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The transformation of countryside into a dispersed city: a critical local-scale analysis of selected Polish suburbs

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Abstract. The purpose of this article is to highlight the main challenges presented by the spatial transformation of countryside as a result of strong investment pressure in the metropolitan zones of selected Polish cities. The research focuses on the spatial structures of selected communes adjacent to Warsaw, Kraków and Lublin. The study deals with the problem of spatial transformations of the rural landscape. This was done on the background of socio-economic redevelopment and demographic changes. The results show a significant investment pressure and identify the stages and forms of spatial development characterising urbanisation in the studied suburban areas in recent years. The author's planning concept is proposed as an example of a tool for controlling excessive dispersal at local and regional levels.

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1. Introduction

Controlling spatial development is a key aspect of urban and regional life, so research on this topic, even in the context of spatial chaos, is common in Poland and other European countries (Kociuba & Szafranek, 2018; Kowalewski et al., 2018; Kaczmarek, 2020; Berisha et al., 2021). Suburban areas in Poland, particularly those near large metropolises, have experienced intense urbanisation pressure in recent years (Śleszyński et al., 2021). Following the political changes of 1989, rural areas near cities gradually began to suburbanise and transform. The absence of suitable policies and the dysfunction of the planning and management systems has facilitated the uninhibited expansion of development (Kubeš, 2013; Lityński & Hołuj, 2017; Karwińska et al., 2018; Śleszyński et al., 2021; Blazy & Ziobro, 2023). Significant depopulation of large cities such as Łódź, Poznań, Katowice, Szczecin, Bydgoszcz and Lublin (Musiał–Malago, 2018) is accompanied by the rapid expansion of small towns and rural communities in metropolitan areas (Statistics, 2023b). This phenomenon places Poland in a small group of countries worldwide that are experiencing a decline in urbanisation (Note 1).

Centrifugal population growth in rural areas leads to spatial disadvantages (Lichter et al., 2021). It redefines these areas' shape and transforms them into quasi-urban structures. Suburbanisation, which is widespread in other countries (Amcoff, 2006; Slaev et al., 2018; Lichter et al., 2021), is detrimental to the visual appeal of residential areas. It also disrupts the established spatial order, poses a threat to sustainable development and impedes the ability to adapt to climate change. Chaotic urbanised areas tend to have a single function, with a strong emphasis on residential areas. They are predominantly accessed by private car transport (Blazy & Ziobro 2023). The construction of new housing developments has the potential to attract residents drawn by the appeal of a natural landscape. However, this can result in people living in a quasi-urban environment that lacks public spaces, green areas and in some cases services, and with an abundance of concrete surfaces.

The aim of this study is to identify the conditions and spatial forms characteristic of the different stages of the transformation of countryside into a "dispersed city". By this term, the authors mean an advanced, continuous, chaotic and random urban-spatial form that has replaced the traditional rural landscape around the metropolitan areas of Polish cities. This phenomenon, which has been observed at varying degrees of intensity in different regions, is linked to investment pressure increasing in metropolitan zones over the past 20 years. The research is part of the discourse on the development of the urban–rural continuum (Bański, 2008; Siemiński, 2010), and aims to present its urban-architectural forms. It can also be combined with established urban concepts of the scattered, patchwork, fragmented or fragmentary city (Balbo, 1993; Taleb, 2008; Batty, 2011; Holloway et al., 2012; Mouratidis, 2019; Kotharkar & Bahadure, 2020; Shawly, 2022).

Such an objective, which is significant for the characterisation of contemporary phenomena taking place in the space surrounding cities, requires the presentation of the economic and social backgrounds that are both their basis and their effect. The article also presents the authors' planning concept, which can serve as an example of urban planning tools to control and limit unrestricted development in regions where this process is only beginning.

2. Research materials and methods

The working method consists of a two-stage action consisting of a preliminary phase – the selection of cases for analysis – and a main research phase. The first step is to select municipalities to characterise the different stages of the spatial transformation of countryside into a dispersed city. It is introduced later in this subchapter.

