XXI. MEZINÁRODNÍ KOLOKVIUM O REGIONÁLNÍCH VĚDÁCH. SBORNÍK PŘÍSPĚVKŮ.

21ST INTERNATIONAL COLLOQUIUM ON REGIONAL SCIENCES. CONFERENCE PROCEEDINGS.

Place: Kurdějov (Czech Republic)
June 13-15, 2018

Publisher: Masarykova univerzita, Brno

Edited by:
Viktorie KLÍMOVÁ
Vladimír ŽÍTEK
(Masarykova univerzita / Masaryk University, Czech Republic)

Vzor citace / Citation example:

AUTOR, A. Název článku. In Klímová, V., Žítek, V. (eds.) *XXI. mezinárodní kolokvium o regionálních vědách. Sborník příspěvků.* Brno: Masarykova univerzita, 2018. s. 1–5. ISBN 978-80-210-8969-3.

AUTHOR, A. Title of paper. In Klímová, V., Žítek, V. (eds.) 21st *International Colloquium on Regional Sciences. Conference Proceedings.* Brno: Masarykova univerzita, 2018. pp. 1–5. ISBN 978-80-210-8969-3.

Publikace neprošla jazykovou úpravou. / Publication is not a subject of language check.
Za správnost obsahu a originalitu výzkumu zodpovídají autoři. / Authors are fully responsible for the content and originality of the articles.

ISBN 978-80-210-8969-3
ISBN 978-80-210-8970-9 (online : pdf)

DOI: 10.5817/CZ.MUNI.P210-8970-2018-84

ASSESSMENT OF THE ENVIRONMENTAL ASPECT OF POLISH VOIVODESHIP CITIES

IWONA KRZYWNICKA

Department of Real Estate Resources
Faculty of Geodesy, Geospatial and Civil Engineering
University of Warmia and Mazury in Olsztyn
✉ Prawochenskiego, 10-720 Olsztyn, Poland
E-mail:iwona.krzywnicka@uwm.edu.pl

Annotation
How a city operates and, in particular, what the quality of life of its citizens is, depends to a great extent on the presence of green areas, forests, protected areas and areas valuable due to environmental reasons. Such areas fulfill numerous functions: aesthetical, educational, recreational and cleansing ones. The purpose of the article is to assess the environmental aspects of voivodeship cities in Poland with the use of generally available statistical data included in the Local Data Bank of the Main Statistical Office. The rating indicators of environmental aspects which were encountered in the literature (presented in Methods and Materials) were selected for the analysis. The conducted analysis showed that the city with the highest rating of environmental aspects is Olsztyn where four out of five indicators have the highest level. Other cities, which environmental aspects are on a similar level, include Szczecin and Poznań. However, Rzeszów has the lowest ratings and the lowest rating of environmental aspects among all voivodeship cities. Also Katowice, Opole and Lublin are the cities with a lower rating of environmental aspects.

Key words
green areas, city planning, environmental system of a city

JEL classification: *Q56, R52*

1. Introduction

A city is a complex system represented mainly by developed areas, technical infrastructure, as well as green areas, which are very important for the environmental operation of this complex system. City greenery has a positive impact on numerous areas of human life, i.e. health, wellness, social relationships and business activity. It provides a wide scope of services and ecosystem utilities (Ives et al 2017, Keniger et al 2013). Cities, in particular the big ones, fulfill various functions: they are centers for the development of trade, culture, science, innovation implementation, etc., but they also need to meet many challenges (overpopulation, air pollution, traffic noise, etc.) (Fijałkowska, Aldea, 2017; Szczepańska et al 2015). The research conducted by Ernst&Young demonstrates that 750 of the biggest cities of the world generate 57% of the global GDP (Megatrends, 2015). On the other hand, cities produce more than 70% of global greenhouse gases (Fijałkowska, Aldea after KPMG 2011).

