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The Quality of the Living Environment versus Natural Factors – the Case Study of Olsztyn

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Abstract. Current social requirements concerning the living environment tend to be more and more related to the natural values of the urban space. People are aware of the fact that contact with nature is extremely important for of mental and physical health. Therefore, the quality of the natural environment around the place of living influences the quality of life. The studies confirm that the presence of natural elements in the urban space may expressly affect the improvement of this quality. An example of a city with high quality of life is represented by Olsztyn, the capital of the Warmian-Masurian Province, located within the borders of the functional area of the Green Lungs of Poland, which is characterized by the particularly valuable quality of its natural environment. This is confirmed by the results of the social Diagnosis dated 2015, which put Olsztyn in 4th place among the largest Polish cities in the ranking concerning the quality of life. It is also influenced by the quality of the natural environment, which in the case of Olsztyn is manifested in a large number of green areas and standing bodies of water located within the administrative borders of the city. The aim of this paper is to compare the quality of the living environment of individual boroughs of Olsztyn conditioned by the natural elements (greenery, bodies of water, air, noise) in relation to the received public opinion polling results.

Keywords: living environment, quality of life, natural factors.

Conference topic: sustainable urban development.

Introduction

People look for a high-quality residential environment because it translates directly to the quality of life. The international idea of the Cittaslow Cities Network – cities of good life – proves best how important this aspect is in the contemporary world. Members of this network are cities which feature sustainable development, where the natural environment of high quality is an important element. Although this network associates small cities (with populations up to 50 thousand), similar actions to improve the city space and the quality of residential environment are also undertaken in larger centres of regional importance. Olsztyn is an example of such a city, the capital city of the Province of Mazury and Warmia. The city's location in the area of the Green Lungs of Poland, the internal structure in the field of land use, and also the city authorities mean that the quality of life resulting from environmental aspects keeps improving. This paper compares the quality of the residential environment of individual districts of Olsztyn conditioned by environmental elements (forests, water, open spaces) by referring to the obtained results of public opinion surveys.

Quality of life vs quality of the natural environment. The goal and subject of studies

The Leipzig Charter on Sustainable European Cities, adopted in 2007, emphasises the necessity of simultaneous and uniform consideration of all sustainable development dimensions, i.e. economic well-being, social equilibrium and a healthy environment. A healthy urban environment comprises both the city's green areas, water bodies, air quality, and the level of noise. Hence, the environmental criteria are among basic elements conditioning the quality of urban space. The environment provides direct benefits to urban societies. Benefits derived by people from nature are called ecosystem services (Mader *et al.* 2011). High-quality ecosystems, efficiently working, provide the basis for the sustainable development of cities because they have a positive impact on human well-being and on the quality of life in the urban environment, and in particular affect health and physical activity (Tian *et al.* 2014; Wolch *et al*. 2014; Hulicka 2015; Vogt *et al*. 2015; Węziak-Białowolska 2016; Pakzad, Osmond 2016; Bertini *et al.* 2016; Kim *et al.* 2016; Rutt, Gulsrud 2016). Hence, the quality of the closest environment is the basic determinant of the quality of life, and the presence of natural elements can help to improve this quality (Schneider-Skalska 2010). Figure 1 presents the relationships between ecosystem services and the quality of life.