The proper research is presented in two groups, according to study method based on a "general to specific" approach – deductive reasoning. It follows from the assumption that the local development is strongly influenced by the character of regional conditions. Firstly, information on the economic, social and demographic background of the communes studied is compared using literature and statistical data. These aspects are closely linked to the spatial transformations taking place and their presence is essential for the presentation of the issue. Then, the transformation of the development structure in the municipality and the selected settlements is analysed, paying attention to the urban and architectural forms and the planning documents that regulated their development. The research methods encompassed literature studies, spatial and statistical data analyses, comparative studies of historical and contemporary orthophotos, online and on-site field research, and photographic imaging.

The economic and social redevelopment was developed on the basis of the research of Rosner and Stanny (2014) Stanny et al. (2018) and Stanny et al. (2023a,b) compiling synthetic evaluation measures and selected indicators showing similarities and differences in the development of the studied communes. The choice of specific indicators was driven by the idea that changes are principally influenced by educational aspects, social involvement, local labour markets and the demographic structure (Stanny et al., 2023b). Based on our literature search and own research, we selected measures to indicate demographic and structural changes towards the intensification of urbanisation processes. Our analysis of statistical data comprised population, population density, migration, and the number of newly constructed dwellings.

The subsequent phase of the study was to undertake an analysis of the dispersion of buildings. Two distinct methods were employed. The Standard Deviation Ellipse (SDE) algorithm and the USM Toolset (Urban Sprawl Metrics toolset) were employed using the QGIS software. Firstly, using the DBSCAN algorithm, a cluster analysis was carried out, assuming that a cluster contains at least five buildings distributed at a maximum distance of 100 m from each other. The SDE algorithm was then applied to the clusters of buildings that had been obtained, and the parameters of the resulting ellipses were compared. Concurrently, the degree of urban dispersion index (DIS) was examined to ascertain the extent of compactness or dispersion of development. DIS measures the dispersion of built-up areas based on the distances between any two points within built-up areas (Jaeger et al., 2010). The more dispersed the built-up areas, the larger the value of DIS.

The analysis of transformations in the development structure of communes was conducted using GIS tools based on archival and current data of BDOT10k's topographic objects (GUGiK, 2023). Land cover data for built-up and greenery areas from 2014 and 2023 were analysed to identify the latest spatial changes in each municipality. Urban transformations of fragments of the selected villages were studied by compiling and analysing orthophotos from the Google Earth Pro portal, by comparing archival images with contemporary ones. This research is complemented by on-site field research and photographs documenting the character of the architecture, the use and accessibility of space, and reviews of local plans.

2.1. Case selection

In order to identify the spatial form characteristic of different stages of transformation of countryside, this study looked at municipalities around three different types of cities, according to their size and function. These are a metropolitan city with a population of more than 1 million (Warsaw); a regional metropolitan city with more than 500,000 inhabitants (Kraków) (Smętkowski et al., 2008) and a city with more than 300,000 residents (Note 2) (Lublin) (European Smart Cities, 2015; Giffinger et al., 2007), which is developing or aspiring to become a medium-sized European metropolis (Kociuba, 2022).

Based on the research of Stanny et al. (2023a, b), Rosner and Stanny (2014) and Stanny et al. (2018), municipalities sharing an administrative border with the area of Warsaw, Kraków and Lublin were examined in terms of their typological evolution, reflecting a specific development model. These results were then compared with data on the degree of urbanisation (Note 3) provided by the EU TERCET territorial typology (Eurostat 2014). It was assumed that the evolution of a municipality's development model implies a transformation from a rural centre into a dispersed city. The classification of rural municipalities as urban areas in the EU TERCET territorial typology confirms the existence of such a phenomenon. The preliminary research is summarised in Table 1 and Table 2, which serve as the basis for selecting three municipalities for detailed analysis.

All municipalities surrounding Warsaw have been highly urbanised since the beginning of observations (Rosner & Stanny, 2014), and three of them are classified as rural areas (Eurostat, 2014; Dijkstra et al., 2021). Around Kraków, urbanisation is strengthening in the municipalities north of the city, such as Zielonki, Michałowice and Wielka Wieś. In Lublin's surroundings, more than half of the municipalities have changed from multifunctional to urbanised in the course of a decade (Stanny et al., 2023a), which indicates the high dynamics of the changes taking place, with rapid urbanisation forming suburbs that still remain in rural areas.

