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Characteristics of Residential Areas in Krakow Functional Urban Area

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ABSTRACT

Urban sprawl is an unfavourable phenomenon not only in economic terms, but also due to the social and spatial effects. The failure to implement a coherent spatial policy in suburban areas may result in a chaotic distribution of residential buildings and cause spatial disorder. The main aim of this study is to present the classification of residential housing in the Krakow Functional Urban Area (FUA). Another objective of the study is to analyse the distribution of residential buildings in selected area. Moreover, it has been hypothesized that the chaotic suburbanization causes an uneven distribution of residential buildings in Krakow FUA. The urban transect method was selected to illustrate the spatial distribution of residential buildings in this area. Additionally, GIS analyses were performed based on official spatial data describing the location and type of residential buildings. Thanks to the combination of both methods, a classification of residential housing and its spatial distribution in Krakow FUA were presented. The analysis of the results obtained leads to the conclusion that the suburbanization process in Krakow FUA is characterized by a significant dominance of single-family housing. The result of chaotic suburbanization is also visible in the lack of developed general urban areas.

1. INTRODUCTION

The main context of the study is the progressive chaotic suburbanization in Polish cities, often identified with the urban sprawl process. This is the phenomenon of decentralization of residence and work places of the population to suburban local administrative units in relation to the core city, which eludes the control of the local spatial policy (Perrsky and Wiewel, 2012). This problem is not new; it was diagnosed in the 1930s in the United States and was described by scattered development, low population density, and the dominant position of the car as a means of transport (Squires, 2002). Over the years, the rapid development of the automotive industry has strengthened urban sprawl, and researchers' interest has focused on the effects of this process, mostly landscape degradation or increase in infrastructure maintenance costs (Carruthers and Ulfarsson, 2003; Ewing, 1997; Gordon and Wong, 1985). Currently, the intensive development of suburban areas is a global issue (Wu and Phelps, 2011), while the difference between the traditional process of suburbanization and the urban sprawl phenomenon is visible (Hall, 1975). In Poland, as a post-socialist country, the development of suburban areas is characterized by different dynamics (Kovács et al., 2019) therefore it is worth mentioning the achievements of Polish researchers in this field.

The topic of suburban areas was raised in Poland for the first time in the 1950s, but the dominant

theme in the debate was the function of food production for the needs of central cities (Kosiński, 1954; Krusze, 1954; Straszewicz, 1955). Over time, suburban areas have become increasingly multifunctional whilst agriculture ceased to play such a significant role. At that time, the research was focused on the changes in land use, morphology and physiognomy of the newly-developed settlements (Miszewska, 1985). Currently, the subject of suburban zones is a very popular issue in geography, and in addition to theoretical work related to the delimitation of these zones, the issue of costs associated with chaotic suburbanization is becoming increasingly important.

The Polish system of spatial planning, especially at the lowest administrative level, is ineffective in relation to the pressure on the creation of new housing developments (Lityński and Hołuj, 2017). Most new housing developments are based on administrative decisions that are not always in line with plans at a higher level. This phenomenon started to intensify after Poland's accession to the European Union in 2004 and is the result of several factors: the increase in the welfare of society, a greater availability of financial instruments (including mortgage loans) and the popularization of car transportation (Skóra and Węgrzynowicz, 2015). Studies on the costs of uncontrolled suburbanization were conducted; for instance, Śleszyński et al. (2020) estimated the annual losses of the Polish state budget resulting from spatial chaos at EUR 18 billion.

The issue of the development of suburban zones has been approached by researchers from many scientific disciplines. Various faces of the suburbanization process are presented in the studies by Lisowski and Grochowski (2009), Kajdanek (2012), Kaczmarek (2020) and Koj (2020). On the other hand, the consequences of suburbanization for cities and suburban areas around the world are analysed by Stelmaszewska (2020).

Currently, one of the main research trends in the subject of suburban zones is the measurement of the size and dynamics of the processes taking place there, e.g. urban sprawl. Some researchers use synthetic indicators for this purpose, for instance, Sudra (2016), Mantey and Pokojski (2020), but more and more often these studies are based on GIS analyses using available statistical and geospatial data (Ismael, 2021). Examples of the use of these methods are studies conducted for the city of Prishtina (Berila and Isufi, 2021) or for the city of Graz, in which data from the Corine Land Cover (CLC) Project was used (Steurer and Bayr, 2020).