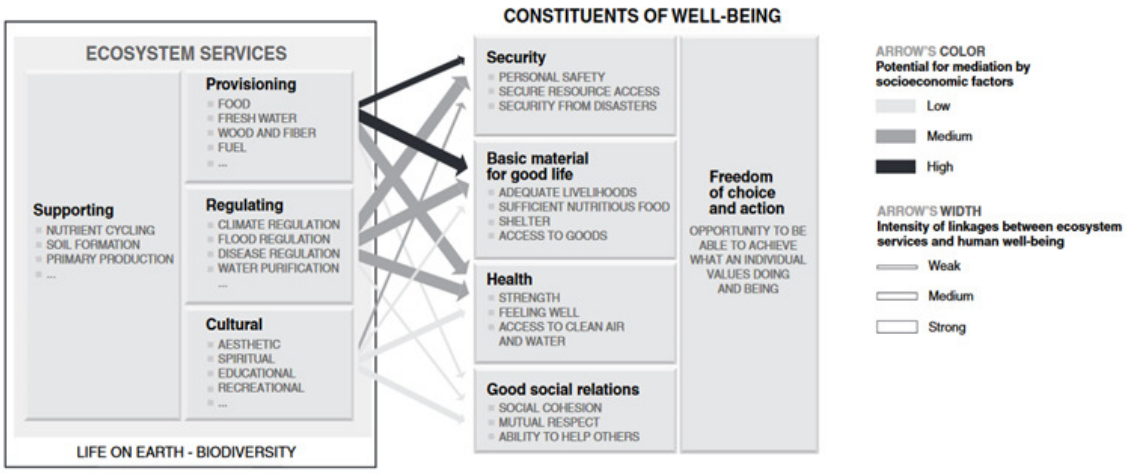

Fig 1. Linkages between Ecosystem Services and Human Well-being
(Source: Hassan 2005: 28)

The quality of life is defined as the whole of the conditions of individual/group life, developing, among other things, in an environmental dimension, which decide about the feeling of satisfying the needs and achieving the life aspirations in the given place and time (Zadrożniak 2016). The quality of life is composed of expectations related to the surrounding space, including the possibility to commune with the natural environment in the vicinity of the place of residence (Michniewicz-Ankiersztajn 2014). As is visible in Figure 1 the ecosystem services affect the quality of life from the point of view of citizens' safety, adequate conditions of life, and health and social relationships. From the point of view of sociology, the quality of life is a premise being the basis for the determination of people's satisfaction with life (Sztumski 2014).

Description of the object of studies

Environmental values of Olsztyn

Olsztyn – a regional centre, the capital of the Province of Warmia and Mazury, being a component of the Green Lungs of Poland. The Green Lungs of Poland comprise the area of northern-eastern Poland (more than 20% of the country's surface). Because of the high natural assets of the area, unique on the European scale, this idea assumes a comprehensive protection of the natural heritage integrated with economic growth and with civilisation progress. In 2015 the area of the city was 8833 ha, of which forests and areas planted with trees and bushes constituted 2111 ha – 23.9% (of which forests 1978 ha – 22.4%), lands under water 850 ha – 9.6% (of which under flowing water 662 ha – 7.5%, under stagnant water – 188 ha – 2.1%), recreational and rest areas 239 ha (2.7%) – which altogether make up 3200 ha (36.2%) (Fig. 2).

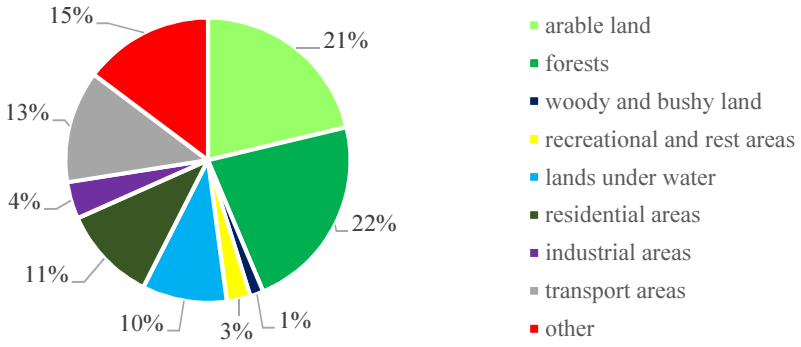

Fig. 2. The structure of land use in Olsztyn
(Source: Authors' own elaboration based on the Land Inventory kept by the Provincial Centre for Geodetic Documentation and Maps in Olsztyn)

It is worth emphasising that within the administrative borders of Olsztyn there are 11 lakes and 3 rivers, which are an extremely valuable element of the landscape, and an asset from the point of view of both nature and tourism and

recreation. The same applies to the City Forest complex, with an area of 1054.7 ha, which is unique on the European scale. Also, significant areas of non-arranged green areas and meadows (219 ha) exist within the city boundaries, most of which are situated in river valleys and in the vicinity of lakes (more than 1590 ha). In various city parts, including the city centre, there are 33 garden allotments (approx. 230 ha – 3% of the total area), which are large green enclaves amid the development (*Studium uwarunkowań*… 2013).

