URBAN DESIGN AND SPATIAL PLANNING

URBANISTYKA I PLANOWANIE PRZESTRZENNE

TEKA KOMISJI URBANISTYKI I ARCHITEKTURY
O/PAN W KRAKOWIE
URBANISM AND ARCHITECTURE FILES
OF THE POLISH ACADEMY OF SCIENCES
KRAKÓW BRANCH
TOM L/2022 PL e-ISSN 2450-0038
pp. 189–201 PL ISSN 0079-3450
DOI: 10.24425/tkuia.2022.144850

BARBARA SZULCZEWSKA
Prof. DSc PhD
Institute of Urban and Regional Development
e-mail: bszulczewska@irmir.pl
ORCID: orcid.org/0000-0001-8589-7512

RENATA GIEDYCH
DSc
Warsaw University of Life Sciences
Department of Landscape Architecture
e-mail: renata_giedych@sggw.edu.pl
ORCID: orcid.org/0000-0002-2524-5886

PAULINA LEGUTKO-KOBUS
PhD
Warsaw School of Economics
Department of Public Policy
e-mail: plegut@sgh.waw.pl
ORCID: orcid.org/0000-0003-0380-8913

MAŁGORZATA BLASZKE
PhD
West Pomeranian University of Technology in Szczecin
Real Estate Department
e-mail: malgorzata.blaszke@zut.edu.pl
ORCID: orcid.org/0000-0001-7806-6710

ELŻBIETA WÓJCIK-GRONT
DSc
Warsaw University of Life Sciences
Department of Biometry
e-mail: elzbieta_wojcik_gront@sggw.edu.pl
ORCID: orcid.org/0000-0002-7172-0529

MACIEJ NOWAK
DSc
West Pomeranian University of Technology in Szczecin
Real Estate Department
e-mail: maciej.nowak@zut.edu.pl
ORCID: orcid.org/0000-0001-6437-3226

RATIO OF BIOLOGICALLY VITAL AREA IN LOCAL SPATIAL PLANS AS AN INSTRUMENT OF GREEN INFRASTRUCTURE CREATION IN SINGLE- AND MULTI-FAMILY RESIDENTIAL DEVELOPMENT IN SMALL AND MEDIUM-SIZED TOWNS IN POLAND

WSKAŹNIK POWIERZCHNI BIOLOGICZNIE CZYNNEJ W MIEJSCOWYCH PLANACH ZAGOSPODAROWANIA PRZESTRZENNEGO JAKO INSTRUMENT TWORZENIA ZIELONEJ INFRASTRUKTURY NA OBSZARACH ZABUDOWY JEDNO- I WIELORODZINNEJ W MAŁYCH I ŚREDNICH MIASTACH W POLSCE

ABSTRACT

One of the principles of green infrastructure (GI) design is a multi-scale approach. Each scale requires taking into account various, differently aggregated GI building blocks. Eco-spatial indices are an important tool for implementing GI. These planning tools make it possible to define the proportion between built-up areas and blue-green areas of a project site. The Ratio of Biologically Vital Area (RBVA) is an indicator that is widely used in Polish spatial planning practice. The objective of this study was to determine how the RBVA is shaped in existing local spatial plans for single- and multi-family residential areas in 20 small and medium-sized towns, and to analyse whether and under what conditions the ratio used would guarantee the implementation of GI. The subject of the study were 814 local spatial plans of residential areas. The authors applied a document analysis method using the READ approach. In addition, statistical analyses of the data obtained and a detailed analysis of three selected plans were carried out. The most common ratio for multi-family residential areas was found to be at the level of 30%, while for single-family residential areas, it was 40%. Statistical analysis showed no significant differences between small and medium-sized towns for single-family residential areas.

In turn, considerable differences were observed for multi-family residential areas (RBVA higher in medium-sized towns). The research corroborates that RBVA is a commonly used indicator. However, it guarantees only to a limited extent the possibility of GI implementation at the local scale.

Keywords: spatial planning, green spaces, residential areas

STRESZCZENIE

Jedną z zasad projektowania zielonej infrastruktury (ZI) jest podejście wieloskalowe. Każda skala wymaga wzięcia pod uwagę różnych, inaczej zagregowanych składowych ZI. Wskaźniki ekoprzestrzenne są ważnym narzędziem w realizacji ZI. Owe narzędzia planistyczne umożliwiają zdefiniowanie proporcji między terenem zabudowanym a niebiesko-zielonymi obszarami w obrębie działki zamierzenia budowlanego. Wskaźnik powierzchni biologicznie czynnej (WPBC) jest często stosowany w polskiej praktyce planistycznej. Celem niniejszego badania było ustalenie, jak WPBC został ukształtowany w istniejących planach zagospodarowania dla zabudowy jedno- i wielorodzinnej w 20 małych i średnich miastach, oraz przeanalizowanie, czy i w jakich warunkach wskaźnik ten zagwarantowałby implementację ZI. Obiektem badań było 814 miejscowych planów zagospodarowania w obszarach mieszkaniowych. Autorzy wykorzystali metodę analizy dokumentów READ. Ponadto wykonano analizę statystyczną pozyskanych danych oraz szczegółową analizę trzech wybranych planów. Najbardziej powszechną wartością wskaźnika dla zabudowy wielorodzinnej, jaką zaobserwowano, było 30%, natomiast dla zabudowy jednorodzinnej — 40%. Analiza statystyczna nie wykazała znaczących różnic między obszarami jednorodzinnymi w miastach małych i średnich. Zaobserwowano natomiast znaczące różnice w ramach obszarów wielorodzinnych (WPBC wyższe w miastach średnich). Badanie potwierdziło, że WPBC jest powszechnie stosowanym wskaźnikiem, niemniej tylko w niewielkim stopniu zapewnia on możliwość wprowadzenia ZI w skali lokalnej.