Polish cities, following the example of other countries (USA, Canada, Sweden, Germany) (Szulczewska, Kaliszuk 2005, Szulczewska 2015) introduce "cities' environmental systems" to their urban planning documents. They have various names, spatial and semantic areas. However, they also have some common features – each of them needs to have areas of environmental importance (often divided into areas of atmospheric, hydrological and biological significance) defined first. The basic elements of a city's environmental system are green, protected and forest areas. Biologically active areas, including green areas to a great extent, significantly contribute to the process of cleaning the air of pollution, which is practically necessary for city conditions. It turns out that trees, bushes, lawns, green roofs and walls efficiently reduce air pollution and regulate the emission of greenhouse gases within city areas (Jayasooriya in., 2017). Small-particle pollution in a wooded area diminishes by 90% and in an area covered by low vegetation – by 50%. Plants absorb large amounts of harmful gases, such as sulfur dioxide (SO_2), hydrogen sulfide (H_2S), carbon dioxide (CO_2), vapors of sulfuric and nitric acids (Malczyk, 2012).

The term "green spaces" is not unambiguous. The Nature Conservation Act of 16th April 2004 (Journal of Laws 2018, item 142) defines it as "areas arranged with technical infrastructure and functionally related buildings, covered with plants, fulfilling public functions and, in particular, parks, greenschist, promenades, boulevards, botanical gardens, zoos, game parks and historical gardens, cemeteries, green by the roads within the developed area, on squares, historic fortifications, buildings, disposal sites, railway stations and industrial facilities". According to Haber and Urbański (2008), green areas are mainly spaces in urbanized areas where plants were been introduced on purpose. In broader terms, the authors also include areas of open landscape together with their resources, as well as elements which the landscape consists of, including national parks, landscape parks and rural parks. Czarnecki (1961) in turn, defines green areas as spaces covered by vegetation which are used and developed according to the spatial management plan. These are green areas available for all citizens (parks, boulevards, squares, children's gardens, sports fields, etc.) and areas with a limited access or unavailable to all users (e.g. allotment, school, educational, hospital, factory gardens, etc.).

So green areas are very important elements of the city's urban planning program and the condition of the city itself is closely connected with the healthy natural environment. In this context, the aim of the research was to assess the quality of environmental aspects of cities in Poland. Voivodeship cities were analyzed in the research. The used data were collected from the Local Data Bank of the Main Statistical Office (access 22nd-28th February 2018). The data included the information about green areas, forests and legally protected areas. The evaluation of the environmental aspects of the cities was conducted with the use of valorizing indicators.

2. Rating indicators concerning the environmental aspect of cities

The share of green areas in the cities' general area determines the quality of life of their citizens (Kim, Kaplan, 2004; Maas et al 2004). Another determinant of green areas' significance in cities is their area per one citizen. Wüstermann (after Roo, 2017) states that the recommended amount of green areas per one citizen in the Netherlands is 60 m² within a 500 m range from their place of residence. Research conducted by Wüstermann on the access to green areas in large cities (with more than 100 000 citizens) in Germany has demonstrated that 92.8% of citizens have access to green areas within a 500m range from their place of residence. There is a significant differentiation in terms of the supply of green areas – from 2.5 m²/per person (city of Schwerin) to 36.3 m²/per person (city of Bergisch Gladbach) when analyzing the area of 500 m from the place of residence. The recommendations of WHO (after Łukasiewicz, Łukasiewicz, 2006) regarding the number of green areas per 1 citizen are 50 m^2 and at least 9 m^2.

Currently, the only indicator related to the environmental aspect of cities which has been defined in the provisions of Polish law is the indicator of biologically active areas. According to the regulation of the Minister of Infrastructure on conditions which buildings and locations thereof should meet, **a biologically active area** is native soil covered by vegetation and surface water on a construction plot, as well as 50% of the sum of terraces and roof spaces arranged as lawns or flowerbeds on a substrate ensuring their natural vegetation, not smaller than 10m². And although the rate of this indicator is imposed for multiple-family housing (not less than 25%), they are often determined in local plans for a single-family housing.