As the above data show, more than 1/3 of the city area constitutes open areas. This translates into high indices for the years 2000 and 2015, illustrating forests and green areas per capita, which continues to be above average for all the provincial cities of Poland (Fig. 3).

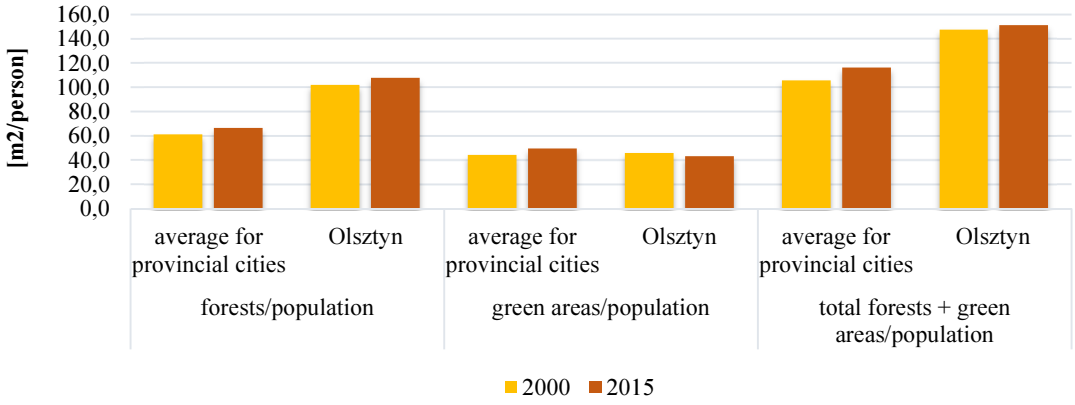

Fig. 3. Forests and green areas per capita in the provincial cities of Poland and in Olsztyn in the years 2000 and 2015 (Source: Authors' own study based on the GUS Bank of Local Data)

Also, the number and the area of parks intended for strolling and recreation have been systematically increasing, as illustrated by Table 1. Apart from the existing ones, the creation of 10 new parks is planned, with an area of 189.7 ha (*Studium uwarunkowań*… 2013). A noticeable shrinking of the surface of residential areas' greenery and of green squares has been an unfavourable trend in recent years, but the city is carrying out compensation planting intended to balance the losses. For example, 1630 trees and 47,964 bushes were planted in 2015.

Table 1. Green areas in Olsztyn in the years 2000 and 2015 (Source: Authors' own study based on the GUS Bank of Local Data)

Year	Parks for strolling and recreation		Green squares		Street greens	Residential areas' greenery
	[number]	[ha]	[number]	[ha]	[ha]	[ha]
2000	10	66.7	45	41.3	112.1	229.9
2015	13	84.43	48	23.35	119.80	206.86

The city area of Olsztyn also comprises legally protected areas – 501.8 ha (5.7% of total area), including nature reserves – 14.8ha (0.1%) and protected landscape areas – 487 ha (5.5%), as well as 17 nature monuments (*Studium uwarunkowań*… 2013).

In the assessment of air quality carried out for 2014 the zone of the city of Olsztyn was classified as C due to the exceeded level of average daily permissible PM10 concentrations. The following should be specified among anthropogenic dust sources: industrial sources (fuel combustion for energy production and process sources), car transport (abrasion dust and airborne dust), fuels combustion in the housing-economic sector. (*Program ochrony powietrza* … 2016). Excessive car transport, in particular in the city centre, additionally causes a growing arduousness of noise due to the increasing number of vehicles and to the heavy transport volume (*Studium uwarunkowań* … 2013). The situation is to be improved by new transport system solutions – the construction of a ring road (under construction) and the modernisation of the public transport structure (the constructed and planned construction of new tram routes, the planned urban rail line, bicycle tracks, new plantings in the insulation green zones at rights-of-way).

Numerous elements of recreation-rest infrastructure have been added in recent years in Olsztyn, especially in the surroundings of lakes and in parks intended for strolling and recreation, and also in residential estates. All this means that the quality of the housing environment, including its natural environment component, is at a very high level in Olsztyn.