Słowa kluczowe: planowanie przestrzenne, tereny zielone, tereny mieszkaniowe

1. INTRODUCTION

One of the principles of green infrastructure (GI) design is a multi-scale approach. This means that GI needs to be designed at different scales, from global to local one. Each scale requires taking into account various, slightly differently aggregated GI building blocks. At the national and regional scales, the basic building blocks of green infrastructure are ecological networks, at the city/town scale urban green areas, while at the local scale — various types of nature-based solutions (NbS) (green roofs, green walls, bioswales) (Khoshkar, Balfors and Wärnbäck, 2018). Specific GI implementation instruments can be identified for each scale. At the national and regional scale, GI can be implemented through the establishment of protected areas (e.g., the Natura 2000 network), at the city/town scale — through the planning of a system of urban green spaces, while at the local scale — through the determination of specific land development principles.

One of the most important tools for implementing GI at the local scale, which is becoming increasingly widespread, are eco-spatial indices. These planning tools to define the ratio between built-up areas and biologically and hydrologically vital areas, as well as NbS solutions within a plot or other unit. Eco-spatial indices have been used in spatial planning practice since the 1990s (Szulczewska et al., 2014). The Biotope Area Factor, introduced in Berlin in order to improve the urban ecosystem in the central part of the city, is considered a pioneering solution in this regard (Hagen and Stiles, 2010). Similar solutions have also been used in other cities, including Stockholm, Malmö, Oslo, Seattle and London (Ring, Damyanovic and Reinwald, 2021). Over more than thirty years, the concept of eco-spatial indices has evolved considerably. When calculating the factor, in addition to the area of various eco-friendly elements, additional components/characteristics are taken into account, e.g., tree size (Malmö Green Space Factor), the use of drought-resistant species (Seattle Green Factor), as well as the use of tree species with high transpiration capacity in areas prone to flooding (Oslo Blue-Green Factor). One of the common features of the above-mentioned tools is the determination of weights for the individual components and the minimum value of the factor to be achieved for individual land uses (Juhola, 2018). These values are adapted to local conditions and have been developed separately for each of the cities mentioned above.

The Ratio of Biologically Vital Area (RBVA) is an eco-spatial index that is widely used in Polish spatial planning practice (Szulczewska et al., 2014), and can be regarded as a general national standard. Its value is determined in local spatial plans. It should be mentioned that there are currently no common guidelines for determining this value. Research by Szczepański, Mrozik and Raszka, 2014) and Szpura (2021) for individual case studies indicated large discrepancies in the value of the index, resulting from various factors, including failure to take local circumstances and conditions into account.

It is also worth noting that there is currently no specified minimum value of the index to be achieved for individual land uses. This means that, in practice, local spatial plans may not specify the value of the index for land uses. Multi-family residential areas are an exception, for which, according to the current regulations (Rozporządzenie Ministra Infrastruktury z dnia 12 kwietnia 2002 r. w sprawie warunków technicznych, jakim powinny odpowiadać budynki i ich usytuowanie [Regulation of the Minister of Infrastructure of 12 April 2002 on the technical conditions to be met by buildings and their placement], 2012), the RBVA value should be at least 25%. There might be exceptions to this rule. The required value can be changed (practically freely) in local spatial plans.

The problems related to the application of RBVA in Polish spatial planning practice were discussed in numerous publications (Zgierski and Szulczewska, 2009; Szulczewska, Giedych and Solarek, 2015; Stelmach-Fita and Wieczorek, 2019), which mainly involved individual case studies and focused mostly on large cities.

The aim of the research presented in this paper (under the National Science Center research project 'Evaluation of the condition and significance of green infrastructure as a natural and social resource of small and medium-sized towns in Poland') was to examine the RBVA value in the existing local spatial plans for single- and multi-family residential areas in selected small and medium-sized towns, as well as to analyse whether and under what conditions the indicator used would guarantee the possibility of GI implementation at the local scale of single- and multi-family residential areas. The results of the research were interpreted against similar indicators used in other countries.

2. MATERIAL AND METHODS

The research covered 814 local spatial plans (as of the 30th of April 2022) of 20 Polish towns (12 medium-sized and 8 small towns), included in the analysis under the second stage of research of the aforementioned NCN project (tab. 1).

The authors applied a document analysis method using the READ approach — a systematic procedure for collecting documents and gaining information from them (Dalglish, Khalid and McMahon, 2020). In line with the method adopted, the research conducted involved four steps: 1) ready materials; 2) extract data; 3) analyse data; and 4) distil findings.

In step one, local spatial plans of the analysed 20 towns were obtained from the LEX electronic legal information database in the Alfa version, published by Wolters Kluwer Polska. The relevant resolutions were retrieved using the Lex Search engine.

In step two, the acquired local spatial plans for each town were categorized in order to identify those of them for which development or rearrangement of single- and multi-family residential areas is planned. If a plan had arrangements for single- and multi-family residential areas, it was included in both categories. Under this stage, it was also verified which plans had the RBVA value determined and only those that did were included in further analysis. In many plans, the RBVA values differed for individual subdivisions. In such a case, they were analysed separately.

In step three, the RBVA indicator was subjected to statistical analysis in terms of its variation and application, which involved the calculation of mean values, medians, minimum and maximum values and BVA standard deviations. The statistical significance of differences between mean values was carried out using the Student's t-test for a significance level of 0.05. Cluster analysis was used to group the towns in terms of the determined BVA parameters. Cluster analysis was conducted based on Ward's method and square Euclidean distance. All analyses were carried out using Statistica 13 software (see TIBCO Software Inc. Statistica, 2017) . In addition, under this step, an analysis of statistical data from Statistics Poland (GUS) was performed and the percentage of the municipality area covered by local spatial plans was determined.

Following a compilation of the results of the analyses mentioned above, a detailed analysis of the content and drawings of the plans with an exceptionally small or exceptionally large RBVA value was carried out in order to identify the reasons for the solution used.