The quality of the environmental aspect of cities can be assessed with the use of indicators which valorize it. This includes, e.g. (Świercz, 2011):

- - indicator of the share of developed areas in relation to city area,
- - indicator of the share of vegetation in the general city area,
- - indicator of obstacle compactness (for the ventilation processes)
- - indicator of air regeneration (% of share of areas with a dominant function of ventilation),
- - general area of legally protected areas in ha and % of the city area,
- - indicator of green areas' accessibility per 1 citizen,
- - indicator of city forests' accessibility per 1 citizen,
- - expenditures for maintenance of green areas in PLN/per person,
- - total outlays for environmental protection.

By using the selected indicators one can conduct an analysis and assessment of the processes occurring in a city and also prepare information for local communities that would show the tendencies in changes in the natural environment, the surface of protected areas, green areas and financial outlays on pro-environmental investments.

3. Methods and materials

This work includes the following research method and techniques:

1. Analysis of statistical data regarding green areas, legally protected areas and forest areas in voivodeship cities in Poland. The data used are from 2016 and have been presented in the Local Data Bank of the Main Statistical Office.
2. Assessment of cities' environmental aspect on the basis of the indicators of:
   - green areas in relation to the city area (%),
   - accessibility of green areas per 1 citizen (m^2/per 1 citizen),
   - legally protected areas within the general city area (%),
   - city forest areas per 1 citizen (m^2/per 1 citizen)
   - forest areas within the general city area (%).
3. Comparative assessment of the analyzed cities and synthetic assessment of the environmental aspect.

The data used are statistical data regarding green areas, legally protected areas and forest areas included in the statistics of the Local Data Bank of the Main Statistical Office (access 22nd-28th February 2018) presented in a commune system. For this reason, not all green areas have been analyzed, since the statistics referred to the commune level include the following types: walking and leisure parks, green squares, street green, community green areas, cemeteries, commune forests. Areas included in the legally protected areas category are national parks, nature reserves, landscape parks, protected landscape areas, ecological utility areas, documentation sites and landscape-nature complexes.

Another stage of works was the calculation of indicators:

- - W1 – percentage share of green areas in the city area:

$$W1 = \frac{\Sigma\, of\ green\ areas\ in\ a\ city}{City\ area} \text{x}100\%,$$

- - W2 – green areas per 1 citizen:

$$W2 = \frac{\Sigma\, of\ green\ areas\ in\ a\ city}{Number\ of\ citizens}$$

- - W3 – legally protected areas within the general city area:

$$W3 = \frac{\Sigma\, of\ legally\ protected\ areas}{City\ area} \text{x}100\%$$

- - W4 – city forest areas per 1 citizen:

$$W4 = \frac{\Sigma\, of\ city\ forest\ areas}{Number\ of\ citizens}$$

- - W5 – forest areas within the general city area:

$$W5 = \frac{\Sigma\, of\ forest\ areas}{City\ area} \text{x}100\%$$

Calculations of the indicators are presented in Table 3.

Next, the synthetic indicator (rating) of the environmental aspect of cities was calculated with the use of the point evaluation method. Such an indicator allows assessing cities and comparing them to one another. The values of particular indicators, in turn, allow for an assessment of improvement or deterioration of the environmental aspect over the years.

The cities analyzed with regard to the environmental aspect are Polish voivodeship cities: Wrocław, Bydgoszcz, Lublin, Zielona Góra, Łódź, Cracow, Warsaw, Opole, Rzeszów, Białystok, Gdańsk, Katowice, Kielce, Olsztyn, Poznań, Szczecin. The cities' location is presented in Figure 1, while their area and population are indicated in Table 1.

Fig. 1: Map of Poland divided into voivodeships and cities, voivodeship capitals.

Source: http://encyklopedia.interia.pl/nauki-spoleczne-humanistyka/news-wojewodztwo,nId,2002163

Tab. 1: Summary of area and population of voivodeship cities in Poland in 2016.