To properly measure the urban sprawl process, it is necessary to recognize the typology of residential buildings built in suburban areas (Szmytkie, 2020). Lityński (2014, 2015, 2016) and Hołuj (2015a, 2015b) analysed the typology of housing development in suburban areas in Poland and indicated a lack of continuity of spatial development, i.e., leapfrog combined with a relatively low density of houses (Lityński and Hołuj, 2017). This article proposes a way of presenting the typology of residential buildings using the urban transect method. This method has become more and more popular in recent years, as evidenced by various research applications around the world (Ghorbanian, 2020; Bin Sulaiman and Almahmood,, 2021; Nizam, 2021; Han, 2021).

The urban transect method was selected to illustrate the classification of residential housing in Krakow Functional Urban Area, which is the main aim of this study. To increase its accuracy, in addition to the use of urban transect method, geospatial analyses were performed using official state geodetic data. The combination of these two methods allowed us to achieve the next objective of the study, which is to perform an analysis of the distribution of residential buildings in Krakow FUA and answer the research question: how does the type of residential buildings change with the distance from the centre of the Krakow FUA area? The conducted research also allowed us to prove the hypothesis that chaotic suburbanization causes an uneven distribution of residential housing in Krakow Functional Urban Area.

2. THEORY AND METHODOLOGY

The problem of urban sprawl goes beyond the administrative boundaries of cities; therefore a larger area, where the influence of the central city can be observed, should be selected for analysis. Relative to the Polish spatial planning policy, in the context of the impact on urban growth, there is a delimitation into Functional Urban Areas (FUA) (Lityński and Hołuj, 2020). Hence, the research area of this study was defined as the Krakow Functional Area (Krakow FUA), extending over 1275 km², consisting of 15 communes, inhabited by over 1 million people (Fig. 1).

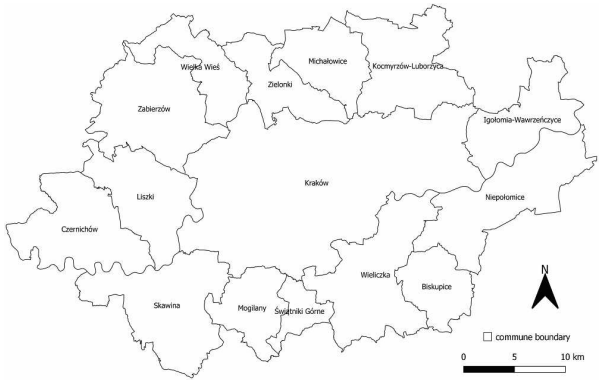

Fig. 1. Study area – Krakow FUA.

The selected space is a rapidly developing area (Krakow is the second largest city in Poland), characterized by a strong process of suburbanization, which generates a risk of chaotic development. The

suburban area of Krakow is currently one of the most rapidly growing areas in the country also in terms of the spatial aspect, as a result of the influx of new inhabitants and the intensive construction traffic.

On the one hand, the proposed research area is artificially delimited, as it does not reflect the actual range of problems typical of suburban zones. On the other hand, the delimitation of the suburban area is not the main research topic, and the range of influence of the central city may only be greater than the ring of surrounding communes. Hence, the adopted delimitation should be treated as a limitation of the research area in which there is no risk of a lack of functional links with the core city.

Searching for a tool that offers a clear classification of city zones based on a morphological criterion (in the case of this study, it concerned the typology of housing development), it was decided to use the urban transect method.

Originally, the transect comes from the natural sciences, where it denotes a method of inventorying animate or inanimate elements of the natural environment through point observations along characteristic lines. It is an elongated research area that is most often used to register the diversity of the examined features in the environmental gradient. In the monitoring of natural habitats, the transect is designated to standardize and ensure the repeatability of field research methods in a homogeneous patch of natural habitat. Thus, the transect is not a representation but an exploration method that can lead to a variety of graphical or tabular representations.