Residents' opinions on the quality of life in the city

According to the "*Diagnoza społeczna 2015"* the quality of residents' life in a number of Polish cities, including Olsztyn, has improved in recent years. The percentage of residents who are very satisfied or satisfied with the place of residence for Olsztyn in 2011, 2013, and 2015 was 61.1%, 56.8%, and 67.5%, respectively, which currently ranks it

8th in the country. The overall quality of life index, in the whole samples from the years 2011–2015 for larger cities represented by at least 60 respondents, placed Olsztyn 19th in 2011, 7th in 2013, and 4th in 2015. The increase in the satisfaction with the place of residence coincides with the observations resulting from questionnaire surveys on the residents' opinions on the quality of life in the city.

The report „*Badanie opinii mieszkańców Olsztyna ich problemów i wizji miasta. Raport z badania*" 2016, Olsztyn, emphasises that the greatest advantage of living in Olsztyn is its location and natural assets: forests and lakes provide huge opportunities in the field of quiet rest, active recreation or practising sports. The advantage of living in Olsztyn is undoubtedly close contact with nature, silence, quietness and clean air, free from pollutants. As residents emphasise in their responses (as many as 77%), the possibilities in the field of sports and recreation are getting better and better, As advantages of living in Olsztyn they specify lakes – 45%, green areas/parks – 20%, forests – 20%, landscape/nature – 20%, clean air/ecology – 9%, beaches – 6%, sport/recreation facilities – 5%, bicycle tracks – 2% (8 out of 23 indications). As disadvantages with respect to the environmental-recreational factors they specify: the few bicycle tracks – 3%, noise – 2%, few sport/recreation facilities – 2%, few green areas/parks – 2% (4 out of 26 indications). The respondents also note significant changes for the better in the field of sport and recreation – 76.5% of respondents consider that the situation is becoming increasingly better. This translates into the overall assessment of the quality of life in Olsztyn (Fig. 8). The results of the report show that in the residents' opinion the quality of life has been systematically improving. This is a long-term trend, because as early as in the 2008 report the residents of Olsztyn noticed an improvement in the field of environmental quality and protection, and due to that the assessment of changes proceeding in this field has improved as compared with the 2003 report (*Mieszkańcy Olsztyna – 2008 raport* ...).

Materials and methods

To verify the influence of housing environment quality, conditioned by the existence of natural assets in the city space, on the quality of residents' life, the results of the analysis of the natural attractiveness of individual spatial units have been compared with the results of public opinion surveys on the quality of life. The surveys were carried out according to the Olsztyn administrative division, in accordance with which 23 neighbourhoods were separated, being auxiliary units. Figure 4 presents the Olsztyn administrative division and the city location in the country space, prepared based on the description of the course of boundaries included in Annex 6 to the Statute of the City of Olsztyn and the map made available by the City Hall of Olsztyn.

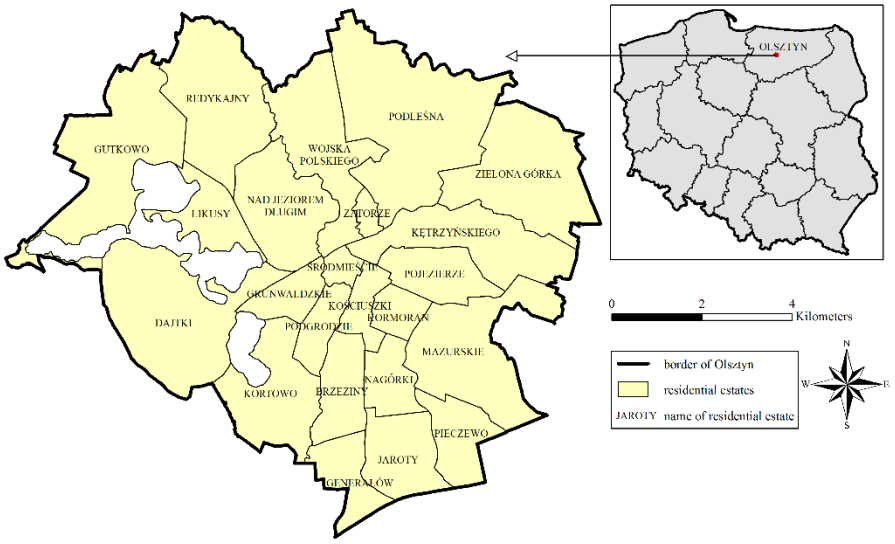

Fig. 4. The administrative division of Olsztyn and its situation in Poland
(Source: Authors' own study based on Annex 6 to the Statute of the City of Olsztyn)