3. RESULTS

The analysis of the collected material (tab. 1) allowed to establish the following overall categorization of the examined towns:

– 6 towns (including 3 small and 3 medium-sized ones) were covered in 100% by local spatial plans; in 4 towns (1 small and 3 medium-sized ones) the percentage of coverage exceeded 95%;
– the lowest percentage of the area covered by local spatial plans was recorded for the towns of Złotów (17.8%) and Jarosław (16.3%);
– the number of plans in total, identified in the towns under analysis ranged from 7 (in small towns, such as Nowe Miasto Lubawskie — 100% of the

area covered by the plan) and 9 (in medium-sized towns, such as Działdowo — 100% of the area covered by the plan) to 117 (in medium-sized towns, such as Inowrocław — 86.4% of the area covered by the plans); in small towns the largest number of plans (65) was identified for the town of Złotów, where only 17.8% of the area was covered by them.

Table 2 presents a summary of the basic RBVA parameters.

No.	Name of the town	Share of area covered by current local spatial plans in total area (%)	Total number of local spatial plans	Including number of local spatial plans specifying designation for single-family residential areas	Including number of local spatial plans specifying designation for multi-family residential areas
Small towns					
1	Hrubieszów	66.8	54	17	16
2	Kostrzyn nad Odrą	18.2	16	16	14
3	Lidzbark Warmiński	71.7	18	10	9
4	Nowe Miasto Lubawskie	100	7	6	6
5	Radlin	100	38	25	17
6	Rejowiec Fabryczny	100	20	12	5
7	Sławków	99.8	17	14	10
8	Złotów	17.8	65	50	25
Medium-sized towns					
9	Chełm	100	52	43	22
10	Działdowo	100	9	5	2
11	Inowrocław	86.4	117	24	18
12	Jarosław	16.3	36	22	10
13	Mińsk Mazowiecki	100	11	6	6
14	Przemyśl	38.6	71	21	11
15	Suwałki	75.7	76	49	25
16	Szczecinek	79	69	64	31
17	Tarnowskie Góry	94.1	28	26	24
18	Wejherowo	95.2	73	34	27
19	Ząbki	99.6	13	12	9
20	Żory	99.9	29	24	17
Note: the number of analysed plans does not add up to 814, as some of them include arrangements for both single- and multi-family residential areas, in which case they appear twice in the table.					

Tab. 1. Location spatial plans for the towns examined — general summary.
Source: own elaboration; the percentage share of the area covered by the current local spatial plans in the total area according to Statistics Poland (GUS) as of 2021.

	Towns studied	Single-family residential areas							Multi-family residential areas						
		LP	L. RBVA	AM	Me	MIN	MAX	SD	LP	L. RBVA	AM	Me	MIN	MAX	SD
SMALL TOWNS	Hrubieszów	17	25	35.0	30	20	70	11.5	16	64	24.4	20	5	50	10.5
	Kostrzyn nad Odrą	16	27	42.4	40	15	60	9.5	14	17	33.5	35	20	50	8.2
	Lidzbark Warmiński	10	44	45.7	50	20	60	11.2	9	14	40.0	43	25	50	10.0
	Nowe Miasto Lubawskie	6	48	41.5	40	20	50	7.0	6	20	25.8	28	10	40	8.0
	Radlin	25	34	49.4	50	40	60	8.1	17	21	40.7	40	35	50	5.1
	Rejowiec Fabryczny	12	19	40.3	40	25	60	10.6	5	9	35.6	40	30	40	5.3
	Sławków	14	24	32.3	40	10	50	11.6	10	14	19.3	20	10	30	7.3
	Złotów	50	92	40.7	40	0	85	13.9	25	40	24.4	20	10	40	7.0
MEDIUM-SIZED TOWNS	Chełm	43	64	34.3	30	10	60	14.6	22	45	24.0	25	10	50	9.7
	Działdowo	5	23	50.7	50	40	60	3.8	2	8	30.6	30	25	40	6.2
	Inowrocław	24	48	38.4	40	20	55	9.7	18	38	31.1	30	0	45	10.3
	Jarosław	22	58	37.4	40	10	60	9.6	10	22	22.5	20	5	40	11.1
	Mińsk Mazowiecki	6	32	32.0	35	5	60	12.9	6	17	28.5	25	5	40	9.5
	Przemyśl	21	37	40.9	40	10	60	13.7	11	20	22.5	20	5	50	12.7
	Suwałki	49	109	42.6	40	20	60	7.7	25	47	25.3	25	10	40	7.0
	Szczecinek	64	124	42.4	40	25	60	7.1	31	102	21.5	20	5	40	7.2
	Tarnowskie Góry	26	42	44.8	45	10	60	10.7	24	33	28.5	30	10	35	6.8
	Wejherowo	34	58	42.3	40	0	80	17.2	27	45	20.6	20	0	50	14.1
	Ząbki	12	17	45.9	50	30	50	6.9	9	11	30.5	30	25	40	5.2
	Żory	24	30	39.8	40	25	50	7.2	17	23	30.9	30	10	40	7.9

Tab. 2. Basic RBVA parameters in the analysed local spatial plans; number of plans (LP), number of RBVA indicators (L. RBVA), mean (AM), median (Me), minimum (MIN), maximum (MAX) and standard deviation (SD) for the RBVA indicator in the surveyed plans. By the authors.

The smallest number of local spatial plans with land use intended for single-family and multi--family residential areas was found for the town of Działdowo (5 and 2, respectively, out of 9 plans in total for the town), while the highest number — for the town of Szczecinek (64 and 31 — out of 79 plans in total for the town).

The smallest mean RBVA in a single-family residential area was observed for Mińsk Mazowiecki (32%) (it is worth mentioning that the minimum value of the index specified in the plans for this type of development was 5%, and the maximum was 60%), while the highest one — for Działdowo (50.7%; with little variation between individual plans: from 40 to 60%). For multi-family residential areas, the smallest mean RBVA was found for the town of Sławków (19.3%; with little variation between individual plans: from 10% to 30%), while the largest one — for Radlin (40.7%; with little variation between individual plans: from 35 to 50%).

