Scaling down the ecosystem services at local level for urban parks of three megacities

Jürgen Breuste, Salman Qureshi and Junxiang Li

13 Figures and 3 Tables

Abstract

Breuste, J., Qureshi, S., Li, J.: Scaling down the ecosystem services at local level for urban parks of three megacities. – Hercynia N. F. 46 (2013): 1 – 20.

The concept of ecosystem services is widely used to highlight the importance of ecosystem functions for human life. The concept is becoming important for urban ecosystems too where ecosystem services are provided at different spatial scales. Climate regulation, recreation and nature experience are three ecosystem services of high importance in urban areas. Three case studies targeting to analyse these ecosystem services – regulating (thermal comfort) and cultural (recreation and nature experience) by indicators show exemplary the applicability of the ecosystem service approach on small scale (site) level. All three studies were originally executed by the authors. The three case studies were placed in three different megacities in different countries to show the comparability of case study results by comparable assessment methods.

Unlike other published studies these three case studies show that climate regulation, recreation and nature experience as ecosystem service are provided and measurable not only at regional or landscape scale but also at the local scale. These services are provided by green elements or basic complex ecosystems (e.g. urban parks). The quantity of provided, and used services on the level of service providing units, can be measured by indicators to compare service providing units in its service degree. Urban parks are used as an example of service providing units. This can be helpful for further decision making, investments and management for these urban parks. In this paper the indicators biodiversity and recreation are used to investigate the measurement of quantity of these services.

A study on thermal conditions in Karachi shows the ability to use satellite image supported indicators for identification of the ecosystem service climate moderation on site level of urban parks. Furthermore, as indicators of the ecosystem service recreation in parks of Buenos Aires, Argentina, duration and frequency of stay were used to quantify the service. Distance to the parks and activities were used for further qualification. The Shanghai study shows that urban parks can be very important for nature experience and to learn from nature. They can't even be replaced by other areas inside or outside big cities with limited possibilities to visit other nature places. The indicator based non-monetary evaluation of ecosystem service allows a comparability of different service providing units (urban parks) within a city and between cities which was exemplary executed.

Key words: biodiversity, ecosystem services, habitat provision, nature experience, urban indicators, recreation, urban parks

1 Introduction – The ecosystem service concept

Ecosystem services (ES) are the benefits people obtain from ecosystems (MEA 2005). Since the first theoretically founded reflections on ES in the 1990s (Daily et al. 1997, Costanza et al. 1997, DeGroot et al. 2002) or at least with the publication of the Millennium Ecosystem Assessment (MEA 2005) and the TEEB study (2011) it became clear that humankind depends upon the nature and their functions (Breuste et al. 2012).

According to the Millennium Ecosystem Assessment (2005) and Costanza et al. (1997) four categories of urban ecosystem services (UES) can be defined:

- provisioning services (food and timber production, water supply, the provision of genetic resources),
- regulating services (regulation of climate extremes such as heavy rainfall and heat waves, floods and diseases, regulation of water flows, treatment and handling of waste),
- cultural services (recreation and tourism, provision of aesthetic features, spiritual requirements) and, finally,
- habitat and supporting services (soil formation and processes, pollination or energy, matter and nutrient fluxes, biodiversity).

COSTANZA et al. (1997) identified 17 major categories of services provided by varying types of ecosystems. The ecosystem service concept can be adapted to urban ecosystems where the services are for many inhabitants are essential and needed (AHERN 2007, TRATALOS et al. 2007). Only small parts of urban ecosystems (service providing units) provide these services. Urban green areas and urban water areas are the main providers of urban ecosystem services. Their services need to be evaluated quantitatively and included in urban design and planning. However, there have been few empirical investigations into its site-based relevance to human health and social well-being, and thus considered to be investigated urgently (QURESHI et al. 2010b).

Beside several studies on ecosystem services on city level there are only a view studies on site or local level in urban areas. The target of this study is to analyse two different ecosystem services – provisioning (habitat service) and cultural (recreation) by indicators and to show exemplary the applicability of the ecosystem service approach on small scale (site) level. Both studies were originally executed by the authors. The two case studies were places in different cities and countries to show the comparability case study results by comparable assessment methods.

2 Urban Ecosystem Services

BOLUND & HUNHAMMAR (1999) named six ecosystem services relevant for their investigations in the city of Stockholm: air filtering, microclimate regulation, noise reduction, rainwater drainage, sewage treatment, recreation/cultural values. Water supply, landscape (aesthetical value), sense of identity and provision of land for economic and commercial activities and housing can be added. They also combine the ecosystem services with quality of life indicators. Tab. 1 shows the ability of all urban vegetation areas to provide ecosystem service.

According to MCDONALD (2009), UES are measurable at different scales within an urban landscape. At the local scale, e.g.

- temperature regulation by tree shade,
- water and pollutant filtration at a single soil plot or
- timber production in a specific tree estate are measurable;

whereas at regional or landscape scale

- recreation,
- climate regulation, and
- biodiversity

could be measured (MCDONALD 2009). Other services should be at determined global scale (carbon mitigation, contribution to the continental or worldwide gene pool and biodiversity as such) determined.

The authors underline that provision of ecosystem services is always only outgoing from green areas with vegetation and blue (water) tables on the site level. NIEMELÄ et al. (2010) shows on a Finish example this relation between services and its providing units. Tab. 2 explains the urban ecosystem service providing units.

Table 1 Ecosystem services of urban vegetation (Breuste, according to Arbeitsgruppe Methodik der Biotopkartierung im besiedelten Bereich 1993, Kowarik 1992, Bolund & Hunhammar 1999, modified).

Tab. 1 Ökosystem-Dienstleistungen urbaner Vegetation (Breuste, nach Arbeitsgruppe Methodik der Biotopkartierung im besiedelten Bereich 1993, Kowarik 1992, Bolund & Hunhammar 1999, verändert).

