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Article

High Biodiversity of Green Infrastructure Does Not Contribute to Recreational Ecosystem Services

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Abstract: Urban lakes, especially those of natural origin, provide ecosystem services, recreation being one of the most important and highly valued by the city dwellers. Fulfilling the need of city residents to relax and have contact with nature has become a priority in urbanized areas and has been proved to positively affect people's health and well-being. The recreational potential of water bodies was identified to be most important aspect of ecosystem services to the residents of the neighboring areas. Assessment of recreational ecosystem services (RES) provisioning to society based on the real time spent by the citizens, in the rural-urban gradient allowed us to show how the economic benefits of lakes differ in urbanized, suburban and rural landscapes. Growth of cities has led to increased population density in the surroundings of ecologically valuable areas, resulting in higher pressure from visitors seeking recreational values. Along with urbanization, the impoverishment of ecosystem functions takes place limiting their capability to provide ecosystem services. In this work provisioning of recreational ecosystem services of 28 floodplain lakes located in urban-rural gradient of Warsaw agglomeration was assessed. The relation between the ecological value of the water bodies, measured using naturalness indices, and the ecosystem services they can provide was assessed. The results showed that the floodplain lakes located along the urban-rural gradient are of a great importance to the citizens due to their recreational potential. However the provisioning of recreational ecosystem services is poorly connected with the ecological value of the floodplain lakes and the economic benefits are of a greatest importance in objects included in the urban green spaces.

Keywords: ecosystem services; urban water; Warsaw; Poland; environment

1. Introduction

Parallel to the increasing population of cities worldwide and anxiety due to the life quality of residents, a general interest in potential and real benefits derived from the city's green infrastructure has arisen [1-9]. These benefits, classified as cultural ecosystem services [10], can often be regarded as the most important services in urban areas for the citizens well-being and health [11-16], while being at the same time commonly underestimated due to difficulties in quantification [17]. Potential benefits from green infrastructure and the possibility of outdoor recreational activities are limited in many cities due to the low occurrence of good quality green space [18-19] and variations in people's preferences [20]. Studies on recreational ecosystem services (RES) have focused on recognizing components of habitats that people want to experience [21] or habitat components that could be enhanced to improve recreation [9, 22, 23]. In this paper we focus on recreational ecosystem services (RES) associated with informal urban greenspace [24, 25].

In contrast to other ecosystem services, it is important that green infrastructure can provide RES which are experienced by the users directly. Degradation of ecosystems which are part of the green infrastructure will lead to a real loss of benefits to people [17, 26, 27]. The benefits from green infrastructure are revealed, for example, in the dependence of property values on the distance from green infrastructure [28-31]. Some results even indicate that the RES provided by components of the green infrastructure in cities can exceed those derived from most natural biotopes due to the direct and frequent use of these services by people, thus higher demand [32].

The ecosystem services framework has become an increasingly popular tool used in the context of the sustainable management of natural resources, as a support for both ecosystems quality and human well-being, thus generating a comprehensive information base for policy makers in their decision making processes [33].

1.1. Does high biodiversity enhance provisioning of cultural ecosystem services?

It is generally accepted that high biodiversity increases the value of urban ecosystems and their neighboring areas [17], but this relationship is poorly investigated. Human perception of biodiversity is influenced by numerous variables such as age, sex or professional experience [34-36], attitude towards nature conservation or appreciation of rural landscapes [37-40] and general knowledge about the immediately surrounding nature [41]. City dwellers declare a demand for direct contact with nature, but at the same time seek areas which are easily accessible [42, 43]. The subject of the demand, however, includes areas of various types, such as semi-natural areas, but even ecosystems associated with typical rural landscape which provide peace and a sense of wilderness [17], but are not necessarily of a high absolute ecological value. Results indicating that the level of particular biotope's naturalness induces the value of RES provided by these systems are hard to find. Based on Qiu et al. [41] one could conclude that the correlation between user preferences and biodiversity will not always be positive.

1.2. Actual and potential benefits from green infrastructure

Most RES assessments are based on estimating the flow of various benefits: ecological benefits, human health and well-being benefits, social and cultural benefits and marketed economic benefits [32]. It is, however, assumed that the usage of resources by people is spatially evenly distributed [44]. Generalization at the regional scale might allow an assessment to reflect the real usage well, whilst at the scale of the city, where the population density varies [45], the assessment can be strongly biased and the RES will be unevenly distributed in space. It can assumed that analogically to hotel prices (the closer to the city centre, the more expensive) the urban-rural gradient will also be revealed in RES provisioning of cities green infrastructure [46-51]. While the benefits derived from potential ES resources of green infrastructure – such as CO_2 and noise reduction or a positive influence on microclimate affect all the citizens in the neighbourhood, benefits associated with recreation or choice of aesthetic neighbourhood for living are subject to the general laws of demand and supply. When valuing those benefits it is crucial to differentiate between potential and real values. Benefits derived from green infrastructure of the same potential but located in different areas can have different real value.