The transect was introduced to urbanism as a planning tool at the turn of the 20th/ 21st century by the American representatives of the New Urbanism (Duany and Talen, 2002). It is a method of inventorying elements of spatial development and spatial structure. It consists in carrying out observations at selected characteristic points on a straight or broken line, the opposite ends of which are in extremely different areas (Wróblewski, 2016). The urban transect serves both for the analysis of space and the organization of the built environment by dividing it into development zones. The zones describe the spectrum of the diversity of human habitats (Fig. 2), which stretches between the natural environment (zone T1) and the most densely urbanized space (zone T6). The areas that fall outside this characteristic are referred to as a special district (SD zone).

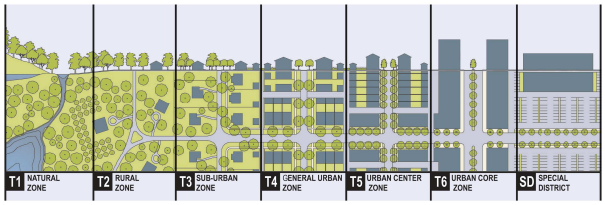

Fig. 2. Urban transect zoning *(source: Centre for Applied Transect Studies).*

The detailed characteristics of urban transect zoning are as follows (Duany et al, 2008):

- Zone T1 - natural - consists of areas close to or returning to their original state, including areas unsuitable for settlement;
- Zone T2 - rural - these are sparsely populated areas of open or arable land, namely represented by forests, arable land, pastures, and meadows; typical buildings here include farms, farm buildings, single-family houses, villas, and former mansions;
- Zone T3 – sub-urban - consists of residential areas of low intensity and partly mixed use; household work can be carried out in housing development, but there are also farm buildings related to crafts and small trades; plantings are naturalistic (free); the building line is significantly withdrawn; quarters can be large and the road network irregular;
- Zone T4 – general urban - consists of mixed use, but mainly residential urban fabric; there are mixed types of single-family and multi-family housing; building lines and street landscapes are variable;
- Zone T5 – urban centre - consists of high buildings density areas with mixed use; in addition to flats and apartments, a large number of retail trade services and offices are found here; a dense network of streets with wide sidewalks, planned tree plantings, and the line of buildings creates frontages or it is slightly withdrawn;
- Zone T6 – urban core - is the core of the city's identity with the highest buildings density and height of buildings, with the greatest variety of forms of use and public utility buildings of regional importance; the zone may have larger quarters, and the streets have regular plantings, wide sidewalks, and frontage buildings;
- SD zone – special district – monofunctional areas not having the features described above, e.g., industrial, commercial, and recreational areas.

Although the urban transect tool has a relatively short history of use, it is faced with criticism regarding, among other things, the subjective dimension of the observer's perception and the imposed zoning, which may be inadequate for cities outside the United States.

The representatives of the New Urbanism consider the criticism premature (Ellis, 2002) and emphasize the flexible form of urban transect, encouraging to apply adjustments to the tool in accordance with local conditions (Bohl and Plater-Zyberk, 2006). The urban transect tool has gained increasing popularity all over the world, as evidenced by new research (Long et al., 2007; Talen, 2002; Volk and Zimmerman, 2002; Yu and Ng, 2007; Zhu et al., 2014) and changes in curricula at university studies outside the US (Wróblewski, 2016).

In this study, the urban transect tool was used to present the classification of residential housing in the Krakow Functional Urban Area. To increase its accuracy, the open QGIS software was used to plan the routes of the transects. Using the *Centroids* function, the 'centre of gravity' of the Krakow FUA area was determined and routes in 16 directions were drawn from it, with observation points, every 500 meters. Thus, some 615 research points were created and inventoried in the field, based on which urban transect zones were assigned. The identification of individual zones was made in accordance with the previously mentioned descriptions. If a given point was in an inaccessible area due to natural conditions or administrative and legal factors, then the study was carried out in its closest vicinity. In particular situations, Google orthophoto map from 2019 was used. Thus, a mosaic of points marking various zones of the transect was created and will be discussed in detail in the next chapter.

Since the results of the study were not based only on field observations, the urban transect method was supplemented with GIS analysis. In this case, official data from the open access database of the Polish Central Office of Geodesy and Cartography were used to present the current situation of residential buildings in the research area. They were categorized into 4 types, as follows:

- single-family housing;
- semi-detached housing;
- multifamily housing;
- collective residence housing (e.g., dormitories, parish houses).