Vegetation group	**Vegetation structure type**	**Main existing ecosystem services**	**Main potential ecosystem services**
A) Vegetation remnants of the original natural landscape	Woods and forests, wetlands	Timber production, recreation, biodiversity, micro-climate regulation, rainwater drainage, sewage treatment	Nature experience
B) Vegetation of the cultural landscapes formed by agriculture	Meadows, pastures, drifts, dry grasslands, arable land	Food production, micro-climate regulation, rainwater drainage	Recreation, biodiversity, nature experience
C) Ornamental, horticultural and designed urban vegetation spaces	Decorative green (flower beds, small lawn patches, bushes, hedges, etc.)	Decoration, cultural values	Biodiversity, rainwater drainage
	Accompanied green along traffic lines or as addition to fill up the space between apartment blocks	Air filtering, micro-climate regulation, rainwater drainage	Recreation, biodiversity
	Gardens/parks Allotment gardens Urban trees	Recreation, micro-climate regulation, Air filtering,	Biodiversity, nature experience, learning about nature
D) Spontaneous urban vegetation spaces	Spontaneous herbaceous bush and pre-forest vegetation	Biodiversity, micro-climate regulation	Biodiversity, learning about nature, nature experience, recreation

The green patches of open spaces within urban areas range from vegetation remnants of the original natural landscape (mainly woods and wetlands), vegetation of the agricultural cultural landscapes (e.g. meadows and arable land), ornamental, horticultural and designed urban vegetation spaces (parks and gardens) to spontaneous urban vegetation (brownfields and derelict land). These four main groups of vegetation cover (Kowarik 1992) are results of different land uses and intensities of utilization and maintenance. They fulfill different ecosystem services and provide potential for even more (Qureshi et al. 2010a, Pauleit & Breuste 2011) (Tab. 3).

Among urban green areas urban parks are specific categories especially created for urban dwellers. Beside other areas they are the `typical` public urban vegetation sites with specific public maintenance and utilization. Urban parks are accessible for everyone. They are as habitats and for recreation ‘islands’ (patches) in the urban matrix. To develop and secure both services is an already accepted planning target. Other

Table 2 Urban ecosystem services and service generating units (NIEMELÄ et al. 2010).

Tab. 2 Stadt-Ökosystem-Dienstleistungen und Dienstleistungen erzeugende Einheiten (NIEMELÄ et al. 2010).

Group	Ecosystem service	Service generating unit	References
Provisioning services	• Timber products	Different tree species	MATERO et al. (2003)
	• Food: game, berries, mushrooms	Different species in land, fresh-water and sea ecosystems	MATERO et al. (2003)
	• Fresh water, soil	Groundwater infiltration, suspension and storage	MATERO et al. (2003) / BAUMANN et al. (2007)
Regulating service	• Regulation of microclimate at the street and city level, changes in heating costs	Vegetation	MCPHERSON et al. (1997), JO & MCPHERSON (2001)
	• Gas cycles, O_2 production, CO_2 consumption	Vegetation, especially forests	LEBEL et al. (2007), MCHALE et al.(2007)
	• Carbon sequestration and storage	Vegetation, especially trees	BALVANERA et al. (2005)
	• Habitat provision	Biodiversity	DEGROOT et al. (2002)
	• Air pollution purification	Vegetation covered areas, soil microorganisms	GIVONI (1991), MCPHERSON et al. (1997), NOWAK et al. (2006), BOWKER et al. (2007)
	• Noise cushioning in built-up areas and by transportation channels	Protective green areas, thick/wide forest, soft surfaces	AAC (2002)
	• Rain water absorption, balancing storm water peaks	Vegetation cover, sealed surface, soil	BOLUND & HANHAMMAR (1999)
	• Water infiltration	Wetlands (vegetation, microorganisms)	EWEL (1997), BOLUND & HANHAMMAR (1999)
	• Pollination, maintaining floral populations, food production	Insects, birds, mammals	NABHAM & BUCHMANN (1997), THOMSON & GOODELL (2001)
	• Humus production and maintaining nutrient content	Litter, invertebrates, microorganisms	DAILY et al. (1997), DEGROOT et al. (2002)
Cultural services	• Recreation of urban dwellers	Biodiversity, especially in parks, forests and water ecosystems	POSTEL & CARPENTER (1997), BOLUND & HUNHAMMAR (1999), ARNBERGER (2006),
	• Psycho-physical and social health benefits	Forest nature	GRAHN & STIGSDOTTER (2003), BUTLER et al. (2005), GIDLÖF-GUNNARSON & ÖHRSTRÖM (2007), HANSMANN et al. (2007), TZOULAS et al. (2007)
	• Science education, research and teaching	Biodiversity	BOLUND & HUNHAMMAR (1999), MATERO et al. (2003)

Table 3 Urban ecosystem services and indicators of quality of life related to the dimensions of sustainability (changed after Breuste et al. 2011).

Tab. 3 Stadt-Ökosystem-Dienstleistungen und Indikatoren der Lebensqualität bezogen auf die Nachhaltigkeitsdimensionen (verändert nach Breuste et al. 2011).

Sustainability dimension	**Urban ecosystem service**	**Quality of life indicator**
Ecology	air filtration climate regulation noise reduction rain water drainage water supply waste water treatment food production	health (clean air, protection against respiratory diseases, protection against heat and cold death) Safety drinking water food
Social sphere	landscape recreation cultural values sense of identity health	beauty of the environment recreation and stress reduction intellectual endowment communication place to live
Economy	provision of land for economic and commercial activities and housing	accessibility income

quantitatively important ecosystem service providers are residential areas of low built-up density with their larger gardens. Loram et al. (2007) studied five British cities and concludes that private domestic gardens covered between 21.8 % and 26.8 % of the whole urban area. Large differences in tree and shrub cover distinguish the urban structural units from each other (e.g. Pauleit & Duhme 2000, Gill et al. 2007). The tree and shrub cover ranges from a minimum of 4 % to a maximum of 55 % for the US-cities (Nowak et al. 1996).

3 Methodology

Three case studies have been selected to quantify ecosystem services with indicators at the site level of service providing units. The case studies are located in megacities in Asia (Karachi and Shanghai) and Latin America (Buenos Aires) on two continents. This shows the worldwide ability to implement the ecosystem service indication even in different natural and cultural surroundings, in megacities and would allow comparing studies results by selecting the same service providing units. For the investigation of recreation service and nature experience by urban parks two cities with high recreational demand and low equipment with recreational sites related to this demand was selected, Buenos Aires and Shanghai. For investigations on climate regulation Karachi has been chosen as this city especially needs this service. All three services are based on complex conditions and had to be represented by selected indicators.

