong (negative) correlation between PC1 (quantity of green spaces) and the proportion of residential areas in the city, as well as between PC1 and the proportion of forest in the urban area;
- there is also a strong correlation between the citizen participation (PC2) and the number of departments in the city charged with urban planning;
- and finally, the performance indicator for urban green planning (PC3) appears to be strongly correlated with recent positive amendments in the total areas of urban green spaces.

We will now present in more detail a further interpretation of the relevant statistical results or each of the 5 PCs. These results will be discussed in 'staccato' form.

PC1: Quantity of green spaces

- The first PC refers to the importance of the quantity of green spaces measured as "*proportion of green spaces with respect to total area %*", "*proportion of residential areas with respect to total area (%)*", and "*proportion of forest with respect to total area (%)*".
- The proportion of green spaces appears to decrease in relation to the proportion of residential areas and the proportion of forest, which means that urbanization negatively affects the quantity of urban green spaces, whereas the existence of natural green spaces such as a forest may be seen as a substitute for urban green spaces.
- As the first and the most explanatory component, the quantity of green spaces may be considered as the key issue among the success factors in planning and management of urban green spaces.

PC2: Participatory planning

- The second PC identifies the importance of participatory planning measured as: "*the number of responsible departments for the planning of urban green spaces*" and "*experience with citizen participation*".
- The number of responsible departments determines the participation level of citizens, while the participation of more departments in planning and management of urban green spaces likely provides more opportunities for the participation of

citizens. This participatory planning approach contributes to the success level and green performance of cities.

PC3: Performance level

- The third PC identifies the success and performance level measured as: "*recent changes in the total area of green spaces in the last 10 years*" and "*success level of urban green space policy in light of the objectives of a city from the representatives' own evaluation perspectives*".
- In parallel to the first PC that strongly identifies the importance of the quantity of urban green spaces, the third PC highlights that the success in planning and management of urban green spaces is seen and evaluated by city representatives in terms of protection and development or urban green spaces. A positive change in terms of an increase in the total surface of green spaces may increase the success level of urban green space policy of the city concerned.

PC4: Built-up level

- The fourth PC is related to the built-up level of the city measured as: "*proportion of built up areas with respect total area (%)*".
- It is obvious that the man-made environment negatively affects the natural environment and leads to the loss of natural green spaces. However, in the case of lack of natural green spaces, especially in big cities, the proportion of urban green spaces can be increased by more awareness of planning authorities. In other words, in the case of lack of natural green spaces (like forests), urban green spaces may play an important role in improving the quality of urban life as a substitute for natural green spaces. Therefore, the built-up level of the city may contribute to the improvement of urban green spaces.

PC5: Availability of green spaces

- The fifth PC is associated with the importance of availability of green spaces measured as: "*proportion of green spaces per 10000 inhabitants (m2)*".
- The quantity of urban green spaces is clearly the most crucial factor in planning and management of urban green spaces. However, the availability of green spaces per inhabitants is also crucial in improving ecological sustainability and the quality of urban life in cities. The satisfaction level of the citizen is undoubtedly one of the most important factors for successful planning stories.

Finally, we may now assess the success level of the European cities in our sample regarding the planning and management of urban green spaces by adding up all factor scores of the cities, obtained by the sum of all sub-factor scores in the groups of the 5 PCs. In this way, one may rank the 23 participating cities according to their success (or performance) level. We have finally classified the 23 cities into 5 performance levels, ranging from 'very low', 'low' and 'medium', to 'high' and 'very high', according to 'natural' breaking point in the total factor scores. The results are given in Table 4 and show interesting tentative features. Cities from Southern and Central/Eastern European countries tend to have a lower urban green achievement than others. Medium-sized cities appear to score in general somewhat better than metropolises. Clearly, our sample is too small to draw solid statistical conclusions.

Table 4. Empirical results: green performance of European cities

Very high	**High**	**Medium**	**Low**	**Very low**
Zurich	Helsinki	Espoo	Berlin	Sarajevo
Antwerp	Warsaw	Salzburg	Istanbul	Malaga
Montpellier	Edinburgh	Leipzig	Cracow	Lodz
Marseilles	Bern		Genoa	Ljubljana
Vienna	Birmingham		Budapest	
	Turin			

5. Concluding and Prospective Remarks

The statistical analysis performed in Section 4 has brought to light the existence of 5 critical success conditions in planning and management of urban green spaces. Our PCA has highlighted the particular importance of 2 background factors, viz. quantity and availability of urban green spaces, and the presence of an integrated and coordinated planning system accompanied by an active involvement of the community in the planning process for sustainable cities.

As far as the typology of city size is concerned, it appears that the success level of urban green policies is relatively higher for medium-sized cities, with a lower achievement of metropolises and big cities. In terms of geography, the results show that Northern European cities seem to be more successful than Southern and Eastern European cities in their planning and management activities of urban green spaces.