Analyses were carried out in the following stages:

1. Stage I – Selection of indices describing the condition of the natural environment in individual spatial units. To analyse the natural attractiveness of the study area the following indices were determined:
   – the length of the shoreline of lakes situated within individual residential estates, including lakes whose shoreline is at the same time the borderline of the given unit (at the contact length of such objects);
   – the length of water courses (rivers) flowing through a specific estate or constituting its border (at the contact length of such objects);
   – the area of forests per capita of a specific estate;

– the area of open spaces per capita of a residential estate (here: the open space should be understood as arranged and non-arranged green areas, including recreation-rest parks, green squares, residential areas' greenery, as well as areas of meadows, arable farming areas, non-urbanised parts of airfields, and other land covered by grasses and shrubs).

2. Stage II – Construction of the database for the calculation of individual indices of natural environment attractiveness. The database creation procedure was based on the application of advanced spatial analyses allowing us to distinguish individual land use structures and forms within the study units and on the calculation of their length or surface, as appropriate.

3. Stage III – Calculation of the indices described above and presentation of their results in the form of cartograms and cartodiagrams.

4. Stage IV – Standardisation of variables. This process consisted in the normalisation of individual index values using descriptive statistics: the arithmetic mean and the standard deviation, by means of the following formula:

$$Z = \frac{x_{ij} - \overline{x}_j}{S(x_j)}, \tag{1}$$

where: z_{ij} – normalised value of the i-th index in the given spatial unit; x_{ij} – value of the i-th index in the given spatial unit; $\overline{x}_j$ – arithmetic mean of the index value in all spatial units; $S\left(x_j\right)$ – standard deviation of the index value in all spatial units.

5. Stage V – Determination of the natural attractiveness of individual estates by summing up the standardised indices.

$$v_j = \sum_{i=1}^{n} z_{ij}, \tag{2}$$

where: v_j – value of the natural environment in the given spatial unit; z_{ij} – normalised value of the i-th index in the given spatial unit.

6. Stage VI – Illustration of the results of natural attractiveness degree for individual spatial units in the form of a cartogram.

7. Stage VII – Comparison of the results of natural attractiveness degree for individual spatial units with the results of a public opinion survey on the population's quality of life (*Raport z badania opinii*…2016).

The data acquired in the process of spatial analyses performed by means of the ArcGIS 10.3 software were used to study the natural attractiveness degree for individual spatial units. The initial source of information was the Database of Topographic Objects BDOT10k, made available by the Provincial Centre for Geodetic and Cartographic Documentation in Olsztyn. These data were additionally updated by the field inventory control. The results of the public opinion survey on the quality of the population's life in Olsztyn were taken from the publication *Badanie opinii mieszkańców Olsztyna ich problemów i wizji miasta. Raport z badania*. 2016, Olsztyn.

Results of studies

The analysis of the lakes' shoreline length and of the water courses' (rivers') length was carried out to determine the natural attractiveness of individual residential estates of Olsztyn in terms of their access to surface water. Figure 5 presents the results of those analyses. The following estates feature the longest lake shorelines: Gutkowo, Likusy and Dajtki, situated in the northern-eastern part of the city. Their administrative borders partly coincide with the shoreline of the largest Olsztyn lake – Ukiel. Moroever, in the area of those spatial units other natural water reservoirs are also situated, i.e. Lake Redykajny and Lake Tyrsko in Gutkowo, Lake Czarne in Likusy, and Lake Kortowskie in Dajtki. In turn, in residential etstates situated in the central and southern part of the city, a total lack of direct access to the lake shoreline was diagnosed. Referring to the water course length analysis, it has been observed that the longest river beds are situated in the northern part of the city, in residential estates: Podleśna, Wojska Polskiego, Nad Jeziorem Długim, and Redykajny. Apart from the main river axis of the city, which is the Łyna river, its right-bank tributary also flows through it – the Wadąg river. On slightly shorter sections the Łyna river also flows through districts situated in the central and southern-eastern part of Olsztyn.