Following Niemelä et al. (2010) ecosystem services here are not reduced to the used parts of ecosystem functions like in DeGroot et al. (2002) and Oudenhoven (2012). Also the indicator concept follows Niemelä et al. (2010). The concepts for ecosystem services and the relation between ecosystem functions and services are seen as still in controversial discussion and this paper doesn't want to contribute to this discussion in a theoretical way, but argues for a practical understanding and used of ecosystem services and its indicators.

3.1 Climate regulation

Karachi metropolitan area has experienced a tremendous population growth (currently having about 18 million inhabitants) and urban sprawl (3,527 km^2), resulting not only in long commuting distances for urban dwellers but also in an increased burden on natural resources (QURESHI 2010). The vegetation cover of the natural resources is being replaced largely by built-up land for residential and commercial purposes (QURESHI et al. 2010b). There is thus a dire need to monitor these changes in vegetation and built-up cover and compare this with the measured thermal conditions.

In this study satellite images were used to derive the land-use / land-cover changes of Karachi (QURESHI et al. 2010b). A time series of Landsat TM images were used for the years 1986-2003. Multi-temporal images were processed for radiometric and geometric errors to evaluate the land use and land cover (LULC) changes. This helped identifying the major areas of changes at local level. Furthermore, this method helped to identify the neighbourhoods (local level) of very unique character as defined by QURESHI & BREUSTE (2010). Therein the green spaces had been surveyed to observe the possible relationships among different land uses and microclimatic conditions (thermal comfort in this case).

Concurrently a trend analysis of the mean annual temperature (MAT) was conducted of air temperature data for the time series of the years 1961–2009 (Computerize Data Processing Center, Pakistan Meteorological Department, Government of Pakistan). The average of five different locations in Karachi was provided and used in this study.

3.2 Recreation

One of the most important and therefore highly valued ecosystem services in cities is recreation, which includes the provision of recreation opportunities by natural and semi-natural landscapes and especially green areas to urban residents and the need by urban residents to relax (BREUSTE et al. 2012). There is a range of studies on analysing the recreation function or the recreation ecosystem service (e.g. DE VRIES et al. 2003, HANDLEY et al. 2003, CHIESURA 2004, LI et al. 2005, JIM & CHEN 2006, MAZUOKA & KAPLAN 2008, COMBER et al. 2008, KAZMIERCZAK & JAMES 2008, QURESHI et al. 2010a). Outgoing from these studies the target was to quantify and qualify the recreational service by comparable indicators. Buenos Aires was selected as example city because of its densely built-up and populated inner city with only neighborhood parks as alternatives for outdoor recreation.

In a study in Buenos Aires (Argentina) five urban parks in various socio-structural locations were investigated to evaluate the recreational service of the sites. 500 visitors were randomly questioned. The visitors were questioned

- about their activities in the parks,
- their motivation for visiting this park,
- their duration of stay, and
- the frequency and distant from where they come to recreate in the park.

These indicators were selected to quantify and qualify recreation service. In order to find out the using people`s needs the population groups who mainly use the park in relation to their age were surveyed.

Four of the five selected five parks are typical neighborhood parks of medium size (4-10 ha) in the central district of Buenos Aires in middle class areas of comparable population density of 14.000 – 16.000 inhabitants / km$^{2;}$ with high recreation demand:

- Parque Presidente Nicolas Avellaneda,
- Parque General Las Heras,
- Parque Brigadier Cornelio de Saavedra,
- Parque del Centenario.

Parque Micaela Bastidas, the fifth park, is the only one located in a renewed inner city with still low population density and high social status (Fig. 1 and 2). This park was added to control if differences in recreation service are cause by social status. Because most of the apartments in these areas are not frequently used the users come from more fare away because of the high attractively of the new established park.

Nevertheless, all the five park neighborhoods are characterized by a wide range of different types housing qualities. All parks are typically equipped with lawns, trees, bushes, trees and playgrounds.

In each park 100 park visitors where questioned with a structured questionnaire, 50 interviews at the weekends and 50 on weekdays in frequently used time slots.

Fig. 1 Parque General Las Heras in Buenos Aires, Argentina (photo J. Breuste).

Abb. 1 General Las Heras Park in Buenos Aires, Argentinien (Photo J. Breuste).

3.3 Nature experience

One of the most dynamic urban green developments worldwide is occurring in Shanghai (China). Between 1978 and 2006 the city extended its green area from 761 to 30,609 ha. The area of public parks increased during this time from 309 ha to 1529 ha. For the majority of the urban dwellers public parks are the only possibility for any contact and experiences of nature. Beside recreation urban parks offer another important ecosystem service – nature experience and Shanghai is a good investigation object because of the high population density and the limited number of parks and other places of possible nature experience.

Fig. 2 Parque Micaela Bastidas, Buenos Aires, Argentina (photo J. BREUSTE).

Abb. 2 Micaela Bastidas Park in Buenos Aires, Argentinien (Photo J. BREUSTE).

The study area was the Changning district of Shanghai (P. R. China) with 614,200 inhabitants in the year 2006 and three main parks. The nature experience service of these three public parks was investigated (STERN 2010, BREUSTE & LI 2011). In the three public parks,

- Zhongshan Park,
- Kai QiaoPark, and
- Tianshan Park

the urban ecosystem service nature experience was investigated by questioning 322 visitors of all age groups randomly (Zhongshan Park 118, Kai Qiao Park 103 and Tianshan Park).

4 Results

4.1 Climate regulation of public parks in Karachi

There is a declining trend in the urban green of the city (QURESHI et al. 2010b) (Fig. 3). The built-up land has increased from 104 km^2 to 200 km^2, whereas the overall green cover has been reduced from 111 km^2 to 75 km^2. Furthermore, urban development has taken over more than 50 km^2 of the open spaces in and

around Karachi. However, the temperature trend suggests that the temperature has increased up to 4° C in Karachi (SAJJAD et al. 2009) (Fig. 4). These are alarming facts for such a populous city.

The results show that the areas which are densely populated suppress the cooling effect of the green space due to increased concrete structures. The smaller green spaces are surrounded by walls from the neighboring built-up areas (Fig. 5), which reduces the ability of parks to provide climate moderating services. Only parks from a certain size up (around 5 ha) are able to provide a temperature moderation as ecosystem service. However, some larger public parks, also due to their regional functional character (Fig. 4, red marks), maintain their position as providers of thermal ecosystem comfort at a local scale in a surrounding of high temperatures.