The aim of this study was to answer the following research questions 1) How do the benefits derived from urban lakes, described as property values and real time spent in nature by the inhabitants change for inhabitants within the city? 2) Are the RES from urban lakes related to their biodiversity?

2. Materials and Methods

Urban lakes are a component of the city's green infrastructure which are highly valued by the citizens for the recreational opportunities they provide [52]. Due to their spatial distinctiveness from the surroundings they make a good object of study. In total 28 urban lakes were selected for this study. We chose a homogenous group of lakes in Warsaw, Poland. All objects are floodplain lakes originating from former Vistula riverbeds. Vistula in Warsaw used to be a braided river, but after

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regulation and construction of embankments which were held in 19-th and 20-th century the channels were cut-off from the main river forming elongated floodplain lakes permanently separated from Vistula river and subjected to strong urbanization pressure from the expansion of Warsaw [53]. The selected lakes are located along an urban-rural gradient up to 30 km from the city centre and are important elements of the green infrastructure of Warsaw (Fig. 1). All lakes are open to the public and play an important recreational function, although most lack permanent recreational infrastructure. The floodplain lakes studied are characterized by a high level of naturalness and act as refuges for rare plant taxa, such as refuges for rare plant taxa, such as *Salvinia natans*, *Wolffia arrhiza*, *Nymphaea alba* [54]. The habitats are subjected to a range of urbanization pressure, being surrounded by various land-use types such as built-up areas or different population density in the neighborhood (Fig. 1). The vegetation of the lake shores is well developed, the banks are natural, slopes < 30°.

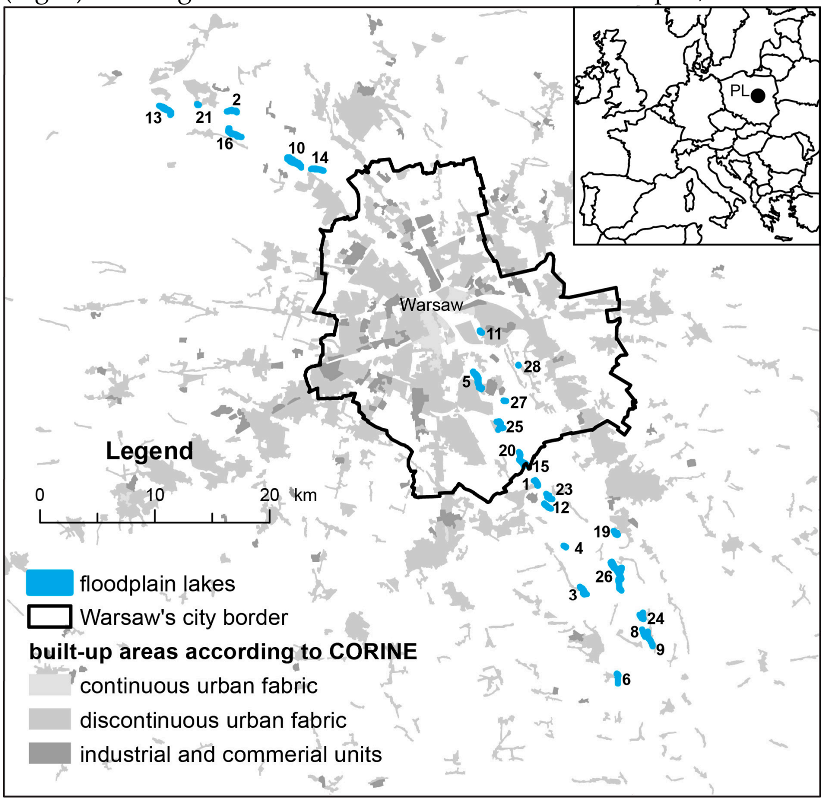

Figure. 1. Location of investigated urban lakes and the strongly built-up areas of Warsaw according to Corine Land-Cover from year 2012, lake numbers according to table 1.

The benefits from urban lakes and their neighborhood provided to city residents were assessed on the basis of 1) housing value and 2) real time spent at the lakes by the inhabitants.
- HOUSING VALUE - mean property transaction prices of housing in the secondary market in Warsaw. Price of housing per m² was calculated according to portal www.mapa.um.warszawa.pl and https://rynekpierwotny.pl. Average property value was calculated from advertisements and transactions held on the primary and the secondary market within a 500 m buffer zone from the shore of the lakes. - REAL TIME SPENT IN NATURE - average people/day and hours of time spent/day per lake. Visitors to the lakes per day were recorded in all formal and informal entrances to the examined area by researchers recording (for one day of weekend and two days of weekdays per lake) in July and September in 2014 and 2015. The person recording was registering the time spent by users with a hidden stopwatch. The routes of probable trespassing places, resting places and potential observation points were selected. All people present within the 50 m buffer zone from the lake shore were recorded. People using public roads or bridges were excluded from the count.
The characteristics of the neighborhood which might influence the benefits to residents were assessed based on a spatial analyses. In order to perform the spatial analysis, a 500 m buffer zone from the shore of each lake was used for a detailed vector land cover map on the basis of orthophotomaps,

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aerial images and verification in the field. Units distinguished included: built-up areas, other impermeable surfaces, agriculture, orchards, meadows and pastures, abandoned unmanaged areas, managed urban green areas, rushes, forests and woodlands. The urbanization gradient was expressed as a distance from the centre of the lake to the city's centre [55].