Based on preliminary studies, we selected the following cases for analysis (Fig. 1):

1. **Piaseczno**, near Warsaw and recognised for its high development indicators
2. **Zielonki**, as the only highly urbanised municipality in 2010 near Kraków, classified as an urban area (Eurostat, 2014)
3. **Strzyżewice**, near Lublin, as the only municipality in the surrounding area that has retained its agricultural identity

Table 1. Transformation of municipalities around selected metropolises according to typological evolution

			Number of rural and rural–urban communes by type by year								
			Warsaw (12)			Kraków (13)			Lublin (7)		
	Type	Features	2014 (2010)	2018 (2015)	2022 (2019)	2014 (2010)	2018 (2015)	2022 (2019)	2014 (2010)	2018 (2015)	2022 (2019)
Types of communes - development models	1	traditional agriculture dominates									
	2	large-scale agriculture dominates									
	3	the agricultural function dominates				2	2	1	1	1	1
	4	multi-income – fragmented agriculture						1		1	1
	5	multifunctional				1	1	1	5	1	
	6	urbanised				9	8	7	1	4	5
	7	highly urbanised	12	12	12	1	2	3			

Source: Own elaboration based on: Rosner & Stanny, 2014; Stanny et al., 2018; Stanny et al., 2023b

Table 2. The quantitative division of the surveyed municipalities according to the EU territorial typology TERCET

Typology of municipalities around selected cities		Number of rural and urban–rural municipalities (and urban [not included in Table 1] in brackets)		
		Warsaw	Kraków	Lublin
Urban areas	Cities	1	1	1
	Small towns or suburbs	9 (+6)	7	(+1)
Rural areas	Rural areas	3	6	7

Source: Own elaboration based on: Statistics Poland, 2022

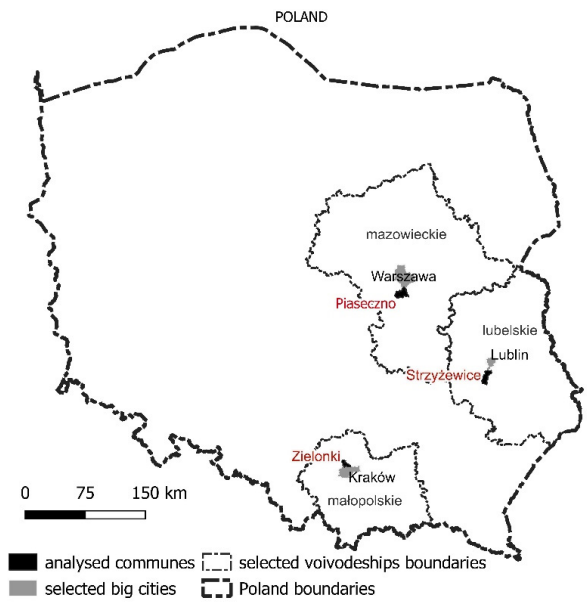

Fig. 1. Location of the study areas in Poland
Source: Own study

3. Research results

3.1. Economic and social redevelopment

Comparing the development factors of the three chosen municipalities (Rosner & Stanny, 2014; Stanny et al., 2018; Stanny et al., 2023a, b), as shown in Table 3, it is evident that Piaseczno and Zielonki, two highly urbanised municipalities, have only minor differences in most indicators. The municipalities' localities have lost their rural identity, shifting towards urban service functions, and agriculture is dwindling (Stanny et al., 2023b). Piaseczno displays higher development levels, as shown by the individual indicators in Table 3, characterised, for example, by its wealth, the presence of a well-organised public transport system and a school enrolment rate that ensures that all the commune's children receive an education in the

area. There is a stark contrast between the two highly urbanised municipalities (Piaseczno and Zielonki) and Strzyżewice, which still retains a predominantly agricultural character. It is worth noting, however, that there are certain similarities among the three municipalities. These include demographic concerns, migration and education attractiveness, as well as economic facets like the features of the agricultural industry and, particularly, the durability of the job market. The REGON indicator shows a comparable level of economic activity growth for all three communes, making them attractive for settlement (Śleszyński, 2010) The presence of several characteristics common to highly urbanised municipalities and a significant growth in the share of non-agricultural businesses in the total number of enterprises over the past decade indicates the potential of Strzyżewice. This could be a sign that the transformation of the area is beginning.