Our comparative analysis has also led to very relevant policy conclusions. First of all, it ought to be mentioned that urban greening may be a necessary but not sufficient condition for achieving urban sustainability. Consequently, urban green spaces deserve due attention in order to improve the quantity, quality and accessibility of green spaces,

as these facilities form the basis for an environmentally-benign vision on the city. Clearly, the pure presence of green spaces in the city is not sufficient; much attention is needed for maintaining and extending a high quality green asset in the city. Especially, metropolises and big cites should assign a high priority to a professional and effective maintenance of urban green.

An often neglected, but absolutely critical factor is the institutional support system for urban green planning, as green space planning and management require intensive, dedicated and coordinated efforts. There is an increasing need for collaborative and enabling partnership not only between local planning agencies, but also between local businesses and voluntary groups. This would be instrumental in reinforcing both green space policies and good practices. The set of stakeholders in local sustainability policy – and hence in green space planning – is varied and comprises inter alia residents' groups, NGOs, local environmental agencies and interest groups, conservation groups, the business sector, real estate agencies, development agencies, local policy-makers etc. Consequently, transparent planning strategies – based on trust, responsibility and accountability – are a *sine qua non* for professional green space management.

An obvious group of success factors that is often attracting attention is sufficient financial resources for green space management. There is a variety of sources, such as lump sum financing, output financing, private sector suppletion (e.g., sponsoring), additional funding from market activities in public urban green spaces (e.g., café's, bike rental facilities etc.). Entry fees are often discussed, but hardly introduced, as this may be at odds with the idea of open access to public facilities. In all cases there is a need for a solid and transparent financing structure, in particular, as urban green space is a non-market environmental amenity with many positive externalities.

References

Archibugi, F., **The Ecological City and the City Effect**, Ashgate, Aldershot, UK, 1997.

Baycan Levent, T. and P. Nijkamp, Evaluation of Urban Green Spaces, **Beyond Benefit Cost Analysis** (D. Miller & D. Patassini, eds.), Ashgate, Aldershot, UK, 2005, pp. 63-87.

Baycan Levent, T. and P. Nijkamp, Urban Quality of Life: Analysis and Policy, **Studies in Regional Science**, vol. 36, no. 2, 2006, pp. 263-268.

Beer, A. R., T. Delshammar and P. Schildwacht, A Changing Understanding of the Role of Greenspace in High-density Housing: A European Perspective, **Built Environment**, vol. 29, no. 2, 2003, 132-143.

Brandon, P. S., and P. Lombardi, **Evaluating Sustainable Development in the Built Environment**, Blackwell, Oxford, 2005.

Breheny, M.J. (ed.), **Sustainable Development and Urban Form**, Pion, London, 1992.

Breuste, J., H. Feldman and O. Uhlmann (eds), **Urban Ecology**, Springer-Verlag, Berlin, 1998.

Camagni, R., Beyond Complexity in Urban Development Studies, **The City and its Sciences** (C.S. Bertuglia, G. Bianchi & A. Mela, eds.), Springer, Heidelberg, 1998, pp. 363-385.

Capello, R., Urban Returns to Scale and Environmental Resources: an Estimate of Environmental Externalities in an Urban Production Function, **International Journal of Environment and Pollution**, vol. 10, no. 1, 1998, pp. 28-46.

Capello R., P. Nijkamp and G. Pepping (eds.), **Sustainable Cities and Energy Policies**, Springer-Verlag, Berlin, 1999.

Carson, R., **The Silent Spring,** Houghton Mifflin, Boston, 1962.

De Sousa, C. A., Turning Brownfields into Green Space in the City of Toronto, **Landscape and Urban Planning**, vol. 62, 2003, pp. 181-198.

DTLR, **Green Spaces, Better Places: Interim Report of the Urban Green Spaces Taskforce,** Department for Transport, Local Government and the Regions, London, 2001.

EEA (European Environment Agency), **Towards an Urban Atlas. Assessment of Spatial Data on 25 European Cities and Urban Areas**, Environmental Issue Report 30, Copenhagen, 2002.

Geenhuizen, M. van and P. Nijkamp, Sustainable Cities, **Essays on Regional Science** (C.R. Pathak, ed.), Indian Regional Science Association, Calcutta, 1997, pp. 3-21.

Gibbs, D. Towards the Sustainable City: Greening the Local Economy, **Town Planning Review**, vol. 65, no. 1, 1994, pp. 99-109.

Girardet, H., **Earthrise: How We Can Heal Our Injured Planet**, Harper Collins, London, 1992a.

Girardet, H., **The Gaia Atlas of Cities: New Directions for Sustainable Urban Living,** Gaia Books, London, 1992b.