Further statistical analyses in this regard identified that the smallest RBVA median for single--family residential areas was observed for Hrubieszów (30%) and the largest one — for Lidzbark Warmiński (50%). For multi-family residential areas, the smallest RBVA median was recorded for Hrubieszów (20%), while the largest one — for Lidzbark Warmiński (42.5%).

Analysis of the plans for single-family residential areas found the smallest and largest RBVA value for the town of Złotów (0% and 85%, respectively). For multi-family residential areas, the smallest RBVA was for Inowrocław (0%), while the largest one for Radlin (90%).

The smallest RBVA variation for single-family residential areas was observed for Działdowo (standard deviation was 3.8 — RBVA value in individual plans ranged from 40% to 60%), while the largest one — for Wejherowo (standard deviation was 17.2 — RBVA value in individual plans ranged from 0% to 80%). In the case of multi-family residential areas, the smallest RBVA variation was for Radlin (standard deviation was 5.1 — RBVA value in individual plans ranged from 35 to 50%), while the largest one — for Wejherowo (standard deviation was 14.1 — RBVA value in individual plans ranged from 0% to 50%).

Statistical analysis showed no significant differences for the RBVA parameter between small and medium-sized towns for single-family residential areas. Statistically significant differences (Student's *t*-test, $p < 0.01$) were, however, observed for the RBVA parameter between small and medium-sized towns for multi-family residential areas.

Interesting findings were provided by a summary showing the frequency of occurrence of different RBVA values in the examined plans (tab. 3).

RBVA	Abundance in single-family residential areas	Abundance in multi-family residential areas
0	2 (1 small, 1 medium-sized)	2 (0 small, 2 medium-sized)
5	1 (0 small, 1 medium-sized)	13 (3 small, 10 medium-sized)
10	13 (3 small, 10 medium-sized)	68 (10 small, 58 medium-sized)
15	9 (3 small, 6 medium-sized)	12 (7 small, 5 medium-sized)
20	45 (16 small, 29 medium-sized)	146 (58 small, 88 medium-sized)
25	31 (6 small, 25 medium-sized)	89 (15 small, 74 medium-sized)
30	129 (44 small, 85 medium-sized)	154 (48 small, 106 medium-sized)
35	31 (8 small, 23 medium-sized)	26 (10 small, 16 medium-sized)
40	337 (118 small, 219 medium-sized)	71 (31 small, 40 medium-sized)
45	14 (1 small, 13 medium-sized)	7 (2 small, 5 medium-sized)
50	263 (79 small, 184 medium-sized)	22 (15 small, 7 medium-sized)
55	3 (0 small, 3 medium-sized)	0 (0 small, 0 medium-sized)
60	64 (28 small, 36 medium-sized)	0 (0 small, 0 medium-sized)

RBVA	Abundance in single-family residential areas	Abundance in multi-family residential areas
65	2 (0 small, 2 medium-sized)	0 (0 small, 0 medium-sized)
70	7 (4 small, 3 medium-sized)	0 (0 small, 0 medium-sized)
75	1 (0 small, 1 medium-sized)	0 (0 small, 0 medium-sized)
80	2 (1 small, 1 medium-sized)	0 (0 small, 0 medium-sized)
85	1 (1 small, 0 medium-sized)	0 (0 small, 0 medium-sized)

Tab. 3. Number of plans with a specific value of the indicator. By the authors.

The summary presented above shows that in the case of single-family residential areas, the most common RBVA value was 40% (this was the case for 141 plans, 42 in small towns and 99 in medium-sized towns, the total number of RBVA indicators being 337, 118 in small towns and 219 in medium-sized towns). In the case of multi-family residential areas, the most common RBVA value was 30% (this was the case for 84 plans, 12 in small towns and 72 in medium-sized towns, the total number of RBVA indicators being 154, 48 in small towns and 106 in medium-sized towns). RBVA above 40% was recorded only in 29 cases out of a total number of indicators of 610 for multi-family residential areas. In this category, no plans had an indicator of 55, 60, 65, 70, 75, 80, or 85% (zero observations). For multi-family residential areas, RBVA of 25% (the legal minimum) or higher was specified 369 times (121 times in small towns and 248 times in medium-sized towns).

A comparison of RBVA values for residential areas in small and medium-sized towns (Tab. 4) corroborates significant differences. In the case of small towns, the mean RBVA values are slightly higher for both single- and multi-family residential areas. The coefficients of variation (i.e., variation in RBVA) in small and medium-sized towns are higher for multi-family residential areas than for single-family ones.

The results of the cluster analysis, whereby the cities were grouped in terms of the number of plans, mean, median, minimum, maximum and standard deviation for single-family and multi-family residential areas, are presented in ill. 1.

The cluster analysis allowed to identify three groups of towns. The towns in each group are similar in terms of the parameters taken into account, i.e., the number of RBVA indicators, mean, median, minimum, maximum and RBVA variation for single-family and multi-family residential areas.

The first group includes the towns of Suwałki, Złotów and Szczecinek. These towns had the highest number of RBVA indicators for single-family residential areas (from 92 to 124). They all had a median RBVA for single-family residential areas of 40% and a fairly high maximum RBVA of 60 and 85% for this

RBVA	Single-family residential areas		Multi-family residential areas	
	Small towns	Medium-sized towns	Small towns	Medium-sized towns
mean	41.5	40.7	28.3	25.6
median	40	40	30	25
coefficients of variation	29%	28%	38%	44%
minimum	0	0	5	0
maximum	85	80	50	50

Tab. 4. Comparison of RBVA values in small and medium-sized towns. By the authors.

type of development. They also featured a high number of RBVA indicators for multi-family residential areas (from 40 to 102). The maximum RBVA value for multi-family residential areas was 40% for all the towns in question.