When performing a collective analysis of the natural attractiveness of individual residential estates of Olsztyn in terms of their access to surface water it has been observed that residential estates situated in the northern and southern-western part of the city feature the best environmental conditions in this field. In turn, the eastern and southern districts (excluding Mazurskie, Kętrzyńskie and Zielona Górka residential estates) feature a lack of access to any surface water.

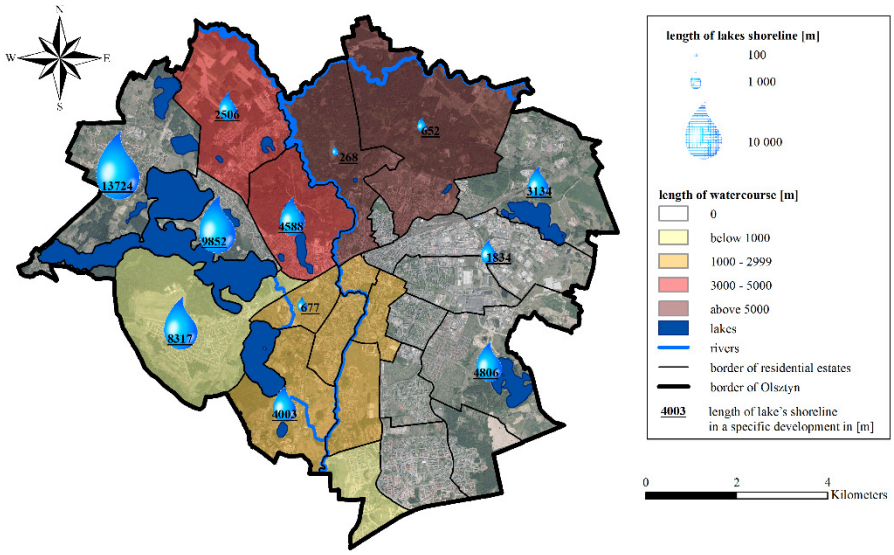

Fig. 5. Water resources in individual residential estates of Olsztyn (Source: Authors' own study)

To determine the natural attractiveness of individual residential estates of Olsztyn in terms of their richness in green areas, forest areas and so-called open space areas per capita of specific residential estatewere analysed. Figure 6 presents the obtained results of studies. The residential estates situated in the northern part of the city feature the largest amount of green areas per capita. City Forest – the largest forest in Europe situated entirely within the administrative borders of a city – is situated in this part of Olsztyn. Moreover, the above area is supplemented by a system of arranged green forms (e.g. recreation-rest parks "Jakubowo", "Park nad Jeziorem Czarnym", Park at Al. Wojska Polskiego, and green squares) and numerous areas of non-arranged green areas. From the considered point of view the residential estates situated in the central and southern part of the city are the areas with the poorest conditions of the natural environment. Those spatial units feature compact residential and service settlements. The system of greenery in those residential estates is created mainly by residential areas' greenery and roadside green areas, and also by a few small city parks of residential-rest character (e.g. Park Podzamcze, Park Centralny, Park Kusocińskiego, and Park Nagórki). No larger forest complexes were found in this part of the urban space (apart from the afforested fragment of the former military firing ground in the Pieczewo residential estate).