The above classification was analysed in terms of distribution within the communes components of the Krakow FUA; subsequently the distribution of different types of residential buildings was compared to the previously identified urban transect zones. For this purpose, circular buffers with a radius of 250 m were marked around the transect points (so that the buffers of subsequent points would not overlap) and the number and type of residential buildings contained in the individual buffers were verified. Based on these comparisons, the hypothesis presented in the introduction was proven and the main goal of the study was achieved.

3. RESULTS AND DISCUSSION

Figure 3 shows the results of the study conducted using the urban transect tool. Along the 16 routes, six main transect zones and special districts (SD) were identified at 615 research points.

It should be stated that Krakow FUA is an area where the metropolitan buildings (zone T6) are located only in the historical centre of the city of Krakow. Therefore, 38 research points were defined. Apart from a few exceptions, the metropolitan zone is adjacent to the urban zone. In the case of 84 research points, the site was recognised as T5 zone. In addition to the downtown area and large housing estates in Krakow, there are also satellite cities in the south such as Skawina and Wieliczka, marked as T5 zone. In 61 research sites, located mainly on the routes towards south, the development consistent with the description of the general urban zone (T4) was observed. The suburban area (T3) is the most frequently noted type of development in the area under study, and 200 research points were marked in this respect. Some 109 points in the rural area (T2) were found located mainly on the outskirts of the studied area. The occurrence of the natural zone (T1) was observed in the case of 103 research points, and their distribution is very diverse, as it occurs both in the centre of the studied area and on its outskirts. Special districts (SD) were recorded only in 13 points, and they are mainly represented by vicinity of facilities such as: heat and power plant, sewage treatment plant or industrial and storage areas. Specialist districts appeared located only in the eastern part of the study area.

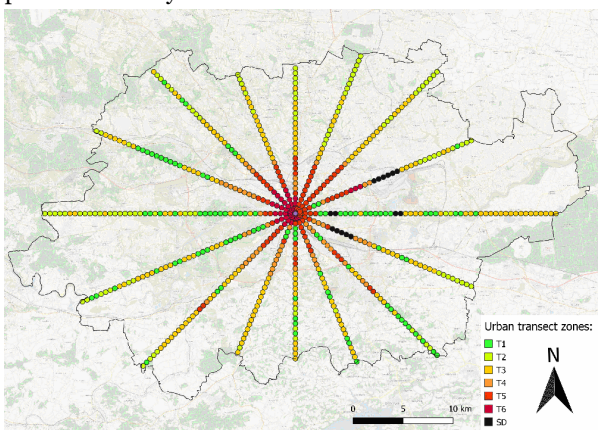

Fig. 3. Urban transect paths in Krakow FUA.

The research using the urban transect method shows Krakow FUA as an area diversified in terms of the typology of residential buildings with a strongly marked central city. However, approximately 32% of all research points were identified as a sub-urban zone, which may indicate the extensive suburbs surrounding the central city. Also GIS analysis was performed to present the structural classification of the residential buildings in Krakow FUA divided into 4 categories. The shapefile layer of buildings was elaborated based on data from the Database of Topographic Objects (BDOT10k) provided by the Central Office of Geodesy and Cartography. BDOT10k is a spatial database with details corresponding to a topographic map on the scale 1:10 000. The layer of buildings was trimmed to the borders of Krakow FUA and a centroid was created in each of the objects. The composition containing the centroids of all residential buildings in Krakow FUA, is shown in Figure 4.

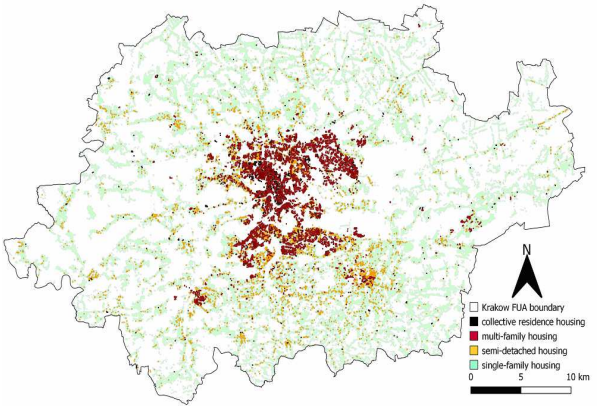

Fig. 4. Spatial distribution of residential buildings within Krakow FUA *(source: own elaboration based on BDOT10k data).*