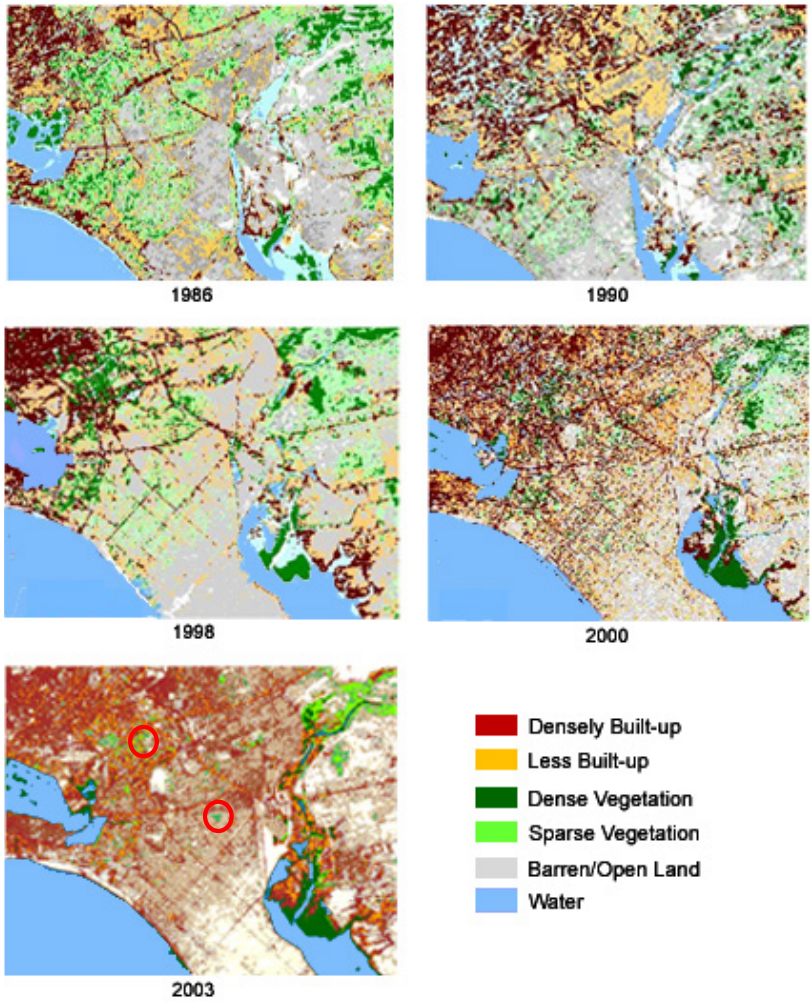

Fig. 3 Land use of the core of Karachi, Pakistan, and the fast developing Defense Housing Authority (DHA) residential areas (time series of 1986-2003). The last image shows a couple of large green spaces. Source: QURESHI et al. 2010b.

Abb. 3 Landnutzung im Stadtkern von Karachi, Pakistan, und die sich rasch entwickelnden Defense Housing Authority (DHA) Wohngebiete (Zeitabschnitt 1986-2003). Die letzte Abbildung zeigt eine Anzahl großer Grünflächen. Quelle: QURESHI et al. 2010b.

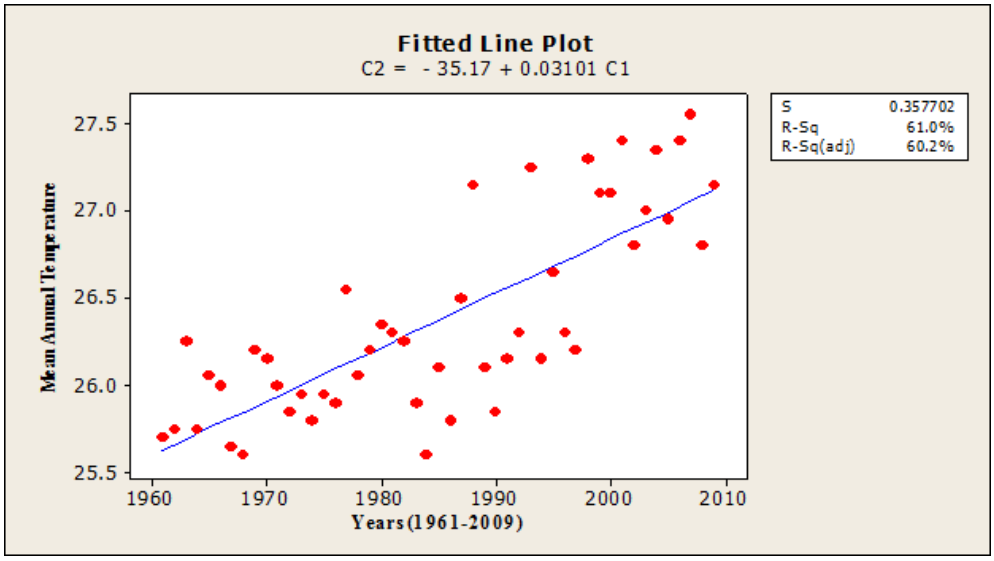

Fig. 4 Trend of mean annual temperatures in Karachi (1961-2009).

Abb. 4 Trend der durchschnittlichen Jahrestemperaturen in Karachi (1961-2009).

Fig. 5 Parks in Karachi surrounded by high rise residential buildings (left – Beach View Park; right – Askari Park) (photos S. QURESHI).

Abb. 5 Parks in Karachi, umgeben von großen Wohngebäuden (links Beach View Park; rechts – Askari Park) (Photos S. QURESHI).

4.2 Recreation in parks in Buenos Aires

The majority of visitors are middle class people (83-91 %). They visit the parks to enjoy nature as contrasting spaces compared to the densely built-up residential areas with only marginal natural elements (some trees) (38-58 %) and for recreation and stress relief (23-39 %). The users of Parque Micaela Bastidas don't have significant different attitudes to use the park (Fig. 6).

Age, sex and family situation influence the visits (time, frequency, duration, activities and preferences of the features). The utilization of the parks is more or less comparable in frequency, duration and activities.