City	Area (in ha)	Population
Wrocław	29,282	637,683
Bydgoszcz	17,598	353,938
Lublin	14,747	340,466
Zielona Góra	27,832	139,330
Łódź	29,325	696,503
Cracow	32,685	765,320
Warsaw	51,724	1,753,977
Opole	9,655	118,722
Rzeszów	11,636	187,422
Białystok	10,213	296,628
Gdańsk	26,196	463,754
Katowice	16,464	298,111
Kielce	10,965	197,704
Olsztyn	8,833	172,993
Poznań	26,191	540,372
Szczecin	30,056	404,878

Source: own elaboration based on data from the Main Statistical Office

The biggest city in terms of its area is Warsaw (51 724 ha) with a population of 1 753 977, while the smallest one is Olsztyn (8 833 ha) with a population of 172 993 (the Main Statistical Office data as of 31st December 2016). The smallest city in terms of its population is Opole (118 722 people), with an area of 9 655 ha.

4. Results and Discussion

The analysis included the Main Statistical Office data regarding green areas, legally protected areas and forest areas from 2016. The scope of analyses could be greater, however, the data in the Local Data Bank of the Main Statistical Office do not include many environmental and infrastructural elements (e.g. developed area, allotment gardens, botanical gardens) in commune or district systems.

The list of all analyzed areas is presented in Table 2.

The largest amount of green areas is in Warsaw (4 828.38 ha) and Poznań (4 452.92 ha), while the smallest amount can be found in Opole (575.06 ha) and Kielce (593.79 ha). The amount of legally protected areas is the largest in Warsaw (12 226.01 ha); a large amount of these areas is also present in Bydgoszcz (6 089 ha), Zielona Góra (6 280.41 ha), Gdańsk (6 545.90 ha) and Kielce (6 800.64 ha). The largest amount of city forests can be found in

Szczecin (2 590.92 ha) and Poznań (2 183.41 ha). The cities with the highest amount of forest areas within their borders are Poznań (2 999.08 ha), Warszawa (2 910.41 ha), Szczecin (2 727.28 ha) and Łódź (2 537.49 ha).

Tab. 2: Summary of green areas, legally protected areas and forest areas in voivodeship cities in 2016.

City	Green areas (ha)	Legally protected areas (ha)	City forest areas (ha)	Forest areas (ha)
Wrocław	3,125.51	1,836.50	931.43	967.10
Bydgoszcz	1,911.66	6,089.00	157.10	267.13
Lublin	1,367.20	2,530.00	1.96	344.83
Zielona Góra	910.01	6,280.41	512.24	785.00
Łódź	3,833.20	2,752.64	1,461.92	2,537.49
Cracow	3,256.91	4,875.50	844.95	1,077.69
Warsaw	4,828.38	12,226.01	125.52	2,910.41
Opole	575.06	28.90	13.90	77.70
Rzeszów	633.78	8.11	9.00	142.00
Białystok	1,054.29	103.93	235.08	437.44
Gdańsk	2,249.17	6,545.90	1,045.20	1,278.01
Katowice	1,249.74	232.00	29.60	106.80
Kielce	593.79	6,800.64	80.93	450.13
Olsztyn	1,851.44	501.80	1,283.62	1,486.16
Poznań	4,452.92	1,105.33	2,183.41	2,999.08
Szczecin	3,487.04	1,717.53	2,590.92	2,727.28

Source: own elaboration based on data from the Main Statistical Office

The data served as a basis for calculation of suggested environmental aspect indicators for every city. The results are presented in Table 3.