Figure 4 shows a high concentration of multifamily housing (buildings with 3 or more apartments) in the central part of Krakow FUA, particularly, in the city centre of Krakow. There are 14,028 multifamily buildings in the study area. A smaller share (8,146) of objects is represented by semi-detached houses, which are also located in the centre of the studied area but are not so highly concentrated. The largest number is recorded by the single-family buildings (129,755) which dominate the rest of the surveyed area. There are 799 collective residence buildings, mainly located in the city of Krakow. Table 1 presents the number of individual types of buildings and their share in relation to all residential buildings by communes included in the Krakow FUA.

Table 1. Types of residential buildings in Krakow FUA communes.

Name of the commune	Single-family housing		Semi-detached housing		Multi-family housing		Collective residence housing		Number of all residential buildings	
	no.	%	no.	%	no.	%	no.	%	no.	%
Biskupice	3550	98.4	42	1.2	6	0.2	10	0.2	3608	100.0
Czernichów	5095	96.0	205	3.9	0	0.0	7	0.1	5307	100.0
Igołomia-Wawrzeńczyce	2325	96.9	63	2.6	5	0.2	7	0.3	2400	100.0
Kocmyrzów-Luborzyca	5572	97.0	150	2.6	18	0.3	6	0.1	5746	100.0
Liszki	5617	96.2	198	3.4	7	0.1	18	0.3	5840	100.0
Michałowice	4231	97.0	119	2.7	10	0.2	4	0.1	4364	100.0
Mogilany	4661	94.2	249	5.0	34	0.7	4	0.1	4948	100.0
Niepołomice	9184	95.6	193	2.0	213	2.2	14	0.2	9604	100.0
Skawina	8338	91.7	515	5.7	225	2.5	14	0.2	9092	100.0
Świątniki Górne	3222	94.6	181	5.3	1	0.0	3	0.1	3407	100.0
Wieliczka	16516	90.3	1450	7.9	294	1.6	30	0.2	18290	100.0
Wielka Wieś	4712	95.5	206	4.2	8	0.2	7	0.1	4933	100.0
Zabierzów	8651	95.6	315	3.5	40	0.4	42	0.5	9048	100.0
Zielonki	7913	95.5	325	3.9	31	0.4	14	0.2	8283	100.0
Krakow (core city)	40168	69.4	3935	6.8	13136	22.7	619	1.1	57858	100.0

Table 1 and Figure 1 show the distribution of the residential buildings in the communes of Krakow FUA. We can note the dominance of single-family housing among other residential buildings in each of the municipalities in Krakow FUA. Their majority share is over 95% of the total number. In the central city of Krakow, the share of single-family houses is also high and amounts to 69.4%. Apart from the core city, two other communes stand out, namely Skawina and Wieliczka, where the share of single-family buildings is about 90%, and there is a greater share of semi-detached buildings and multifamily buildings compared to other communes. These percentages indicate that Krakow is surrounded by communes dominated by single-family housing, typical for suburbanization processes. Among them, there are two towns that are more diversified in terms of the typology of residential buildings (Skawina, Wieliczka). It should also be noted that Krakow, despite being a central city, is also characterized by a large share of single-family housing. On the one hand, it is a result of the expansion of the city borders in the last century to the areas of former villages, where this type of development was common. On the other hand, it may indicate that the process of construction and settlement in the form typical for suburban zones begins already in the territory of the central city. To obtain a complete picture of the distribution of residential buildings in Krakow FUA, the number of individual types of buildings should be compared with the area of each commune (Table 2).

Table 2. Types of residential buildings/km² in Krakow FUA communes.