3.2 Demographic changes

The populations of the municipalities under consideration are gradually increasing (Statistics Poland, 2023a) (Fig. 2). In 1998, Strzyżewice Municipality had a population of slightly over 7,700. Subsequently, there was a regular increase in population, other than a brief decline in 2002. As of 2022, the municipality's population has grown by 5%. Comparatively, the population of the commune of Zielonki has seen a sustained, successive increase of nearly 115%, rising from 12,640 individuals in 1998 to over 27,000 in 2022. The most significant

Table 3. Level of synthetic evaluation measure and selected indicators as factors studied in the transformation of a rural area into a dispersed city, for three municipalities

		Piaseczno	**Zielonki**	**Strzyżewice**
Type of municipalities – development model		**strongly urbanised**	**Strongly urbanised**	**the agricultural function dominates**
Synthetic evaluation measure of the range (in 5 equidistant ranges from very high to very low) of:	development of non-agricultural functions	very high	very high	low
	the degree of de-agrarianising of the local economy	very high	very high	low
	elements of housing conditions	very high	very high	low
	social activity	very high	very high	average
	community cohesion and prosperity	very high	very high	average
	spatial accessibility	very high	very high	average
	assessments of local public finances	very high	very high	average
	characteristics of the agricultural function	very low	very low	low
	demographic issues	very high	very high	high
	educational issues	very high	very high	high
	degree of labour market sustainability	very high	very high	very high
	Migration attractiveness	increase in population	increase in population	increase in population
	Enrolment rate in primary schools / average result in the eighth-grade exam	>100% >55%	<.85% > 55%	<85% > 55%
	Number of entities in REGON per 1,000 persons of working age/ growth 2010–19	>160 >40%	>160 >40%	120–140 >40%
	Share of non-agricultural businesses in their total number / growth 2010–19	>60% 0–15%	> 60% 0–15%	15–30 > 30%
	Number of plots per 100 ha	100–150	> 150	100–150
	Municipal wealth – G-index/national average	rich –150%	wealthy 100–150%	poorer 50–65%
	Percentage of villages in the municipality connected by public transport	>99%	75–90%	60–75%
Degree of transformation of countryside into a dispersed city		**full**	**advanced**	**initial**

Source: Own elaboration based on: Stanny et al., 2023b

population growth occurred in the rural area of Piaseczno. The population stood at around 15,450 people in 1998 and is expected to surpass 44,430 in 2022, representing an increase of over 187% in that period. The urbanisation of this area began early and developed exceptionally intensively, likely due in part to its proximity to Warsaw.

The available population density data cover the years 2002 to 2022 and reflect an apparent steady population growth, which in the case of both Zielonki and Piaseczno takes on values (Note 4) characteristic of predominantly urban areas according to the typology adopted by Eurostat. The greatest rise in population density occurred between 2018 and 2022 in both municipalities.

In this context, the statistics regarding internal migration, which showcase the number of new registrations in the municipality based on the type of unit (rural or urban) of newcomers, are intriguing. A comparison of the data demonstrates the extent of migration from urban to rural regions (Fig. 3). In Piaseczno and Zielonki municipalities, 83% of all registrations in rural areas were from the city, with a periodic (Note 5) average of up to 87%. Conversely, in the Strzyżewice commune, the average share of new arrivals from the city among new settlers was 60%, peaking twice in 2002 and 2022 at 67% and 65%, respectively. Demographics overlap with the number of new housing completions.

Data on the completion of dwellings per 1,000 inhabitants is most dynamic in the municipality of Piaseczno over the period studied (Fig. 4). Between 2002 and 2010, the number of dwelling completions almost tripled. It decreased in 2014, but already in 2018 there were again nearly 18 new housing units per 1,000 inhabitants. This figure also coincides with the most intensive growth in new construction. In the municipality of Zielonki, investment activity has remained stable over the period under review. In the municipality of Strzyżewice, short-lived spikes in new housing units per 1,000 inhabitants were observed, correlating with the increase in population. Comparing the values for the three municipalities, it was found that in 2022 the number of dwellings per 1,000 inhabitants in Strzyżewice (8.0) was slightly lower than in Zielonki (9.7). Such an increase in comparison to previous years, when the differences more than doubled, demonstrates the high investment dynamics in the municipality of Strzyżewice.