The ecological value assessment of the lakes and their surroundings was based on a detailed vegetation survey in 2014 and 2015 and water quality sampling. Sample plots of vegetation (2×2 m) – all plant species and their abundance were recorded in representative transects in each of the lakes, separately from each vegetation zone – aquatic vegetation, rushes, shore terrestrial vegetation (Fig. 2). The number of transects depended on the size of the lake, and was approximately every 100 m, but in case of more diverse vegetation was performed more frequently. 321 sample vegetation plots were collected in total. In summer 2014 water samples were collected from the center of each lake (0.5 m depth) and from the bottom (0.5 m above the bottom) for quality assessment. In case of a ditches connected to the lakes present additional samples were taken at the inflow and data was averaged. Eutrophication state was assessed by measurements of PO_4, NO_2, NO_3, NH_4 content of water by ion chromatography system in ICS-1000 DIONEX Co. USA equipment. Analyses of the urban lakes biodiversity included indices calculated separately for each lake. The ecological value of the lakes was expressed as number of plant species taxa, Shannon-Wiener index of plant species [56]. naturalness index – hemeroby [57], averaged from all transects per each lake. The relationships between RES expressed as property values and real time spend and ecological parameters concerning the lakes quality were calculated as Spearman's correlations at $p<0.05$ using STATISTICA 10 software.

Figure. 2. Research area (dotted line) and vegetation sampling plots scheme (white squares; a - aquatic vegetation, b - vegetation of the rushes, c - terrestrial vegetation of the shores). Signs based on Powsinkowskie Lake example.

3. Results

The investigated urban lakes along with their neighborhood occupy in total 180.7 ha (Table 1) and are an important element of Warsaw's green infrastructure, where on average 836.7 people spend their leisure time daily, devoting in total 126.5 hours/day (Table 1). Taking into account how scattered the lake areas are, they nevertheless play a role as important as formal green areas of similar size. The mean value of analyzed property prices in the neighborhood of the lakes was 2485.02 Euro per 1 m^2 (Table 1), a value similar to the average price of property outside the strict city centre (www.mapa.um.warszawa.pl/mapaApp1/mapa?service=rciwn).

No correlation between biodiversity and the property values in the neighborhood or the duration of real time spent by the citizens at the urban lakes was found (Table 2). This concerns ecosystem quality indices calculated – number of plant species in the aquatic zone, rushes, at the shores, hemeroby or Shannon-Wiener diversity index. Only the terrestrial zone of the shores, adjacent to existing informal walking trails, which was most easily accessed by the visitors, was related to high hemeroby index. The higher the naturalness of this zone the higher the property values and longer time spent by the users at the shores of the lake. In general no relation was found between the water quality parameters and property values and leisure time duration. Only the hypertrophic water bodies, characterized by high NO_3 load were subjected to lower pressure from the visitors.

Distance to the city centre, and at the same time access to workplaces and socio-cultural infrastructure is important to citizens of Warsaw when choosing a place for a living and the same time for future recreation possibilities (Table 2).

A certain dissonance between the effect of the neighborhood on property prices and the perception of the surroundings after already inhabiting the area by the citizens can be observed. When choosing

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a place to live the parameters exhibiting high RES of the surroundings, such as share of managed green areas or unmanaged abandoned areas providing similar functions or share of impermeable surfaces treated as a general measure of available infrastructure present in the area are not taken into account. They start to play a significant role to the local community actually using the space (Table 2).

Table 1. Characteristics of investigated urban lakes and distance from center, mean property value within 500 m buffer area, mean number of visitors, total time spent of people per day