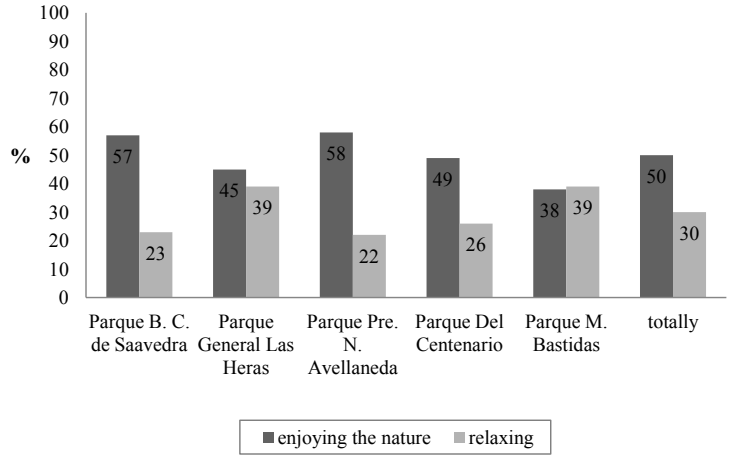

Fig. 6 Reasons for visiting the parks in Buenos Aires, Argentina (% questioned people).

Abb. 6 Gründe für Parkbesuche in Buenos Aires, Argentinien (% befragte Personen).

The majority of visitors stay more than two hours in the parks (50-68 %). Younger (15-21 years old) and older people (more than 50 years old) stay longer than others (up to 68 % of these groups). The users of Parque Micaela Bastidas use the park significantly longer than users of other parks. The reasons are unknown. It can be expected that longer distant and time to reach the part result in longer duration of stay (Fig. 7).

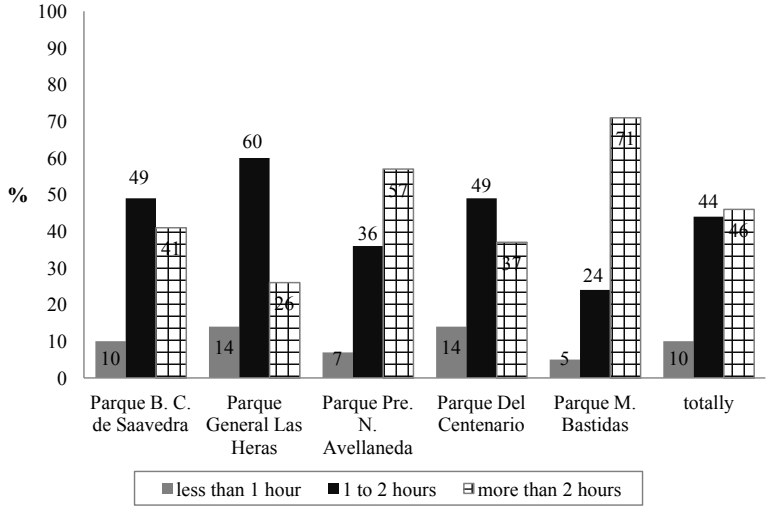

Fig. 7 Duration of stay in the parks in Buenos Aires, Argentina (% questioned people).

Abb. 7 Dauer des Parkaufenthalts in Buenos Aires, Argentinien (% befragte Personen).

The frequency of visits varies between parks and social groups. A large proportion of the users visit the park every day or whenever they have time (62-76 %) independent of social status, but depending on age and family situation. A bigger group visits the parks every day (17-40 %) (Fig. 8).

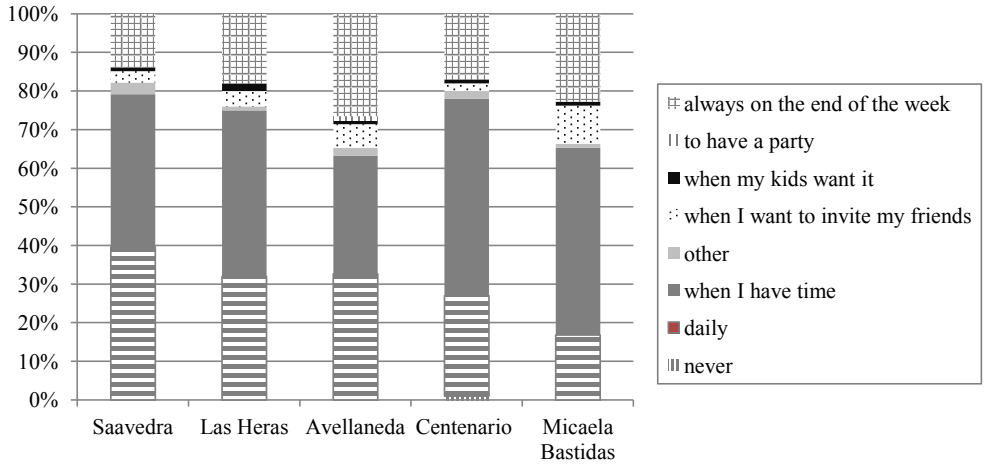

Fig. 8 Frequency of park visits in Buenos Aires, Argentina (% questioned people).

Abb. 8 Häufigkeit der Parkbesuche in Buenos Aires, Argentinien (% befragte Personen).

This shows the importance of these green spaces as providers of recreational functions in the daily life of people living next to the areas. Visits to green spaces are the most time consuming and most important free time activities for 36 % to 46 % of the questioned persons. This open space activity is much more important than any other (followed by shopping, family visits, special sports and cinema visits) (Fig. 9).

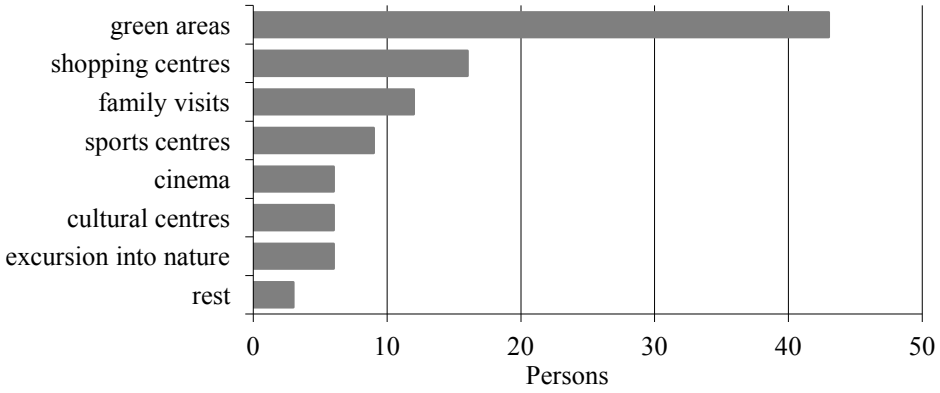

Fig. 9 Preferred places and activities for park users in leisure time, example Parque Saavedra in Buenos Aires, Argentina.