The second group includes the towns of Działdowo, Kostrzyn nad Odrą, Lidzbark Warmiński, Radlin, Rejowiec Fabryczny and Ząbki. They were characterized by high mean (40.3 to 50.7%) and median (40 to 50%) RBVA values for single-family residential areas. They also featured the highest minimum RBVA values (from 15 to 40%) and an almost identical maximum RBVA value of 60% (only Ząbki had a value of 50%) for single-family residential areas. These towns have a low number of RBVA indicators for multi-family residential areas (from 8 to 21). Mean (from 30.5 to 40.7%), median (from 30 to 42.5) and minimum RBVA values (from 20 to 35%) for multi-family residential areas were high for these towns. The towns also have the smallest standard deviations (variation) of RBVA values for multi-family residential areas (from 5.1 to 10).

The third group includes the largest number of towns: Chełm, Hrubieszów, Inowrocław, Jarosław, Mińsk Mazowiecki, Nowe Miasto Lubawskie, Przemyśl, Sławków, Tarnowskie Góry, Wejherowo and Żory. The minimum RBVA values (from 0 to 10) for multi-family residential areas were the lowest for this group. In addition, these towns were characterized by large variation in RBVA values in single-family (from 7.0 to 17.2%) and multi-family residential areas (from 7.3 to 14.1%).

Based on the analysis of the research results presented above concerning the number of plans, the degree of coverage of the surveyed towns, as well as the value, variation and distribution of the RBVA used, 3 plans were identified for further analysis. Their detailed investigation helped to gain deeper insight into the issue of RBVA as an instrument for GI implementation at the local scale.

Case 1: circumstances from the 2000s

The local spatial plan, adopted in 2002 for the whole town of Działdowo, does not specify the minimum RBVA value. This is due to the fact that the general obligation to use RBVA in spatial plans was introduced in 2003, in connection with the entry into force of new spatial planning regulations. For this reason, despite the fact that the entire town is covered by local spatial plan, currently this indicator is determined only for those parts of the town for which the 2002 plan amendment was drawn up. A similar situation exists in Chełm.

Case 2: hidden bonus

In the local spatial plan from 2017 for a fragment of the town of Wejherowo for the road connector from the integration node in the area of railway station to Łęgowskiego Street for the existing multi-family residential areas, the RBVA was set at a fairly low level of 10%. At the same time, for selected areas, the plan indicated the need to protect existing greenery (ill. 2). In this case, for a part of the site, the size of the RBVA was specified at 70%. In the area C.5.MW shown in ill. 2, on about 40% of the site, the size of the RBVA is set at 70%. In the rest of the area, it remained at 10%. As a result, the size of RBVA for the area C.5.MW was higher than the basic minimum established in the plan.

Case 3: densely built-up but green

Low RBVA value does not always entail high density of residential development. In the local spatial plan for Złotów, an interesting provision was made for single-family residential areas in the section of the town located on Lake Burmistrzowskie concerning a high percentage share of RBVA. The existing residential areas were divided into two areas with different intended use and principles of land development: single-family residential areas (MN) and green areas (ZO). Different RBVA values have been used for these areas (ill. 3), 30% and 90% respectively.

4. DISCUSSION

The starting point for the discussion on the use of the RBVA indicator as an instrument supporting the creation of green infrastructure at the local scale (in this case, of a residential area or an urban block) are three issues.

- The current legislation (see the Introduction) stipulates that for multi-family residential areas, the RBVA should be minimum 25%, whereby BVA is understood as an area with a surface arranged in such a way so as to ensure natural vegetation of plants and retention of rainwater, as well as 50% of the surface of terraces and flat roofs with such a surface and other surfaces enabling natural vegetation of plants, with an area of at least 10 m^2, and surface water within this area (pursuant to the Regulation of 14 November 2017 amending the Regulation on the technical conditions to be met by buildings and their location of 2002; see Rozporządzenie Ministra Infrastruktury z dnia 12 kwietnia 2002 r. w sprawie warunków technicznych, jakim powinny odpowiadać budynki i ich usytuowanie, 2002).

- A ratio of approximately 45% (between 40 and 50%) ensures relatively proper functioning of the natural environment (retention, air exchange, enclaves ensuring the survival of small animal species) in multi-family residential areas (Szulczewska et al., 2014). Although it should be stressed that the study did not take into account NbS-type solutions, currently widely recommended for densely built-up areas, as they were not present in the examined residential areas.
- The use of various NbS in the shaping of eco-spatial indices in cities abroad (see the Introduction) offers much greater possibilities compared to the simplified approach in the case of the Polish RBVA indicator.

Based on the aforementioned findings, it should be noted that among the examined RBVA indicators, there are some (237 out of 610 examined for multi-family residential areas) in which the RBVA indicator is below the recommended threshold of 25%, with 429 out of 610 being characterized by an indicator value of 25–40% (including 89 at the level of 25%), which is lower than what is considered sufficient for the proper functioning of the natural environment within the developed area, which also translates into the quality of life of the residents thereof. Naturally, it should be noted that what is of key importance is not only the proportion of BVA, but also the way in which the residential area or urban block is developed (the plant species used, especially trees), the wider spatial context (vicinity of a park, forest, other open areas or built-up land), as well as the way in which the residential area is linked to it (prevalence of gated communities, also through the spatial configuration of buildings). However, a low percentage share of BVA (including the recommended 25%), gives little leeway as to the development of multi-family residential areas that would be both nature- and resident-friendly (Szulczewska et al., 2014). Currently, many of the indicators developed for individual towns take into account the aforementioned NbS solutions to improve the functioning of the natural environment (Ring, Damyanovic and Reinwald, 2021). However, their actual effectiveness of eco-spatial indices have not yet been studied in a comprehensive way. Since they are designed individually for each town, comparative analysis might be difficult.