Name of the commune	Single-family [housing/km²]	Semi-detached [housing/km²]	Multi-family [housing/km²]	Collective residence [housing/km²]	Area of the commune [km²]
Biskupice	86.3	1.0	0.1	0.2	41.135
Czernichów	60.5	2.4	0.0	0.1	84.215
Igołomia-Wawrzeńczyce	37.0	1.0	0.1	0.1	62.789
Kocmyrzów-Luborzyca	67.2	1.8	0.2	0.1	82.92
Liszki	77.9	2.7	0.1	0.2	72.066
Michałowice	50.2	1.4	0.1	0.0	84.215
Mogilany	106.6	5.7	0.8	0.1	43.709
Niepołomice	95.4	2.0	2.2	0.1	96.292
Skawina	83.5	5.2	2.3	0.1	99.831
Świątniki Górne	158.4	8.9	0.0	0.1	20.345
Wieliczka	165.7	14.5	2.9	0.3	99.676
Wielka Wieś	97.6	4.3	0.2	0.1	48.273
Zabierzów	87.0	3.2	0.4	0.4	99.409
Zielonki	163.9	6.7	0.6	0.3	48.273
Krakow (core city)	122.9	12.0	40.2	1.9	326.846

In the communes of Zielonki, Wieliczka and Świątniki Górne there is a clear dominance of single-family housing, over 150 buildings/km² being recorded here. The highest density of semi-detached buildings is found in Wieliczka and Krakow (over 12 buildings/km²), as well as in Świątniki Górne (8.9 buildings/km²). In terms of multifamily housing, the central city – Krakow dominates (more than 40 buildings/km²), and Niepołomice, Skawina, and Wieliczka also stand out from other communes (with more than 2 buildings/km²). The list above confirms the location of collective residence housing mainly in Krakow (1.9 facilities/km²).

The last phase of the analysis was to combine the results of the used methods. Buffers in the shape of a circle with a radius of 250 m were created around the transect points and the number and type of residential buildings contained in individual buffers were checked (Table 3).

In the analysis combining both methods used in this study, some 20,226 residential buildings were considered. The smallest number of residential buildings was found around the research points in the SD zone - only 20 facilities (mainly single-family houses). In the T1 (natural) and T2 (rural) zones, a few objects were also observed, and these were mainly single-family houses, fact that seems to confirm the characteristics of both zones. Moreover, two opposing trends can be observed. The percentage of single-family housing grows from the T6 urban core zone (4.2%) to the rural zone T2 (97.2%). In the opposite direction, there is an increase in the percentage share of multifamily housing. The semi-detached buildings are most visible in the general urban zone T4 (11.2%). The collective residence buildings are mostly located in the T5 urban centre zone, and the T6 urban core zone, i.e., mainly in the city centre of Krakow.

The verification of the type of residential buildings in the vicinity of research points of the urban transect method in the vast majority confirms the correct selection of urban transect zones. The best justification for this statement is the aforementioned trends indicating increasing / decreasing the intensity of residential buildings along with the distance from the centre of the studied area. The graphic studies and tables presented in this chapter show the classification of residential housing in Krakow FUA and indicate the characteristics of the suburbanization process taking place here, which are: a significant domination of single-family housing in the vicinity of the central city and an increase in the intensity of residential development as we approach the city centre. Namely, single-family housing is the dominant form of residential building, regardless of the identified transect zones. On the one hand, it proves the character of Krakow (some researchers of Krakow's space define it as - the city of small towns (Ziobrowski, 1996)), but on the other hand, it illustrates the process of strong suburbanization that begins in the central city. The effect of this phenomenon is a poorly developed general urban zone [T4] in the south or it is completely absent in the north and east. In these zones, the share of semi-detached buildings is high, which is characteristic of the urban sprawl process (it allows investors to achieve higher profits than in the case of single-family housing). Apart from the central city and satellite cities, the most frequently identified zones were the interpenetrating rural and sub-urban zones.

Looking at the communes where this phenomenon occurs and comparing it with the density of types of residential buildings/km², it can be concluded that single-family housing is entering areas that were previously only used for agriculture. This conclusion relates to research conducted by Polish researchers in the 1950s and onward (Krusze, 1954; Straszewicz, 1955; Lityński, 2014). The urban transect theory shows that the optimal spatial layout of buildings is concentric and zonal. Starting from the urban core area, the intensity of development gradually decreases to the rural area.

Table 3. Types of residential buildings divided into urban transect zones.