	Lake name (ID)	*Area*	*Lake perimeter*	*Coordinates of the centroid (PUWG 1992)*		*Distance from center*	*Mean property value within 500 m buffer zone*	*Mean number of visitors*	*Total time spent of people per day*
		[ha]	*[m]*	*X*	*Y*	*[km]*	*[EUR]*	*[people /day]*	*[h]*
1	*Bielawa*	6,1	1487	646648,21	473915,90	16,1	1327,2	35,2	5,25
2	*Boża Wola*	5,6	2250	620133,09	506266,20	25,3	1350,2	24,4	3,4
3	*Brzeście*	5,8	2748	650661,15	464613,40	26,5	1405,5	22,1	3,3
4	*Ciecieszewskie*	1,6	682	649102,31	468396,80	22,1	1390,6	26,2	3,6
5	*Czerniakowski*	17,7	4096	641505,59	482874,00	6,7	1359,4	126	12,9
6	*Czerskie*	4,0	2049	653719,46	456946,40	34,2	1621,0	18,1	2,7
7	*Kosumce*	0,7	706	656008,69	460641,70	32,3	816,4	15,3	2,7
8	*Dziecinów N*	1,4	1222	655950,97	460908,40	32,1	816,4	11,6	1,65
9	*Dziecinów S*	6,8	2943	656491,89	460255,50	33,5	1277,2	8,1	1,2
10	*Dziekanowski*	26,5	4030	625488,97	501856,80	18,7	1084,1	48	7,2
11	*Gocławskie*	1,8	957	641756,84	487071,30	5,2	1716,6	80,2	12
12	*Habdzin*	3,9	1687	647538,26	471911,90	18,1	1621,0	20	3,5
13	*Nowy Kazuń*	14,4	3132	614401,37	506377,50	30,5	1371,0	18,3	2,7
14	*Kiełpińskie*	6,9	2400	627508,07	501195,00	17,4	1084,1	17,1	2,8
15	*Lisowskie*	7,4	2310	645454,90	475668,40	14,0	1621,0	38,7	5,7
16	*Łomna E*	3,2	1471	620663,38	504106,40	24,2	910,1	14,1	2,1
17	*Łomna M*	5,2	1438	620128,68	504304,60	24,3	910,1	19,2	2,85
18	*Łomna W*	2,8	810	619849,01	504630,10	25,1	910,1	18	2,7
19	*Karczew*	2,9	1878	653560,34	469533,60	24,8	816,4	42,4	6,3
20	*Pod Morgami*	2,3	1047	645189,90	476406,10	13,3	1954,8	31,2	4,4
21	*Nowy Dwór*	1,1	456	617152,18	506811,10	28,4	910,1	4	4,6
22	*Opacz E*	1,1	1189	647804,97	472562,50	18,4	1390,6	23,1	3,45
23	*Opacz W*	0,7	859	647579,48	472894,30	18,1	1390,6	25,1	3,75
24	*Piotrowice*	5,2	2120	655828,61	462257,20	31,7	816,4	25,3	3,2

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25	Powsinkowski	10,9	2720	643462,43	478953,30	10,4	1762,7	54,5	8,1
26	Otwockie	33,1	8007	653635,42	466188,90	27,5	816,4	61,1	5,15
27	Syta	1,3	627	643889,49	481052,70	9,2	1589,9	4,8	4,2
28	Żabie	0,3	279	645057,90	484160,70	9,1	1992,9	4,6	5,1

Table 2. Spearman's correlation coefficients between the ecological characteristics of investigated urban lakes and their surroundings and recreational ecosystem services provided by these ecosystems, expressed as mean property values in the neighborhood and real time spent by the citizens at the lakes at $p<0.05$

	Property value in the 500 m buffer zone [Euro/m²]		***Duration of time spent by the users [hours/day]***	
	R square	*p-value*	*R square*	*p-value*
distance from centre	***-0,430****	***0,023***	***-0,720*****	***0,000***
Land use in the 500 m buffer zone				
Built-up areas [%]	***0,468****	***0,012***	***0,498*****	***0,007***
Managed green areas [%]	*0,282*	*0,147*	***0,489*****	***0,008***
Abandoned unmanaged areas [%]	*0,179*	*0,362*	***0,564*****	***0,002***
Impermeable surfaces [%]	*0,270*	*0,164*	***0,542*****	***0,003***
Rushes and wetlands[%]	*0,042*	*0,834*	*0,032*	*0,872*
Forests and woodlands [%]	*-0,330*	*0,090*	*0,069*	*0,729*
Aquatic vegetation				
Number of species	*0,290*	*0,135*	*-0,040*	*0,838*
Shannon-Wiener Index	*0,278*	*0,152*	*-0,110*	*0,583*
Hemeroby	*0,085*	*0,667*	*0,139*	*0,481*
Vegetation of the rushes				
Number of species	*-0,350*	*0,072*	*-0,400*	*0,036*
Shannon-Wiener Index	*-0,200*	*0,317*	*-0,210*	*0,277*
Hemeroby	*-0,170*	*0,391*	*-0,180*	*0,37*
Terrestrial vegetation of the shores				
Number of species	*-0,260*	*0,187*	*0,107*	*0,588*
Shannon-Wiener Index	*-0,420*	*0,026*	*0,163*	*0,409*

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Hemeroby	***-0,420****	***0,026****	***-0,390****	***0,040****
Water eutrophication				
PO_4	*0,035*	*0,861*	*-0,220*	*0,260*
NO_2	*0,234*	*0,230*	*0,149*	*0,449*
NO_3	*-0,030*	*0,880*	***-0,380****	***0,046***
NH_4	*-0,140*	*0,475*	*-0,040*	*0,854*