Abb. 9 Bevorzugte Örtlichkeiten und Aktivitäten der Parknutzer in ihrer Freizeit im Saavedra Park in Buenos Aires, Argentinien.

Cleanliness (35-59 %) and security (14-21 %) are very important for the visitors, more than natural elements (trees and plants) (6-15 %). The lawns and the trees are the most valued natural features (35-55 %). In combination, the trees provide shade, structure the space and give a picturesque impression. The lawns allow for resting, walking (partly) and observing.

The majority of visitors were from a distance of less than 500 m (37-57 %). This can vary if there are no green spaces nearer or if a green space further away is more attractive. This is the case with the Parque Micaela Bastidas where 45 % of visitors travel a distance of more than 2 km to the park (Fig. 10). For more than 40 % of the visitors the distance is always the main reason to visit the most frequently used park. This means the parks are mainly important for the neighborhood population and should fit their recreational interests.

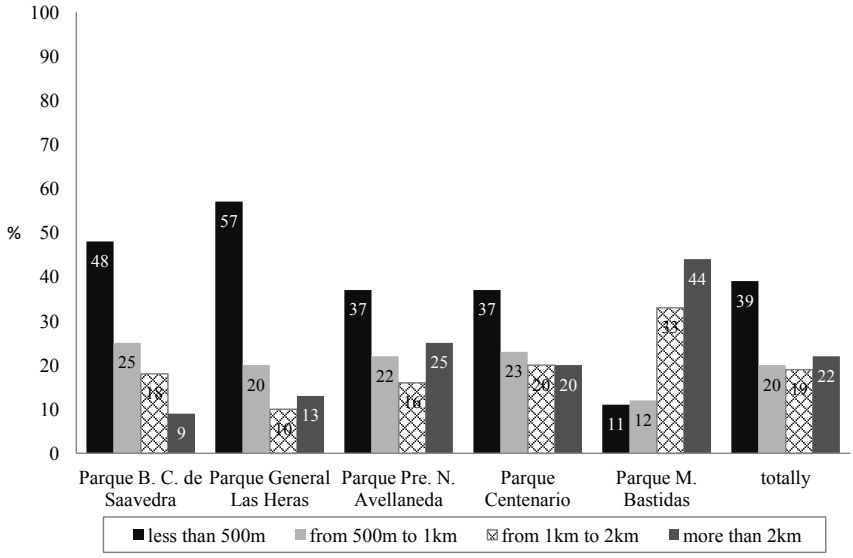

Fig.10 Distance from where the park visitors come in Buenos Aires, Argentina

Abb. 10 Entfernung aus der die Parkbesucher in Buenos Aires, Argentinien, kommen.

Most activities include sitting, resting on lawns, sunning one self, reading, walking, walking dogs etc. Several activities are more active, such as sports, children's play or special activities like visits with children etc. The activities can be partly in concurrence to each other depending on the size of the green space and the number of visitors doing them at the same time. The spatial separation of functional activities helps to reduce conflicts. Overcrowding based destruction of services can be avoided by a green planning strategy including the urban regional demand for recreation.

4.3 Nature experience and education about nature in Shanghai

All three investigated Shanghai parks are very intensively used on all days during the whole day. This shows the general relevance of parks in Shanghai's urban life for the close by living neighborhood population. Most of the visitors come from the neighborhoods. For a great majority of the visitors the environmental conditions are an important reason for visiting the park. The differences between the parks (83 % to 94 %) are not big (Fig. 11).

Fig. 11 Park nature in Kai Qiao Park, Shanghai, China (photos N. STERN).

Abb. 11 Parknatur im Kai Qiao Park, Shanghai, China (Photos N. STERN).

The term "environmental conditions" describes the visitor's perspective on the natural features of the parks as different surroundings compared to the limited spaces and nature in Shanghai's residential areas. The majority of visitors questioned also expressed the view that nature experience is an important reason for visiting the park (73 % to 86 %). The ornamental nature of the parks creates the general vision of nature for most of the urban dwellers.

Many of the visitors express being regular observers of nature in the parks (36 % to 44 %). A majority does this only sometimes and a certain percentage of the visitors never (11 % to 18 %). This seems to be more an emotional relation than an educational one (Fig.12).

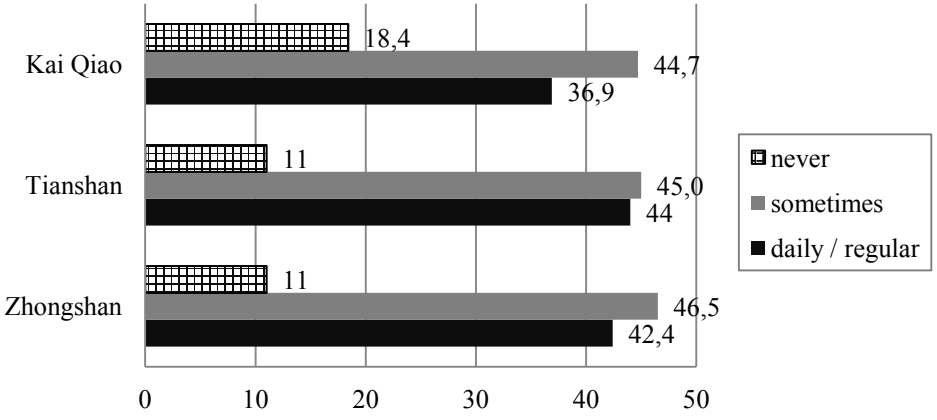

Fig. 12 Intension to observe nature during the park visit in Shanghai, China (in % questioned persons).

Abb. 12 Naturbeobachtungsabsicht während eines Parkbesuchs in Shanghai, China (in % der befragten Personen)

The majority of the visitors never use the parks to learn about nature (37 % to 53 %), but they enjoy and observe it. This shows the still unused potentials of these parks to built-up ecological knowledge starting from already existing emotional relations between people and the park (Fig. 13).