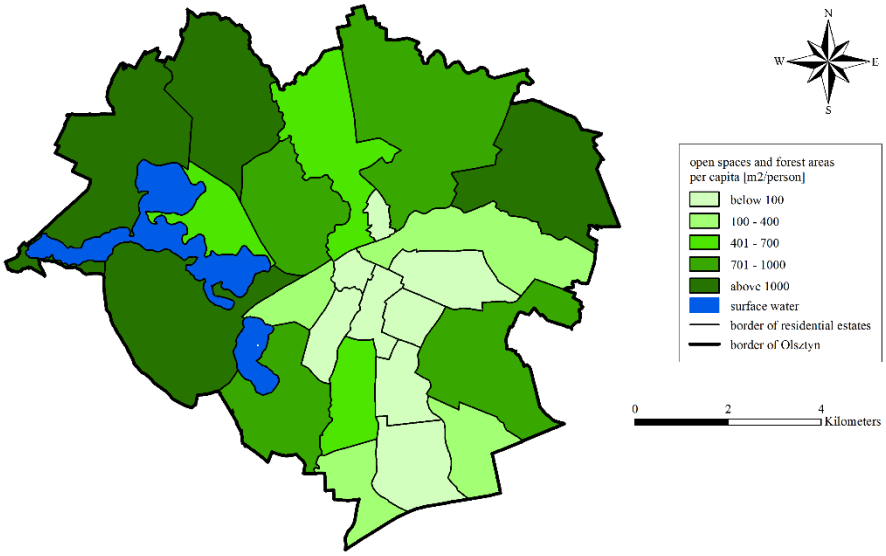

Fig. 6. The area of forests per capita in individual residential estates of Olsztyn (Source: Authors' own study)

The map, presenting the natural attractiveness of individual residential estates of Olsztyn, conditioning the quality of the housing environment, and hence the quality of the population's life in the city, is a synthetic result of the above analyses (Fig. 7). When interpreting the spatial arrangement of the obtained results it is possible to state that in terms of natural attractiveness the area of Olsztyn is divided into two parts: the northern part – featuring high qualities of the natural environment, and the southern part, with poorer natural conditions, where compact city settlement has been

intensively developing. The Zatorze residential estate is a small exception, being a kind of "peninsula" squeezed into the northern, so-called "natural" part of the city, but featuring very poor quality of the natural environment. This is related to the historical development of the city, including the intensification of residential settlements in the vicinity of the newly constructed railway line.

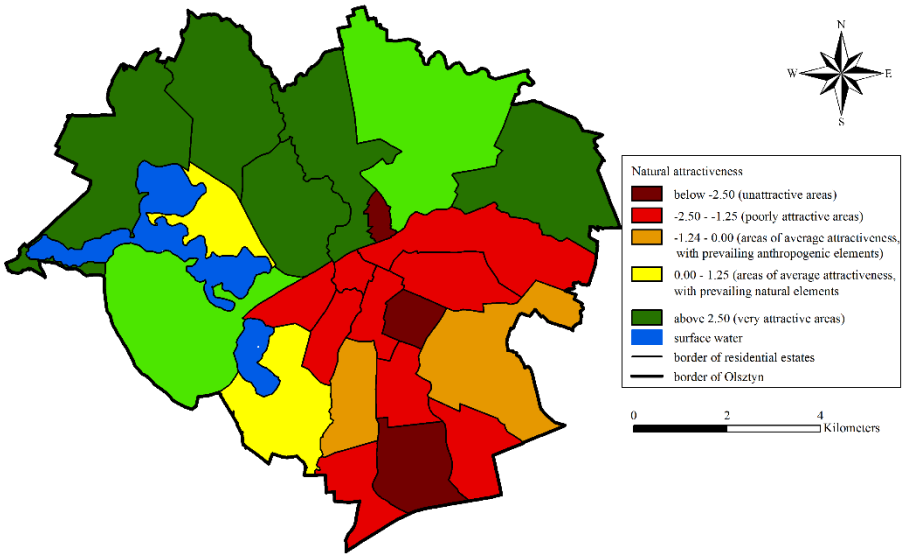

Fig. 7. Natural attractiveness of individual residential estates of Olsztyn (Source: Authors' own study)

Figure 8 presents the results of the overall assessment of the quality of life in Olsztyn, presented in the publication *Badanie opinii mieszkańców Olsztyna ich problemów i wizji miasta. Raport z badania*, 2016. These results are based on the opinion of Olsztyn residents on the quality of life with respect to various conditions: social, economic, transport, spatial, and natural.