4. Discussion

According to the results of this study, the general value and quality of the ecosystems examined do not correspond to the visiting frequencies and their duration, when visiting a green area the ecological quality of the area is not a strong influencing factor (Table 2). However, some clear relations were found showing that values of properties are in general higher in the close vicinity of floodplain lakes considered in the analysis. Well selected representative sampling areas can supply examples of positive relation between the biodiversity of urban green spaces and the preferences of individuals visiting [58, 59]. In reality the users do not necessarily prefer places characterized by unique biological diversity. They do recognize most common types of ecosystems, which can indirectly indicate biodiversity, but in many cases this recognition depends strongly on the general education level and knowledge about nature of the individual [41, 60, 61]. For the homogenous habitats, the measured ecological indices reflecting diversity of these ecosystems and the landscape associated with them were not correlated at all to the benefits perceived by the citizens. Thus, basing management and maintenance of the city's green infrastructure on social judgment and preferences might lead to improper conclusions. Moreover, the existing research on urban lakes indicated that if the habitats are less accessible the users will base their judgments on the basis of the most exterior zone only. The naturalness of these areas is not perceived as a number of species or vegetation diversity but as a share of plant species associated with humans (hemeroby). Lake edges, negatively perceived by the users, were commonly overgrown with invasive plant species such as *Solidago canadensis* and *S. gigantea*, though not always the neighboring rushes and aquatic vegetation were characterized by low richness and diversity – invasive species presence did not contribute to biodiversity loss of other zones.

The urban-rural gradient should be one of the directions the RES of green infrastructure management and planning should follow. The distribution of benefits from RES should include demand and other social aspects [62]. Psychological studies highlight that direct contact with nature is crucial for human well-being and psycho-physical development in a long term perspective. It is even accepted that the presence of green areas affects life expectancy [11, 13, 14, 16]. Thus, green infrastructure can become the infrastructure of a healthy life, and are most needed in city centers, densely built-up areas or highly populated areas. In such places the demand for RES is the highest, and over half of the green infrastructure users people are those expecting direct contact with nature [42]. The possibilities to develop and expand formal green areas, such as forests or natural urban parks in the city centers are usually spatially limited. Thus implementing informal green spaces, such as urban lakes and their neighboring unmanaged areas into existing green infrastructure can provide high benefits to both nature [63] and the city's inhabitants [25]. The higher the share of such areas the higher the real possibilities of recreation provided (Table 2). In the neighborhood surrounding the floodplain lakes in this study, which comprise the city's most valuable natural ecosystems, on average 9.5 people/ha per day utilized the space, which are values similar to those obtained for urban parks. Areas at the city's lakes are quite frequently visited – on average 830 people visit the urban lakes each day, but spent little over 9 minutes per visit, indicating that they were highly transient. Comparing these values to those obtained for one of the most attractive big urban parks of Warsaw, the latter is visited by far less people per day, but the people spend much more time there [64].

The difference between the property value in the market and perception of the neighborhood by the inhabitants can be complex. When choosing a property for purchase and a place to live, the parameters contributing to high RES appear to be of little importance. This difference in perception of the surroundings by the citizens is enhanced by the lack of the spatial planning documents that would promote high provisioning of RES for the housing estates and is accelerated by the low ecological awareness among the citizens. These differences result undoubtedly to some extent from the fact that the group actually visiting the informal green areas, such as urban lakes is rather small – less than 30% of the citizens [25], which can affect the perception of biodiversity [60, 61]. These results can be also influenced by the fact that the average number of apartments per 1000 inhabitants is much lower than the average value in other EU countries [65]. This tendency has been changing drastically lately. Only a couple of years ago in the purchase functionality of the building interior (56%) or low rent cost, (48%) or safety (33%) were the factors affecting the decision about the purchase of an apartment, now they tend to become less important [66]. During the last years number of citizens declaring will to live in the neighborhood characterized by high share of green areas has increased from 12 to 27% [66]. However, the indications from this study are that the quality of the green area *per se* is of little importance, as long as the area green area exists.

Taking into account that psychological studies reveal that the benefits from a vital natural infrastructure in a neighborhood are only revealed after many years – we should conclude that multiple data about RES from inhabited areas and their surrounding should be collected. This is of particular importance in a high density urban environment such as Warsaw, where general anxiety and protests due to too poor information provision to the citizens in terms of nature conservation issues are common [67]. Collecting such data which could be easily accessed by the members of a community is one of the best practices implemented in other EU countries [68]. Green infrastructure systems require constant verification due to insufficient recognition of RES along with the changing social conditions, property prices, and changes in land use. Multidisciplinary research, new methods and frameworks followed by on-site investigations are required to assess RES in urban areas and provide adequate management and planning strategies to optimize RES for the urban community [69].