Glaeser, E., Are Cities Dying? **Journal of Economic Perspectives**, vol. 12, no. 2, 1999, pp. 139-160.

Goode, D., Integration of Nature in Urban Development, **Urban Ecology** (J. Breuste, H. Feldman & O. Uhlmann, eds), Springer-Verlag, Berlin, 1998.

Haughton, G. and C. Hunter, **Sustainable Cities**, Jessica Kingsley, London, 1994.

Jim, C. Y., Green-space Preservation and Allocation for Sustainable Greening of Compact Cities, **Cities**, vol. 21, no. 4, 2004, pp. 311-320.

MacHarg, I. L., **Design with Nature**, Doubleday, Garden City, New York, 1971.

Nijkamp, P. and A. Perrels, **Sustainable Cities in Europe**, Earthscan, London, 1994.

Nijkamp, P., E. Rossi and G. Vindigni, Ecological Footprints in Plural: A Meta-analytic Comparison of Empirical Results, **Regional Studies**, vol. 38, 2004, pp. 747-765.

OECD, **Urban Energy Handbook**, Paris, 1995.

Pauleit, S., Perspectives on Urban Greenspace in Europe, **Built Environment**, vol. 29, no. 2, 2003, pp. 89-93.

Pauleit, S., P. Slinn, J. Handley and S. Lindley, Promoting the Natural Greenstructure of Towns and Cities: English Nature's Accessible Natural Greenspace Standards Models, **Built Environment**, vol. 29, no. 2, 2003, pp. 157-170.

Priemus, H., Sustainable Cities: How to Realize an Ecological Breakthrough: A Dutch Approach, **International Planning Studies**, vol**.** 4, no. 2, 1999, pp. 213-236.

Rees, W.E., Ecological Footprints and Appropriated Carrying Capacity: What Urban Economics Leaves Out, **Environment and Urbanization**, vol. 4, 1992, pp. 121-130.

Roelofs, J., Building and Designing with Nature: Urban Design, **Greening Cities: Building Just and Sustainable Communities** (J. Roelofs, ed.), The Bootstrap Press, New York, 1999.

Scottish Executive, **Rethinking Open Space**, The Stationery Office, Kit Campbell Associates, Edinburgh, 2001.

Selman P., **Local Sustainability**, Paul Chapman, London, 1996.

Swanwick, C, N. Dunnett and H. Woolley, Nature, Role and Value of Green Space in Towns and Cities: An Overview, **Built Environment** , vol. 29, no. 2, 2003, pp. 94-106.

Szulczewska, B., and E. Kaliszuk, Challenges in the Planning and Management of 'Greenstructure' in Warshaw, Poland, **Built Environment**, vol. 29, no. 2, 2003, pp. 144-156.

Tjallingii, S., Green and Red: Enemies or Allies? The Utrecht Experience with Green Structure Planning, **Built Environment**, vol. 29, no. 2, 2003, pp. 107-116.

Tyrväinen, L., and H. Väänänen, The Economic Value of Urban Forest Amenities: an Application of the Contingent Valuation Method, **Landscape and Urban Planning**, vol. 43, 1998, pp. 105-118.

Wackernagel, M. and W.E. Rees, **Our Ecological Footprint: Reducing Human Impact on the Earth**, New Society Publishers, Gabriola Island, 1996.

WCED (World Commission on Environment and Development), **Our Common Future**, Oxford University Press, Oxford, 1987.

ANNEX: Statistical Results of Principal Component Analysis

Table A.1. Empirical results: total variance explained

	Initial Eigenvalues			**Rotation sums of squared loadings**		
Component	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	2,270	25,225	25,225	2,242	24,915	24,915
2	1,925	21,391	46,616	1,693	18,806	43,721
3	1,519	16,881	63,497	1,466	16,284	60,005
4	1,296	14,400	77,897	1,342	14,911	74,915
5	,996	11,067	88,964	1,264	14,049	88,964
6	,429	4,770	93,734			
7	,331	3,680	97,414			
8	,166	1,849	99,263			
9	6,632E-02	,737	100,000			

Table A.2. Empirical results: factor loadings of variables

	Principal Components				
	PC1	PC2	PC3	PC4	PC5
PC1-1	-,707	1,338E-02	,269	,531	,215
PC1-2	,882	-,110	,205	,210	,288
PC1-3	,948	6,762E-02	-5,288E-02	6,975E-02	-2,691E-02
PC2-1	-,137	,805	,140	4,000E-02	,247
PC2-2	9,919E-02	,874	-,105	-,184	-,195
PC3-1	-6,877E-02	-,105	,900	-,165	-,224
PC3-2	,106	,485	,699	,177	,245
PC4-1	,126	-,105	-,104	,956	-7,763E-02
PC5-1	8,064E-02	7,172E-02	-8,522E-02	-4,725E-02	,959