The issue of RBVA in single-family residential areas has not been studied as widely as in the case of multi-family residential areas, so it would be risky to extrapolate recommendations concerning the desired RBVA from such data. It should be noted that the differences in the indicators used between single-family and multi-family residential areas are not statistically significant, although there is a clear tendency to use slightly higher RBVA values for the former. These areas, usually in the form of home gardens, are important, since in the case of medium-sized and small towns they constitute a significant component of residential development and, hence, also a significant component of the GI at the town scale. Their functioning as a component of the town's GI has not yet been studied. It can, however, be assumed that while the natural value of home gardens will vary, depending primarily on the design and management thereof, the plant species and NbS solutions used, their social value, important for the full implementation of the GI concept, will be negligible, unless communal spaces are designed within single-family residential areas.

The results of the research also indicate some differences in the application of RBVA for small and medium-sized towns. In general, lower RBVA values are used in medium-sized towns for both multi-family and single-family residential areas. This trend is also characteristic of attempts to set a standard for towns of different sizes (see: Krajowe przepisy urbanistyczne. Projekt…, 2010; Ziobrowski, 2012).

The results of the cluster analysis, although showing similarities between towns, do not allow for identification of the general trends of RBVA application. They point to an incidental nature of the decisions taken, which are probably also based on the existing state. This thesis is corroborated by the results of the analysis of specific cases, which show that the authors of the plans tried to creatively solve problems arising either from the formal-legal aspects or from the spatial or natural context.

The indicators discussed in this paper also need to be examined in the context of the 'compact city' concept, which has been recommended for a long time, but has recently started to attract greater attention due to the worsening climate crisis, to which cities and towns contribute significantly, being responsible for 60–70% of energy consumption and 75% of carbon emissions (Zespół Doradczy ds. Kryzysu Klimatycznego przy Prezesie PAN, 2021). Compact, multi-functional land development is supposed to reduce transport needs, leading to the reduction of exhaust gases released, as well as fuel consumed. It is also supposed to lead to a decrease in energy needs (by shortening transmission networks). However, while compact cities can help to mitigate and minimize the pace of climate change, they may also result in problems with adaptation to the consequences thereof. It should be noted that small and medium-sized towns, by definition, are the best for implementation of the compact city concept, as they are less affected by the disadvantages associated with the vast, densely built-up areas of large cities. Hence, it would be reasonable to reanalyse recommendations that have been put forward in Poland, to adopt small RBVA values for large cities and larger values for smaller towns (Krajowe przepisy urbanistyczne. Projekt…, 2010; Ziobrowski, 2012). Perhaps the reverse would be more appropriate, at least for residential areas. Naturally, consideration should be given to the existing circumstances of the built-up areas layout in individual towns.

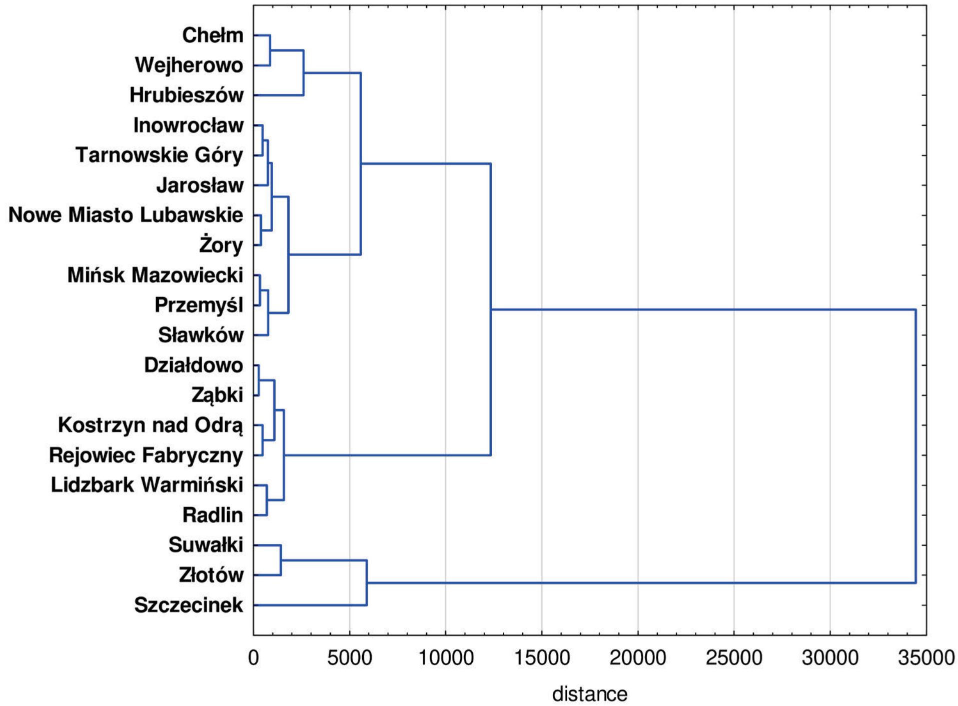
5. CONCLUSIONS

RBVA is an eco-spatial indicator that is widely used in the planning of spatial development of small and medium-sized towns. Its value ranges around 40% (median) for single-family residential areas in both small and medium-sized towns and 30% for multi-family residential areas in small towns and 25% in medium-sized towns.

The possibility of using this indicator as an instrument for GI development is limited, especially in the case of multi-family residential areas due to its excessively low value, which does not allow for the development of the space (multi-family residential areas) in a manner that is conducive to the proper functioning of the natural environment and thus increasing the quality of residents' life. In addition, the way in which spatial planning policy is implemented through the development of local spatial plans of an interventionist nature (plans for several plots of land, plans for specific projects or numerous minor adjustments of the plan, when the plan for the entire town is in force) does not favour the proper use of the RBVA tool, although there are examples of creative interventions.

The introduction of eco-spatial indices of a similar nature to those currently used in European cities is a solution worth considering, especially in the face of recommendations for the development of compact cities and the need for cities to adapt to the consequences of climate change. It should be noted, however, that those solutions were prepared for specific large cities, considered as eco-leaders, which in the case of Polish small and even medium-sized towns is not feasible due to limited resources. Such solutions would have to be established at the national or regional level.