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References

1. Benedict, M.A.; McMahon, E.T. *Green infrastructure linking landscapes and communities*. Island Press Washington, Covelo, London, 2006.
2. Tzoulas, K.; Korpela, K.; Venn, S.; Yli-Pelkonen, V.; Kazmierczak, A.; Niemela, J.; James, P. Promoting Ecosystem and Human Health in Urban Areas using Green Infrastructure: a Literature Review. Landsc. Urban Plan. 2007, 81, 167–178.
3. Breuste, J; Niemela, J; Snep, R.P.H. Applying Landscape Ecological Principles in Urban Environments. Landsc. Ecol. 2008, 23, 1139–1142.
4. Vandermeulen, V.; Verspecht, A.; Vermeire, B.; Van Huylenbroeck, G.; Gellynck X., 2011. The Use of Economic Valuation to Create Public Support for Green Infrastructure Investments in Urban Areas. Landsc. Urban Plan. 2011, 103, 198–206.
5. Gómez-Baggethun, E; Barton, D.N. Classifying and Valuing Ecosystem Services for Urban Planning. Ecol. Econ. 2013, 86, 235–245.

6. Schäffler, A.; Swilling, M. Valuing Green Infrastructure in an Urban Environment under Pressure — The Johannesburg Case. Ecol. Econ. 2013, 86, 246–257.
7. Netusil, N.R.; Levin, Z.; Shandas, V.; Hart, T. Valuing Green Infrastructure in Portland, Oregon. Landsc. Urban Plan. 2014, 124, 14–21.
8. Breuste, J.; Rahimi, A. Many Public Urban Parks, but Who Profits from Them? The Example of Tabriz, Iran. Ecological Processes 2015, 4, 1–15.
9. Richards, D.R.; Warren, P.H.; Moggridge, H.L.; Maltby, L. Spatial Variation in the Impact of Dragonflies and Debris on Recreational Ecosystem Services in a Floodplain Wetland. Ecosystem Serv. 2015, 15, 113–121.
10. MEA, 2005. Ecosystems and Human Well-Being: Synthesis. Island Press, Washington DC.
11. Suding, K.N. Toward and Area of Restoration in Ecology: Successes, Failures and Opportunities ahead. Annu. Rev. Ecol. Evol. Syst. 2011, 42, 465–487.
12. Lachowycz, K.; Jones, A.P. Towards a better understanding of the Relationship Between Greenspace and Health: Development of a Theoretical Framework. Landsc. Urban Plan. 2013, 118, 62–69.
13. White, M.P.; Alcock, I.; Wheeler, B.W.; Depledge, M.H. Would you be happier living in a greener urban area? A Fixed-effects Analysis of Panel Data. Psychological Science 2013, 24, 920–928.
14. Alcock, I.; White, M.P.; Wheeler, B.W.; Fleming, L.E.; Depledge, M.H. Longitudinal Effects on Mental Health of Moving to Greener and Less Green Urban Areas. Environ. Sci. Technol. 2014, 48, 1247–1255.
15. Gascon, M., Triguero-Mas, M., Martínez, D. Residential Green Spaces and Mortality: A Systematic Review. Environ. Intern. 2016, 86, 60–67.
16. Gascon, M.; Triguero-Mas, M.; Martinez, D.; Dadvand, P.; Forns, J.; Plasencia, A. Mental Health Benefits of Long-term Exposure to Residential Green and Blue Spaces: A systematic Review. Int. J. Environ. Res. Public Health 2015, 12, 4354–4379.
17. Fitter, A.; Elmqvist, T.; Haines-Young, R.; Potschin, M.; Rinaldo, A.; Setälaä, H.; Stoll-Kleemann, S.; Zobel, M.; Murlis, J. An Assessment of Ecosystem Services and Biodiversity in Europe. Environ. Sci. Technol. 2010, 30, 1–28.
18. Bolund, P.; Hunhammar, S. Ecosystem Services in Urban Areas. Ecol. Econ. 1999, 29, 293–301.
19. Daniel, T.C.; Muhar A.; Arnberger, A.; Aznar, O.; Boyd, J.W.; Chan, K.M.A. Contributions of Cultural Services to the Ecosystem Services Agenda. Proc. Natl. Acad. Sci. 2012, 109, 8812–8819.
20. Cord, A.F.; Roeßiger, F.; Schwarz, N. Geocaching Data as an Indicator for Recreational Ecosystem Services in Urban Areas: Exploring Spatial Gradients, Preferences and Motivations. Landsc. Urban Plan. 2015, 144, 151–162.
21. Westerberg, V.H.; Lifran, R.; Olsen, S.B. To Restore or not? A Valuation of Social and Ecological Functions of the Marais des Baux wetland in Southern France. Ecol. Econ. 2010, 69, 2383–2393.
22. Bullock, C.H.; Elston, D.A.; Chalmers, N.A. An Application of Economic Choice Experiments to a Traditional Land Use—Deer Hunting and Landscape Change in the Scottish Highlands. J. Environ. Manage. 1998, 52, 335–351.
23. Smyth, R.L.; Watzin, M.C.; Manning, R.E. Investigating Public Preferences for Managing Lake Champlain Using a Choice Experiment. J. Environ. Manage. 2009, 90, 615–623.
24. Rupprecht, C.D.D.; Byrne, J.A. Informal Urban Greenspace: A Typology and Trilingual Systematic Review of its Role for Urban Residents and Trends in the Literature. Urban For. Urban Greening 2014, 13, 597–611.
25. Rupprecht, C.D.D.; Byrne, J.A.; Uedac, H.; Lo, A.Y. 'It's Real, not Fake Like a Park': Residents' Perception and Use of Informal Urban Green-space in Brisbane, Australia and Sapporo, Japan. Landsc. Urban Plan. 2015, 143, 205–218.
26. Costanza, R.; d'Arge R.; de Groot, R.; Farberk, S.; Grasso, M.; Hannon, B.; Limburg, K.; Naeem, S.; O'Neill, R.V.; Paruelo, J.; Raskin, R.G.; Sutton, P.; van den Belt, M. The Value of the World's Ecosystem Services and Natural Capital. Nature 1997, 387, 253-260.
27. Riechers, M.; Barkmann, J.; Tscharntke T. Perceptions of Cultural Ecosystem Services from Urban Green. Ecosystem Serv. 2016, 17, 33–39.
28. Tyrväinen, L. The Amenity value of the Urban Forest: an Application of the Hedonic Pricing Method. Landsc. Urban Plan. 1997, 37, 211–222
29. Benson, E.D.; Hansen J.L.; Schwartz A.L.; Smersh G.T. Pricing Residential Amenities: The Value of a View. J. R. Estate. Finance. Econ. 1998, 16: 55–73.
30. Morancho, A.B. A Hedonic Valuation of Urban Green Areas. Landsc. Urban Plan. 2003, 66, 35-41.