Urban transect zoning	Single-family housing		Semi-detached housing		Multi-family housing		Collective residence housing		Number of all residence housing	
	no.	%	no.	%	no.	%	no.	%	no.	%
T1	611	88.7	34	4.9	43	6.2	1	0.1	689	100.0
T2	770	97.2	22	2.8	0	0.0	0	0.0	792	100.0
T3	7564	92.8	481	5.9	90	1.1	12	0.2	8147	100.0
T4	3327	74.5	501	11.2	605	13.6	31	0.7	4464	100.0
T5	1642	43.9	293	7.8	1719	45.9	90	2.4	3744	100.0
T6	99	4.2	19	0.8	2158	91.1	94	3.9	2370	100.0
SD	18	90.0	2	10.0	0	0.0	0	0.0	20	100.0

Leaving aside the issue of the location of the T1 zone, which is largely the result of natural conditions and SD zones, in the area under study, there is a discontinuity in the sequence of zones (in particular, the absence or a small share of the T4 zone). A significant advantage is also visible in the presence of T2 and T3 zones, where the type of residential buildings is typical for the suburbanization process. It can be concluded that the suburbanization process affects the distribution of residential housing in Krakow FUA. This influence may have a negative dimension on the perception of the "urbanity" of the studied area, analysed according to the intensity of housing development. When answering the research question posed in this article, it should be stated that high-intensity residential development zones are located in the centre of the area and most often adjacent to low-intensity residential zones. The process of suburbanization, which begins within the borders of the central city, resulted in the lack of development of zones with an medium intensity of residential buildings (T4 - general urban zone), and thus disturbs the concentric system of zones. The dominance of single-family housing in the entire area of Krakow FUA may also affect the perception of the research area as a smaller urban centre than it really is.

The urban transect method used in this study is only gaining in popularity, and examples of its use mainly concern cities in the USA. In Poland, the most similar research was carried out by Wróblewski for the city of Łódź (2016), where the transect paths were also marked out and then the transect zones were assigned to research points. However, it was used to determine the development of various city zones with regard to transport accessibility to public facilities, and it was also supported by GIS analyses. The use of zoning in the transect method in terms of the type of residential development is important due to the clarity of the perception of urban space. It allows to assess whether the city is developing in an orderly, concentric manner, and the intensity of spatial development increases with the approach to the centre.

This method has its limitations. It does not cover the entire area, but only the closest vicinity of research points. It is based on the subjective perception of the observer / researcher, even though they use a unified description (code) of zoning for interpretation. On the other hand, the urban transect method takes into account the direct experience of the studied space, which would be impossible to achieve only with GIS analysis. However, the use of GIS analyses was necessary to confirm the observations resulting from the urban transect method.

The value of the study will certainly be greater if it is repeated in a few years, which will allow us to verify the observations made considering the time factor. One of these observations was related to the underdeveloped general urban zone, which may be taken a suggestion for local planners to emphasize the importance of intensive housing development in shaping the city and integrate this matter in the elaboration of regulations.

4. CONCLUSIONS

It should be emphasized that thanks to the combination of the two methods (urban transect and

GIS analysis), it was possible to fully achieve the main goal of the study, mainly to present the classification of residential housing in Krakow FUA. An analysis of the distribution of residential buildings was also performed, which allowed us to answer the research question about how the type of residential buildings is changing in Krakow FUA. The following observations have been made on this topic. The results of the study, presented both at the commune level and in a holistic approach, provide the opportunity to observe the strong process of suburbanization resulting in the dominance of single-family housing in each of the communes of Krakow FUA, including the central city. The consequence of this poorly developed general urban area or its complete absence. Single-family and semi-detached housing extends over areas that were previously used for agriculture, and the boundaries between the rural and suburban zones are no longer visible. It can therefore be concluded that the chaotic suburbanization causes an uneven distribution of residential buildings in Krakow FUA. The results of the study may be useful for local planners who, by creating legal regulations, may influence the development of buildings. The desired action is the creation of zones with greater intensity of residential development replacing single-family housing, which is the result of the suburbanization process starting already within the borders of the central city. This action will allow to reduce infrastructure and social costs in the long term for the entire Krakow FUA. The course of the study may also be interesting for researchers looking for new research methods. An additional goal to be achieved by this study is to popularize the urban transect method as a research tool for space exploration. At the same time, it is worth noting that the support of additional analyses (e.g., spatial data analysis) may facilitate the implementation of the main research assumptions and make the study more valuable.

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