The research presented in this paper is quantitative in nature. It analyses the scale of the solution used in the examined towns. Little reference is made to the solutions adopted in individual plans, apart from three specific cases. The next stage of research will involve qualitative survey designed to establish the predominant use of green spaces and gardens in single-family residential areas in terms of their role as a GI component at the local scale and to determine the importance of auxiliary spaces of residential areas as a GI component at the city/town scale.



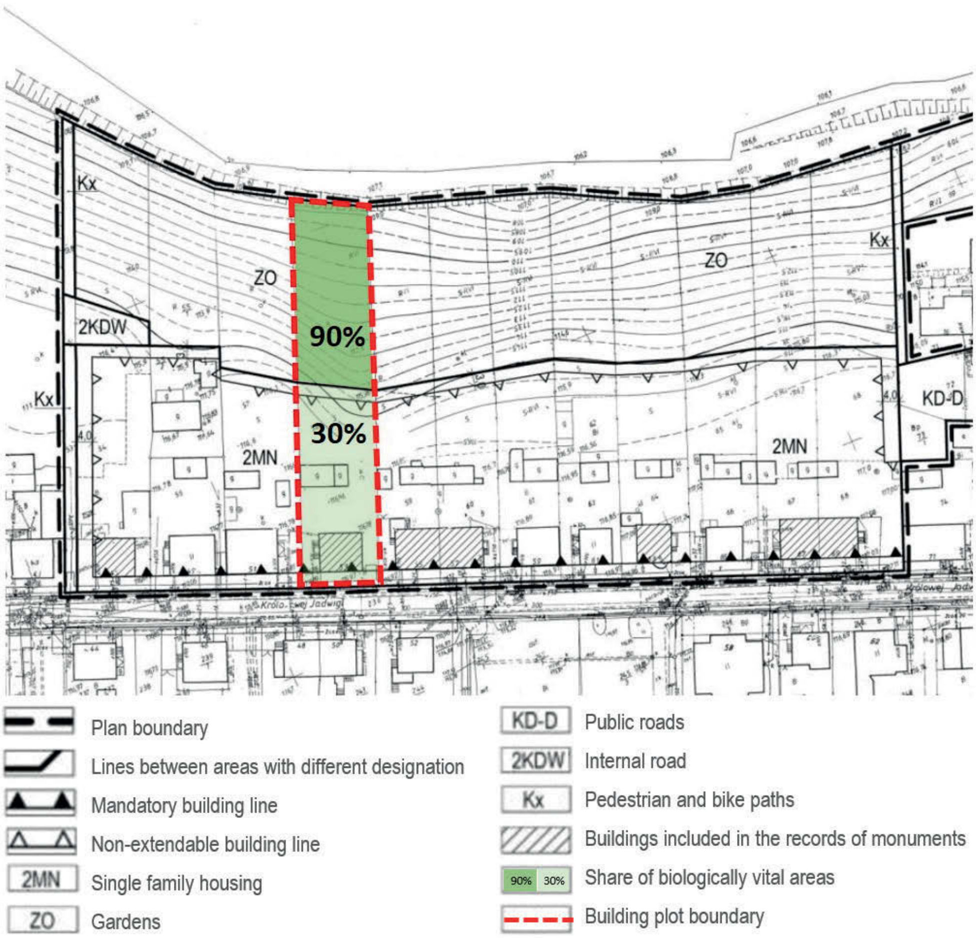
Ill. 1. Clustering of towns in terms of the number of RBVA indicators, mean, median, minimum, maximum and RBVA variation for single-family and multi-family residential areas. By the authors.

Il. 1. Klasteryzacja miast w zależności od liczby WPBC, średniej mediany, minimum i maksimum oraz zróżnicowania WPBC dla obszarów mieszkalnych jedno- i wielorodzinnych. Opracowanie własne.

Ill. 2. Possibility of increasing RBVA value within areas with valuable greenery. Original work based on the drawing of the plan.

Il. 2. Możliwość zwiększenia wartości WPBC na obszarach z wartościową zielenią. Opracowanie własne na podstawie rysunku planu.

Source/źródło: (Uchwała Nr VIIk/XXXVI/424/2017 Rady Miasta Wejherowa…, 2017, p. 32).



Ill. 3. Principle of introducing high RBVA in single-family residential areas. Original work based on the drawing of the plan.

Il. 3. Zasada wprowadzania wysokiego WPBC na obszarach mieszkaniowych jednorodzinnych. Opracowanie własne na podstawie rysunku planu.

Source/źródło: (Uchwała Nr XXIV.170.2016 Rady Miejskiej w Złotowie…, 2016, p. 6).

REFERENCES

Besser, A. (2018), ‘Ochrona i kształtowanie środowiska miejskiego na przykładzie miejscowego planu zagospodarowania przestrzennego dla obszaru miasta Świdnica — osiedle Zawiszów’, *Przestrzeń Urbanistyka Architektura*, 1, pp. 239–253. Available at: https://doi.org/10.4467/00000000PUA.18.017.8625 (accessed: 07.07.2022).

Dalglish, S.L., Khalid, H. and McMahon, S. (2020), ‘Document Analysis in Health Policy Research: The READ Approach’, *Health Policy Plan*, 35, pp. 1424–1431. Available at: https://doi.org/10.1093/heapol/czaa064 (accessed: 07.07.2022).

Hagen, K. and Stiles, R. (2010), ‘Approaches from Landscape Architectural Point of View. Towards a Sustainable and Diverse Urban Space Planning’, [in:] Müller, N., Werner, P. and Kelcey, J.G. (eds.), *Urban Biodiversity and Design*, Chichester–Hoboken: Wiley-Blackwell Publishing, pp. 580–582.