31. Jim, C.Y.; Chen, W.Y. External Effects of Neighborhood Parks and Landscape Elements on High-rise Residential Value. Land Use Policy 2010, 27, 662–670.
32. Sutton, P.C.; Anderson, S.J. Holistic valuation of urban ecosystem services in New York City's Central Park. Ecosystem Serv. 2016, 19, 87–91.
33. Turner, R.K.; Paavola, J.; Cooper, P.; Farber, S.; Jessamy, V.; Georgiou, S. Valuing Nature: Lessons Learned and Future Research Directions. Ecol. Econ. 2003, 46, 493–510.
34. Lyons, E. Demographic Correlates of Landscape Preference. Environ. Behav. 1983, 15, 487–511.
35. Strumse, E. Demographic Differences in the Visual Preferences for Agrarian Landscapes in Western Norway. J. Environ. Psychol. 1996, 16, 17–31.
36. Dramstad W.E.; Tveit M.S.; Fjellstad W.J.; Fry G.L.A. Relationships Between Visual Landscape Preferences and Map-based Indicators of Landscape Structure. Landsc. Urban Plan. 2006, 78, 465–474.
37. Kaltenborn, B.P.; Bjerke, T. Associations Between Environmental Value Orientations and Landscape Preferences. Landscape and Urban Planning, 2002, 59, 1–11.
38. van der Berg, A.E.; Koole, S.L. New Wilderness in the Netherlands: An Investigation of Visual Preferences for Nature Development Landscapes. Landsc. Urban Plan. 2006, 78, 362–372.
39. Stilma, E.S.C.; Smit, A.B.; Geerling-Eiff, F.A.; Struik, P.C.; Vosman, B.; Korevaar, H. Perception of Biodiversity in Arable Production Systems in the Netherlands. NJAS—Wageningen J. Life Sci. 2009, 56, 391–404.
40. Grygoruk, M.; Rannow, S. Mind the Gap! Lessons from Science-based Stakeholder Dialogue in Climate-adapted Management of Wetlands. J. Env. Man. 2017, 186, 108–119.
41. Qiu, L., Lindberg S., Nielsen A.B. 2013. Is Biodiversity Attractive? - On-site Perception of Recreational and Biodiversity Values in Urban Green Space. Landsc. Urban Plan. 119:136-146.
42. Chiesura A. 2004. The Rrole of Urban Parks for the Sustainable City. Landsc. Urban Plan. 68: 129–138.
43. Faizi M. 2006. The Role of Urban Parks in a Metropolitan City. Environ. Sci. 12: 29–34.
44. Rasmussen, L.V.; Mertz, O; Christensen, A.E.; Danielsen, F; Dawson, N; Xaydongvanh, P. A Combination of Methods Needed to Assess the Actual Use of Provisioning Ecosystem Services. Ecosystem Serv. 2016, 17, 75–86.
45. Bertaud, A; Malpezzi, S. *The Spatial Distribution of Population in 48 World Cities: Implications for Economies in Transition, Research working paper*, University of Wisconsin, Center for Urban Economics, 2003.
46. Thrane, C. Examining the Determinants of Room Rates for Hotels in Capital Cities: The Oslo Experience, J. Revenue Pricing Manag. 2006, 5, 315–323.
47. Andersson, D.E. Hotel Attributes and Hedonic Prices: An Analysis of Internet-based Transactions in Singapore's Market for Hotel Rooms, Ann. Reg. Sci. 2010, 44 (2), 229–240.
48. Chen, C.; Rothschild, R. An Application of Hedonic Pricing Analysis to the Case of Hotel Rooms in Taipei, Tour. Econ. 2010, 16, 685–694.
49. Schamel, G. Weekend vs. Midweek Stays: Modelling Hotel Room Rates in a Small Market, Int. J. Hosp. Manage. 2012, 31, 1113–1118.
50. Balaguer, J.; Pernias, J.C. Relationship between Spatial Agglomeration and Hotel Prices: Evidence from Business and Tourism Consumers, Tour. Manage. 2013, 36, 391–400.
51. Becerra, M.; Santaló, J.; Silva, R. Being Better vs. Being Different: Differentiation, Competition, and Pricing Strategies in the Spanish Hotel Industry, Tour. Manage. 2013, 34, 71–79.
52. Mansor, M.; Said, I.; Mohamad, I. Experiential Contacts with Green Infrastructure's Diversity and Well-being of Urban Community. Procedia Soc. Behav. Sci. 2012, 49, 257–267.
53. Sudnik-Wójcikowska, B.; Galera, H. Warsaw [in:] Kelcey, J.G., Müller, N. [ed.]. *Plants and Habitats in European Cities*. Springer, New York, 2011, 499-545.
54. Sikorska D. The Former Vistula River Beds Near Warsaw: Vegetational Diversity and Change. Doctoral thesis. Warsaw University of Life Science. Warsaw. 1-130 (in Polish).
55. Hahs, A.K.; McDonnell, M.J. Selecting Independent Measures to Quantify Melbourne's Urban-rural Gradient. Landsc. Urban Plan. 2006, 78, 435-448.
56. Magurran, A.E. *Measuring Biological Diversity*. Oxford: Whiley & SONS 2004.
57. Fanelli, G.; Tescarollo, P.; Testi A. Ecological Indicators Applied to Urban and Suburban Floras. Ecol. Indic. 2006, 6, 444–457.
58. Fuller, R.A.; Irvine K.N.; Devine-Wright, P.; Warren, P.H.; Gaston, K.J. Psychological Benefits of Greenspace Increase with Biodiversity. Biol. Lett. 2007, 3(4), 390-394. DOI: 10.1098/rsbl.2007.0149