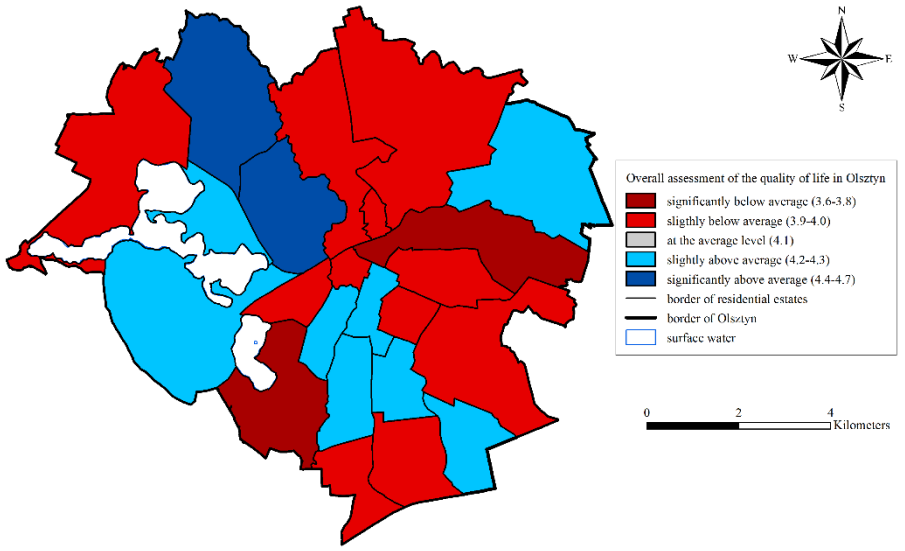

Fig. 8. Overall assessment of the quality of life in Olsztyn (Source: Authors' own study based on *Badanie opinii mieszkańców Olsztyna ich problemów i wizji miasta. Raport z badania*. 2016, Olsztyn).

Comparing the results of analysis defining the natural attractiveness of individual residential estates of Olsztyn with the results of the overall assessment of the quality of life in the city, it is possible to state that in a substantial part of residential estates there is a relatively high degree of correlation between the attractiveness of the natural environment and the level of people's life. In residential estates of high natural qualities, situated in the northern part of the city: Redykajny, Nad Jeziorem Długim, Dajtki, Likusy, and Zielona Górka, the quality of life was defined as significantly or slightly higher than average. Gutkowo, Wojska Polskiego and Podleśna estates are exceptions, where the quality of life is at a level slightly below average. The opinions of residents were most likely affected by the transportation problems of those estates and the low level of safety. In turn, in the southern part of Olsztyn, in a decisive

majority of the studied units, which because of the level of natural attractiveness were classified as "unattractive areas", "poorly attractive areas" or "areas of average attractiveness, with prevailing anthropogenic elements", the quality of life was assessed as significantly or slightly below the average. The following residential estates are exceptions in the southern part of the city: Podgrodzie, Brzeziny, Kościuszki, Nagórki, and Pieczewo, where despite not having the best conditions of the natural environment, the quality of life was defined as slightly above average. This situation could be justified by the fact that these are estates with a high level of safety, with very good transport links to the city centre.

Summary and conclusions

Summing up, the quality of the population's life in the city is determined by many conditions of social, economic, spatial, cultural, environmental, etc. nature. Contemporary social requirements related to the housing environment to an increasingly large degree refer to the natural conditions of the urban tissue. Access to spaces of high quality of the natural environment may become the factor that conditions the high level of the quality of the population's life. The city of Olsztyn is an example confirming such statements. The performed studies show that in a prevailing part of the residential estates of the capital of Warmia and Mazury there is a close correlation between the attractiveness of the natural environment and the level of people's life. Conclusions from these studies may provide preliminary guidelines for town planners and developers in the field of the favourable selection of new housing investments, maintaining a high quality of so-called "natural surroundings", and ensuring a high level of residents' life. At the same time the results show how a housing environment which is attractive in terms of nature, with large areas of residential areas' greenery, with neighbourhood recreation-rest parks, green squares, etc. affects the opinions expressed by residents, thereby showing their preferences in the field of environmental factors in the place of residence.

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