Tab. 3:. Summary of calculated environmental aspect indicators for voivodeship cities in Poland

City	W1 (%)	W2 (m^2/per 1 citizen)	W3 (%)	W4 (m^2/per 1 citizen)	W5 (%)
Wrocław	10.7	49.0	6.3	14.6	3.3
Bydgoszcz	10.9	54.0	34.6	4.4	1.5
Lublin	9.3	40.2	17.2	0.1	2.3
Zielona Góra	3.3	65.3	22.6	36.8	2.8
Łódź	13.1	55.0	9.4	21.0	8.6
Cracow	10.0	42.6	14.9	11.0	3.2
Warsaw	9.3	27.5	23.6	0.7	5.6
Opole	6.0	48.4	0.3	1.2	0.8
Rzeszów	5.4	33.8	0.1	0.5	1.2
Białystok	10.3	35.5	1.0	7.9	4.3
Gdańsk	8.6	48.5	25.0	22.5	4.9
Katowice	7.6	41.9	1.4	1.0	0.6
Kielce	5.4	30.0	62.0	4.1	4.1
Olsztyn	21.0	107.0	5.7	74.2	16.8
Poznań	17.0	82.4	4.2	40.4	11.4
Szczecin	11.6	86.1	5.7	64.0	9.1

Source: own elaboration based on data from the Main Statistical Office

The city with the highest W1 indicator (share of green areas in the general city area) is Olsztyn (21.0). Furthermore, a high indicator can be found in: Poznań (17.0) and Łódź (13.1) followed by Szczecin (11.6), Bydgoszcz (10.9), Wrocław (10.7), Białystok (10.0). The lowest W1 indicator can be found in Zielona Góra, which may stem from 21 998 ha of rural areas being incorporated into the administrative borders of the city. The city's original area was then increased nearly five times, which impacted the W1 indicator. It is to be noted that despite the fact that rural areas are predominantly biologically active, they are not included in the statistics of the Main Statistical Office as green areas. The highest indicator of W2, similarly to W1, can be found in Olsztyn (107 m^2/per 1 citizen); the indicators are also very high in Szczecin (86.1) and Poznań (82.4). A low indicator can be found in Rzeszów (33.8). Kielce has the highest W3 indicator (62.02) in view of a large number of protected areas within the city borders; the indicator is quite high in Bydgoszcz (34.60), Gdańsk (24.99) and Warsaw (23.64), while it is the lowest in Rzeszów (0.07). The W4 indicator is the highest in Olsztyn (74.20) and Szczecin (63.99); quite high in

Poznań (40.41) and Zielona Góra (36.76), and the lowest in Lublin (0.06) and Katowice (0.99). The W5 indicator is the highest in Olsztyn (16.83) and Poznań (11.45) and the lowest in Katowice (0.65) and Opole (0.80).

The calculated indicators formed a basis for a rating of voivodeship cities with regard to every indicator. This was followed by a determination of a synthetic rating combining all of the analyzed elements (Table 4). It was determined with the use of point evaluation – position of a city per each indicator is a number of points; the sum of points formed a basis to determine the synthetic rating (order of the cities).

Tab. 4: Synthetic rating of voivodeship cities

Rating	W1	W2	W3	W4	W5	Synthetic rating
1	Olsztyn	Olsztyn	Kielce	Olsztyn	Olsztyn	Olsztyn
2	Poznań	Szczecin	Bydgoszcz	Szczecin	Poznań	Szczecin
3	Łódź	Poznań	Gdańsk	Poznań	Szczecin	Poznań
4	Szczecin	Zielona Góra	Warsaw	Zielona Góra	Łódź	Łódź
5	Bydgoszcz	Łódź	Zielona Góra	Gdańsk	Warsaw	Gdańsk
6	Wrocław	Bydgoszcz	Lublin	Łódź	Gdańsk	Bydgoszcz
7	Białystok	Wrocław	Cracow	Wrocław	Białystok	Wrocław
8	Cracow	Gdańsk	Łódź	Cracow	Kielce	Zielona Góra
9	Lublin	Opole	Wrocław	Białystok	Wrocław	Cracow
10	Warsaw	Cracow	Szczecin	Bydgoszcz	Cracow	Warsaw
11	Gdańsk	Katowice	Olsztyn	Kielce	Zielona Góra	Białystok
12	Katowice	Lublin	Poznań	Opole	Lublin	Kielce
13	Opole	Białystok	Katowice	Katowice	Bydgoszcz	Lublin
14	Rzeszów	Rzeszów	Białystok	Warsaw	Rzeszów	Opole
15	Kielce	Kielce	Opole	Rzeszów	Opole	Katowice
16	Zielona Góra	Warsaw	Rzeszów	Lublin	Katowice	Rzeszów

Source: own elaboration

The city with the highest rating is Olsztyn, which placed 1st almost in every indicator category. The city has a small area and a small population, yet at the same time, it is rich with green areas, commune forests and protected areas. High in the ratings are also Szczecin, Poznań, Łódź and Gdańsk. The cities with the lowest ratings are Opole, Katowice and Rzeszów.