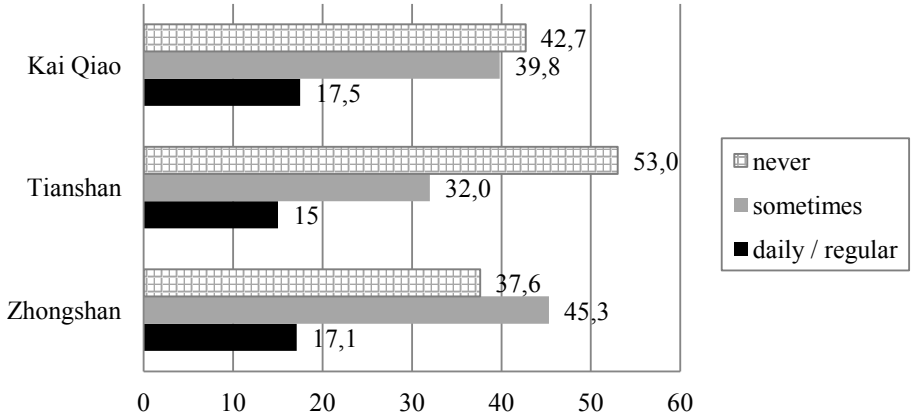

Fig. 13 Learning about nature while visiting the parks in Shanghai, China (in % questioned persons).

Abb. 13 Lernen über die Natur während eines Parkbesuchs in Shanghai, China (in % der befragten Personen)

It becomes clear that nature experience is not only dependent on the offered nature of the parks but also from the nature related pre-education of the visitors and the educational activities (e.g. information panels etc.) in the park. All three parks are structured comparatively and also their ecosystem service nature experience is comparable (Stern 2010, Breuste & Li 2011).

5 Discussion

5.1 More ecosystem services are needed where the people live

Urban green in different countries and cities can be different. Many studies reflect valuable results on urban green but have not investigated comparable types of green. A glance at recently published literature reinforces the evidence of climate change effects at all scales (Brown 2011). Cities will be among the most affected ecosystems that are also first influenced by climate changes (Satterthwaite et al. 2007). A review of numerous observed and predicted climatic extremes has been reported by Easterling et al. (2000). Increased precipitation and runoff in some regions will lead to an increased frequency and / or intensity of flooding with consequent economic costs (Baker & Barnes, 1998). To cope with these challenges, an ecosystem services approach has the potential for adapting cites to climate change at all spatial scales (Kates & Wilbanks 2003). The cooling effect of urban green (e.g. Gill et al. 2007) can be a key concern for thermal comfort and for combating the microclimatic changes (including heat island effects) (Wong et al. 2011) besides helping to plan settlements in a sustainable way (Mills 2006). The climate regulation service will become more important in most of the cities worldwide. Green areas will be the most effective providers of moderate climate in heat stress situations without any energy consumption. This climate regulation function will be necessary in all areas of cities where people live and will link to a changed design of new urban residential areas and to a necessary change and adaption of existing residential areas. To adapt cities to climate change challenges means to improve ecosystem services provided mostly by urban green (Gill et al. 2007, Grant 2010).

Urban biodiversity and urban nature experience will become more and more important in urban development. Cities offer habitats which only rarely exist in the intensively used cultural landscapes of the surrounding areas. They became alternatives for native flora and fauna but also offer perspectives for new forms of nature as urban-industrial nature. Nature protection in many countries has changed its perspec-

tive from the isolated protection of rare species and habitats to protect nature to support nature experience. This has even become the most important reason for protecting urban nature. In many countries the third generation is already growing up without any close relationship to nature or experiencing nature. The opportunities that urban nature offers for nature experience, learning from nature or even simply to enjoy nature are still only partly recognized. These services have to become a part of new urban planning concepts.

The growing cities need publically accessible open spaces for recreation. This can be supported by public urban green spaces like parks. Other forms of nature can also provide this service (forests, wetlands, agricultural land, wasteland etc.). The actual studies show that traditional public parks still play an import role in recreation in urban neighborhoods. They are needed here, directly next to the people in order to fulfill the urgent needs of urban dwellers for recreation as part of their daily lives. The studies show that this is not only an ecosystem service needed in cities of highly developed countries. In every city, even and especially in fast developing cities of the developing world where this service does not develop in parallel to urban growth, it has to be included in urban planning.

5.2 Fewer ecosystem services are available where people live

Rapid urban growth links to more intensive use of all urban space and to a territorial extension of cities (CLARKE & GAYDOS 1998, SMITH 2002). All available urban space is actually used for economic profitable land use (residential and commercial buildings etc.). Only social groups with high income can afford to have their own green open space (QURESHI et al. 2010a). For the majority of urban dwellers only public green remains as a provider of adequate regulated climate, urban outdoor recreation and nature experiences. Nevertheless, due to reduced finances and less public income communities are economically unable to provide functional public green spaces that are equally distributed in all residential areas. Green areas outside the cities cannot replace the necessary green areas inside the cities, which are disappearing apace or cannot be added or linked to the existing ones.

The trend suggests that the majority of urban dwellers will have limited access to urban ecosystem services in their neighborhoods. This will influence their health status (MARTENS 1999, KOVATS et al. 1999) and contact with nature. The need for ecosystem services in residential areas is increasing, whereas the ability to provide these services by communities is decreasing. A cautious inventory of existing ecosystem services at the site level for each green area is therefore recommended. The identification of ecosystem service gaps in the urban form is advisable to develop them with the remaining communal abilities exactly at the places where a specific service or services are urgently needed.

Urban ecosystem service should become part of urban planning concepts (COLDING 2011). This includes the definition of targets for urban ecosystem services in an urban regional context and in a proposed quantity. This is actually only partly the case, is often fragmented and especially not seen in a demand and supply context.

Urban green is not always the same in different countries and cities. Many studies reflect valuable results on urban green but have not investigated the same kind of areas. To avoid incomparability between different studies this paper reports only on public urban green spaces, for instance different kinds of public parks, without single specialized functions such as for sports.

6 Conclusion

The urban park is a typical element of urban green which is found mostly in every city. Its functionality and provision of services could be comparable at local scale including the natural and cultural differences.