59. Carrus, G.; Scopelliti, M.; Lafortezza, R.; Colangelo, G.; Ferrini, F.; Salbitano, F.; Sanesi, G. Go Greener, Feel Better? The Positive Effects of Biodiversity on the Well-being of Individuals Visiting Urban and Peri-urban Green areas. Landsc. Urban Plan. 2015, 134, 221–228.
60. Lin, B.B.; Fuller, R.A.; Bush, R.; Gaston, K.J.; Shanahan, D.F. Opportunity or Orientation? Who Uses Urban Parks and Why. PloONE 2014, 9(1), e87422 DOI: 10.1371/journal.pone.0087422
61. Murateta, A.; Pellegrini P.; Dufourc A.B.; Arrif, T.; Chiron, F. Perception and Knowledge of Plant Diversity among Urban Park Users. Landsc. Urban Plan. 2015, 137, 95–106.
62. Hand, K.L.; Freeman, C.; Seddon, P.J.; Stein, A.; van Heezik, Y. A Novel Method for Fine-scale Biodiversity Assessment and Prediction across Diverse Urban Landscapes Reveals Social Deprivation-related Inequalities in Private, not Public Spaces. Landsc. Urban Plan. 2016, 151. 33–44.
63. Kowarik, I. Novel Urban Ecosystems, Biodiversity, and Conservation. Environ. Pollut. 2011, 159, 1974–1983.
64. Cieszewska, A.; Kowalczyk, M.; Szumacher, I. 2015, Skaryszewski Park users in years 2009-2015, [in:] J. Romanowski [ed.] Park Skaryszewski in Warsaw – nature and use, UKSW Press, Warszaw, 37-48 (in Polish).
65. Pittini, A.; Ghekière, L.; Dijol, J.; Kiss, I. Housing in Europe, the European Federation for Public, Cooperative and Social Housing Brussels 2015. Available online: http://www.housingeurope.eu/file/306/download (accessed on 20.12.2016).
66. Pankowski, K. How do Poles live, or how they would like to be living (in Polish). Fundacja Centrum Badania Opinii Społecznej. 2010. Available online: www.cbos.pl/spiskom.pol/2010/k_120_10.PDF (accessed on 20.12.2016).
67. Pawłowska, K. Public Participation in Decision Making on Urban Nature. 2012. Available online: http://www.sendzimir.org.pl/images/zrz_3_en/03_public_participation_in_decision_making_on_urban_nature.pdf (accessed on 20.12.2016).
68. Mabelis, A.A.; Maksymiuk, G. Public Participation in Green Urban Policy: Two Strategies Compared. Int. J. Biodivers. Sci. Manage. 2009, 5, 63–75.
69. Wang, Y.F.; Bakker, F.; de Groot, R.; Wortche H. De Build. Environ. 2014, 77, 88–100.