This analysis definitely does not exhaust the subject, since it does not include other assessment indicators of the environmental aspect of cities. The statistics in the Local Data Bank do not include uncontrolled green areas, furthermore, areas of allotment and botanical gardens are stated in a voivodeship and not a city system. The scope of analyses should be broadened to include such areas. Another aspect which has not been analyzed are green areas on roofs or roof spaces (no information from the Main Statistical Office). One can then assume that the indicators calculated in the work constitute minimum values which could only be higher if the scope of analyses were extended to include information on uncontrolled green areas obtained from other sources.

Conclusions

The present paper is an attempt to assess the environmental aspect of Polish voivodeship cities. The indicators used were developed on the basis of reference books and data from the Local Data Bank in the Main Statistical Office. The conducted valuation showed that the highest level of environmental aspects is in Olsztyn. The assessment demonstrated that the city which deserves particular recognition in comparison to other assessed ones is Olsztyn, which has the highest rating in four out of five indicators (1, 1, 11, 1, 1). Szczecin (4, 2, 10, 2, 3) and Poznań (2, 3, 12, 3, 2) are also cities with the environmental aspect being on a high level; here four of the indicators have high values. Quite a high level is also represented by Łódź and Gdańsk. A low level of the environmental aspect can be observed in Opole (13, 9, 15, 12, 15) and Katowice (12, 11, 13, 13, 16), where all the indicators are low. The city with the lowest rating out of all the assessed ones is Rzeszów (14, 14, 16, 15, 14) – here all the indicators have nearly the lowest values.

Since not all elements influencing the environmental aspect of cities were analyzed, the indicators determined in this paper can be treated as an estimate or simplification of the perspective on the environmental aspect of cities. On the other hand, they provide a resource for making comparisons between the cities and a basis for assessment of improvement or deterioration of the condition of the environment in the cities subjected to analysis.

The thorough analyses are the basis for complementing green infrastructure of a city, as low rating shows that there is a small surface of areas relevant to the environmental aspects. The cities with the lowest rating should undertake actions aimed at improving their environmental aspect by planning, designing and creating various green areas. The detailed regulations of creating the concept by the city council would depend on investment possibilities and the availability of greenfield sites.

Literature

[1] CZARNECKI W., (1961). Planowanie miast i osiedli, Tom II Tereny zielone. *Państwowe Wydawnictwo Naukowe,* Warszawa, Poznań (Cities and residential areas planning, Vol. II Green areas).

[2] ERNST&YOUNG, (2015). *Megatrends 2015*. [online]. [cit. 2018-03-02]. Accessible: http://www.ey.com/Publication/vwLUAssets/ey-megatrends-report-2015/$FILE/ey-megatrends-report-2015.pdf.

[3] FIJAŁKOWSKA J., ALDEA T., (2017). Raportowanie zrównoważonego rozwoju miast a norma ISO 37120. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, no. 478, pp. 174-184. ISSN 1899-3192. DOI: 10.15611/pn.2017.478.16.

[4] HABER Z., URBAŃSKI P., (2010). Kształtowanie terenów zieleni z elementami ekologii. *Wydawnictwo Uniwersytetu Przyrodniczego w Poznaniu*. ISBN 9788371605932.

[5] IVES C.D., OKE C., HEHIR A., GORDON A., WANG Y., BEKESSY S.A., (2017). Capturing residents' values for urban green space: Mapping, analysis and guidance for practice. *Landscape and Urban Planning* (ELS), vol. 161, pp. 32-43. DOI: 10.1016/j.landurbplan.2016.12.010.