The growing cities need publically accessible open spaces for recreation. This can be supported by public urban green spaces like parks. Other forms of nature can also provide this service (forests, wetlands, agri-

cultural land, wasteland etc.). The actual studies show that traditional public parks still play an import role in recreation in urban neighborhoods. They are needed here, directly next to the people in order to fulfill the urgent needs of urban dwellers for recreation as part of their daily lives. The studies in Buenos Aires' and Shanghai parks show that recreation and nature experience in urban nature in cities as ecosystem service are extremely important or have high potential importance. In every city, even and especially in fast developing cities of the developing world where these service does not develop in parallel to urban growth, it has to be included in urban planning. These recreation sites as parks are not a luxury in urban development but a need.

The Karachi study shows the importance of bigger and in residential areas (short distance) located parks for providing thermal comfort under extreme urban climate conditions in warm and very warm cities. This service as small urban cool islands is still underestimated but will become more important together with urban climate change phenomena to keep these cities livable.

The results also show that well-established parks in Buenos Aires and Shanghai are high attractive and that there is a social need for recreational service which results in bridging long distances and accepting more time to reach the recreational site. Generally impressive are the long distances to reach the parks. This is a strong signal for decision makers to meet the needs and demands for recreational service embedded into the residential areas and depending from the numbers of (potential) users in high quality. This service will be supported by size and equipment of the parks and has always to be adapted to the changing demands. This is a not easy to realize task of urban green management.

The trend suggests that the majority of urban dwellers will have limited access to urban ecosystem services in their neighborhoods. This will influence their health status (Martens 1999) and contact with nature. The need for ecosystem services in residential areas is increasing, whereas the ability to provide these services by communities is decreasing. A cautious inventory of existing ecosystem services at the site level for each green area, especially urban parks, is therefore recommended. The identification of ecosystem service gaps in the urban form is advisable to develop them with the remaining communal abilities exactly at the places where a specific service or services are urgently needed.

Urban ecosystem service should become part of urban planning concepts. This includes the definition of targets for urban ecosystem services in an urban regional context and in a proposed quantity as well as its indication and quantification. This is actually only partly the case, is often fragmented and especially not seen in a demand and supply context.

7 Zusammenfassung

Breuste, J., Qureshi, S., Li, J.: Anwendung von Ökosystem-Dienstleistungen auf lokaler Ebene für Stadtparks in drei Megacities. - Hercynia N. F. 46 (2013): 1 – 20.

Ökosystem-Dienstleistungen sind ein verbreitet genutztes Konzept, um die Bedeutung von Ökosystemen für den Menschen sichtbar zu machen. Dieses Konzept ist auch für Stadtökosysteme wichtig. Ökosystem-Dienstleistungen können auf unterschiedlichen Maßstabsebenen ermittelt werden.

Im Unterschied zu McDonald (2009) zeigt diese Studie, dass Klimamoderation, Erholung und Gewinnung von Naturerfahrung als Ökosystem-Dienstleistung nicht nur in regionaler oder Landschaftsebene, sondern auch auf der Ebene konkreter Flächen messbar sind. Diese Dienstleistungen werden durch Vegetationsflächen oder komplexe Ökosysteme (Grünflächen) erbracht. Der Umfang der angebotenen und genutzten Dienstleistungen die diese Flächen anbieten kann quantifiziert („gemessen") werden. Damit kann der Umfang der Serviceerbringung unterschiedlicher Grünflächen verglichen werden. Stadtparks werden als Beispiel von Service leistenden Einheiten betrachtet. Die Messung der Dienstleistungsquantität durch Indikatoren wird in dieser Studie anhand der Klimamoderation, Erholung und Gewinnung von Naturerfahrung untersucht.

Dazu wurde eine Untersuchung in Karachi, Pakistan, hinsichtlich der Temperaturregulation von Stadtparks durchgeführt. Es zeigt sich, dass die Klimaregulation von Parks mit Fernerkundungsdaten messbar ist und durch Größe, Lage (Umgebung) und Struktur der Parks mitbestimmt wird.

Das Erholungsverhalten der Bevölkerung in Stadtparks in Buenos Aires, Argentinien, wurde hinsichtlich des Indikators Erholung untersucht. Für die Quantifizierung der Erholungsleistung wurden Dauer und Frequenz des Aufenthaltes als Indikatoren benutzt. Die Entfernung zum Park und dortige Aktivitäten der Besucher wurden für weitere Qualifizierung des Servicegrades genutzt.

Die Quantifizierung der Ökosystem-Dienstleistung „Naturerfahrung gewinnen“ wurde durch Untersuchung von Shanghaier Stadtparken mittels Fragebögen vorgenommen.

Alle drei Untersuchungen erfolgten in Megacities in Lateinamerika und Asien in denen in einer dynamischen Stadtentwicklung eine Beurteilung und Quantifizierung von Ökosystem-Dienstleistungen dringend notwendig ist. Stadtparke tragen in besonderer Weise zu diesen Dienstleistungen bei. Klimaregulation, Erholung und Naturerfahrung sind solche wesentlichen Dienstleistungen. Deren Quantifizierung auf der Ebene der Einzelflächen (Stadtparks) wurde durchgeführt und erlaubt Vergleiche mit anderen Stadtparks und die Unterstützung von Planungsentscheidungen. In allen drei Beispielstudien zeigt sich die sehr große Bedeutung von Stadtparks als Anbieter von Ökosystem-Dienstleistungen, oftmals ohne vorhandene Alternativen.

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Manuskript angenommen: 25. Mai 2013

Anschriften der Autoren:
Prof. Dr. Jürgen Breuste
Department of Geography and Geology, University of Salzburg, Hellbrunnerstrasse 34, Salzburg 5020, Austria
E-Mail: juergen.breuste@sbg.ac.at

Dr. Salman Qureshi
Department of Geography, Humboldt University of Berlin, Rudower Chaussee 16, 12489 Berlin, Germany
E-Mail: salman.qureshi@geo.hu-berlin.de
School of Architecture, Birmingham City University, Gosta Green, B4 7DX Birmingham, United Kingdom
E-Mail: salman.qureshi@bcu.ac.uk

Dr. Junxiang Li
Department of Environmental Sciences, East China Normal University, 3633 Zhongshan Road N., Shanghai, P.R. China
E-Mail: jxli@des.ecnu.edu.cn