Juhola, S. (2018), ‘Planning for a Green City. The Green Factor Tool’, *Urban Forestry & Urban Greening*, 34, pp. 254–258. Available at: https://doi.org/10.1016/j.ufug.2018.07.019 (accessed: 07.07.2022).

Khoshkar, S., Balfors, B. and Wärnbäck, A. (2018), ‘Planning for Green Qualities in the Densification of Suburban Stockholm — Opportunities and Challenges’, *Journal of Environmental Planning and Management*, 61(14), pp. 2613–2635. Available at: https://doi.org/10.1080/09640568.2017.1406342 (accessed: 20.06.2022).

Krajowe przepisy urbanistyczne. Projekt z dnia 17 sierpnia 2010 r. (2010). Available at: https://grafik.rp.pl/grafika2/572896 (accessed: 11.07.2022).

OECD (2012), ‘Compact City Policies: A Comparative Assessment’, *OECD Green Growth Studies*, 14.05.2012. Available at: https://www.oecd.org/cfe/regionaldevelopment/50524895.pdf (accessed: 02.07.2022).

Ring, Z., Damyanovic, D. and Reinwald, F. (2021), ‘Green and Open Space Factor Vienna: A Steering and Evaluation Tool for Urban Green Infrastructure’, *Urban Fo-*

restry & Urban Greening, 62, 127131. Available at: https://doi.org/10.1016/j.ufug.2021.127131 (accessed: 16.07.2022).

Rozporządzenie Ministra Infrastruktury z dnia 12 kwietnia 2002 r. w sprawie warunków technicznych, jakim powinny odpowiadać budynki i ich usytuowanie (2002), Dz.U. 2022, item 1225 (Legal status current as of: 30.07.2022).

Stelmach-Fita, B. and Wieczorek, A. (2019), 'Problemy z ocenianiem zgodności z prawem miejscowych planów zagospodarowania przestrzennego: definicje pojęć powierzchnia zabudowy i powierzchnia całkowitej zabudowy', *Metropolitan. Przegląd Naukowy*, 11(1), pp. 50–59.

Szczepański, P., Mrozik, K. and Raszka, B. (2014), 'Wskaźnik powierzchni biologicznie czynnej jako narzędzie równoważenia struktury przestrzennej gminy miejskiej Luboń', *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, 339, pp. 220–228. Available at: https://doi.org/10.15611/pn.2014.339.20 (accessed: 30.07.2022).

Szpura, A. (2021), 'Kształtowanie wskaźnika minimalnej powierzchni biologicznie czynnej w dokumentach planistycznych na przykładzie gminy Chrzanów', *Urban Development Issues*, 72, pp. 136–148. Available at: https://doi.org/10.51733/udi.2021.72.13 (accessed: 05.06.2022).

Szulczewska, B. et al. (2014), 'How Much Green Is Needed for a Vital Neighbourhood? In Search for Empirical Evidence', *Land Use Policy*, 38, pp. 330–345. Available at: https://doi.org/10.1016/j.landusepol.2013.11.006 (accessed: 07.07.2022).

Szulczewska, B., Giedych, R. and Solarek, K. (2015), 'Problemy stosowania wskaźnika terenów biologicznie czynnych na tle wyników badań — podsumowanie', [in:] Szulczewska, B. (ed.) *Osiedle mieszkaniowe w strukturze przyrodniczej miasta*, Warszawa: Wydawnictwo SGGW, pp. 141–148.

TIBCO Software Inc. Statistica (Data Analysis Software System) (2017), *Version 13*, Palo Alto: TIBCO Software Inc. Available online: www.statsoft.com (accessed: 30.06.2022).

Uchwała Nr VIIk/XXXVI/424/2017 Rady Miasta Wejherowa z dnia 12 września 2017 r. w sprawie uchwalenia zmiany miejscowego planu zagospodarowania przestrzennego miasta Wejherowa dla łącznika drogowego od węzła integracyjnego w rejonie dworca PKP Wejherowo do ul. Łęgowskiego wraz z przyległymi obszarami (2017), Dz. Urz. Woj. Pom. 2017 item 3767.

Uchwała Nr XXIV.170.2016 Rady Miejskiej w Złotowie z dnia 28 grudnia 2016 r. w sprawie miejscowego planu zagospodarowania przestrzennego miasta Złotowa w rejonie położonym między ul. Królowej Jadwigi (lewa strona ulicy od budynku nr 45 do torów kolejowych) a Jeziorem Burmistrzowskim (2016), Dz. Urz. Woj. Wlkp. 2017 item 121.

Uchwała Nr XXXVI/445/02 Rady Miejskiej w Działdowie z dnia 24 maja 2002 r. w sprawie miejscowego planu zagospodarowania przestrzennego miasta Działdowo (2002). Dz. Urz. Woj. Warm.-Maz. 2002 item 1166.

Zespół Doradczy ds. Kryzysu Klimatycznego przy Prezesie PAN (2021), *Komunikat 04/2021 interdyscyplinarnego Zespołu doradczego do spraw kryzysu klimatycznego przy prezesie PAN na temat zagrożeń miast wobec kryzysu klimatycznego*. Available at: https://klimat.pan.pl/wp-content/uploads/2021/10/komunikat_4_zespolu_ds_kryzysu_kliamtycznego_pan.pdf (accessed: 20.06.2022).

Zgierski, K. and Szulczewska, B. (2009), 'Wskaźnik terenów biologicznie czynnych jako instrument kształtowania przestrzeni w miejscowych planach zagospodarowania przestrzennego miasta stołecznego Warszawy', *Biuletyn KPZK PAN*, 240, pp. 108–124.

Ziobrowski, Z. (2012), *Urbanistyczne wymiary miast*, Kraków: Instytut Rozwoju Miast.

The article is the result of the research project entitled Evaluation of the condition and significance of green infrastructure as a natural and social resource of small and medium cities in Poland, No. 2019/35/B/HS4/04221, funded by the National Science Center.