[6] JAYASOORIYA V.M., Ng A.W.M., MUTHUKUMARAN S., PERERA B.J.C., (2017). Green infrastructure practices for improvement of urban air quality. *Urban Forestry & Urban Greening*, vol. 21, pp. 34–47. ISSN 1618-8667. DOI:10.1016/j.ufug.2016.11.007.

[7] KIM J., KAPLAN R., (2004). Physical and psychological factors in sense of community new urbanist Kentlands and nearby Orchard Village. *Environment and Behavior,* vol. 36, no. 3, pp. 313-340. DOI: 10.1177/0013916503260236.

[8] KENIGER. L., GASTON K., IRVINE K., FULLER R., (2013). What are the benefits of interacting with nature? *International Journal of Environmental Research and Public Health,* vol. 10, no. 3, pp. 913-935. DOI:10.3390/ijerph10030913.

[9] ŁUKASIEWICZ A., ŁUKASIEWICZ S., (2006). Rola i kształtowanie zieleni miejskiej, *Wydawnictwo Naukowe UAM*, Poznań. ISBN 8323216479.

[10] MAAS J., SPREEUWENBERG P., VAN WINSUM-WESTRA M., A VERHEIJ R., DE VRIES S., GROENWEGEN P., (2009). Is green space in the living environment associated with people's feelings of social safety? *Environment and Planning A* 2009, vol. 41, pp. 1763-1777. DOI:10.1068/a4196.

[11] MALCZYK T., (2012). Zieleń w krajobrazie terenów inwestycyjnych. Oficyna Wydawnicza PWSZ w Nysie. ISBN 978-83-60081-66-2..

[12] MAIN STATISTICAL OFFICE, (2018). *Local Data Bank.* [online]. [cit. 2018-02-22/28]. Accessible: http://www.stat.gov.pl.

[13] REGULATION OF THE MINISTER OF INFRASTRUCTURE of 12 April 2002 r. on conditions which buildings and locations thereof should meet (Journal of Laws from 2015, No 1422 as amended).

[14] SZCZEPAŃSKA, A., SENETRA, A., WASILEWICZ-PSZCZÓŁKOWSKA, M., (2015). The effect of traffic noise on the prices of residential property – A case study of the polish city of Olsztyn. *Transportation Research Part D-Transport and Environment*, vol. 36, pp. 167-177. ISSN 1361-9209. DOI: 10.1016/j.trd.2015.02.011.

[15] SZULCZEWSKA B., KALISZUK E., (2005). Koncepcja systemu przyrodniczego miasta: geneza, ewolucja i znaczenie praktyczne. *Teka Komisji Architektury, Urbanistyki i Studiów Krajobrazowych,* pp.7-24. [online]. [cit. 2018-02-25]. Accessible: http://www.pan-ol.lublin.pl/wydawnictwa/TArch1/Szulczewska.pdf.

[16] SZULCZEWSKA B., (red.) (2015). Osiedle mieszkaniowe w strukturze przyrodniczej miasta. *Wydawnictwo SGGH Warszawa.* ISBN 978-83-7583-604-2.

[17] THE NATURE CONSERVATION ACT of 16th April 2004. (Journal of Laws, 2018, item 142).

[18] ŚWIERCZ A., (2011). Zieleń miejska w systemie przyrodniczym Kielc – kształtowanie i wskaźniki. *Problemy Ekologii Krajobrazu,* T. XXIX, pp. 173-184. ISSN 1899-3850. ISBN 978-83-62089-09-3.

[19] rok wydania: 2011 (City greenery and Kielce natural system - development and indicators. *The Problems of Landscape Ecology Journal*).

[20] WÜSTERMAN H., KALISCH D., KOLBE J., (2017). Access to urban green space and environmental inequalities in Germany. *Landscape and Urban Planning,* vol. 164, pp. 124-131. https://doi.org/10.1016/j.landurbplan.2017.04.002.