The number of newly constructed housing units in Piaseczno municipality has decreased since 2018 compared to the years 2014–2018. However, an observable upward trend in Zielonki and Strzyżewice municipalities has been noted since 2014 (Fig. 4). The aforementioned data indicate that the areas of the communes under study appear to be attractive to city dwellers and that the constant influx of people with urban lifestyles has an impact on the social transformation of these areas.

For interpreting the statistical data, we used a multiple comparison and presented it on an ordinal scale (Table 4). The data collected for the survey revealed that the Piaseczno commune had the highest indicators, thus being categorised as a highly urbanised area with a rank of 3. The Zielonki commune had intermediate values, earning a rank of 2, as an urbanised area. The commune

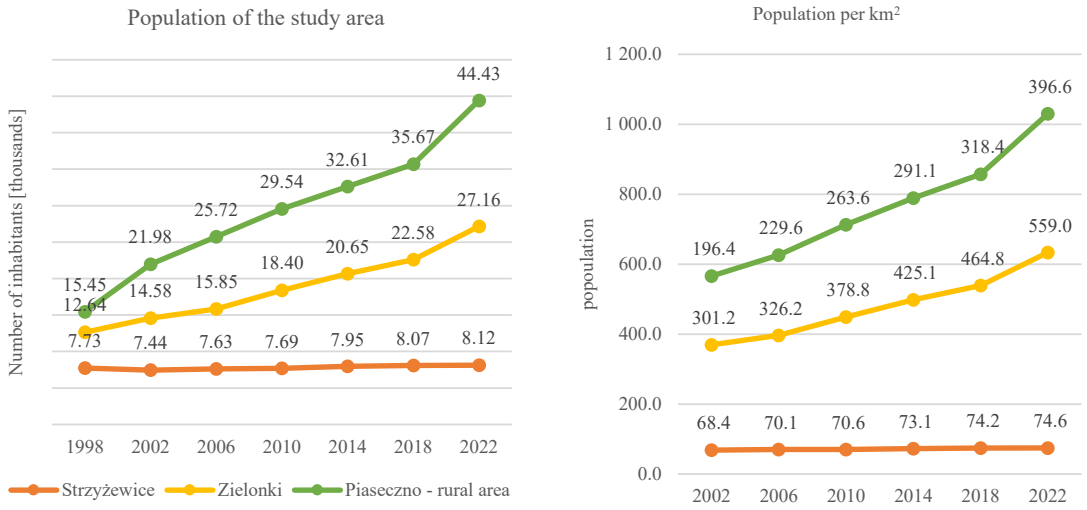

Fig. 2. Population of the study area and population per km² in Strzyżewice Commune, Zielonki Commune and rural part of Piaseczno Commune
Source: Own study based on Statistics Poland, 2023a

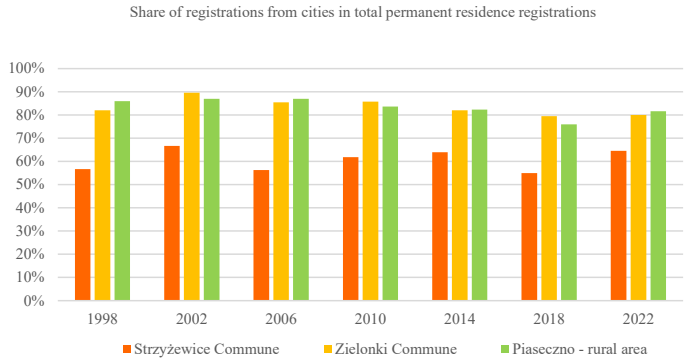

Fig. 3. Internal migration in Strzyżewice Commune, Zielonki Commune and Piaseczno Commune
Source: Own study based on: Statistics Poland, 2023a

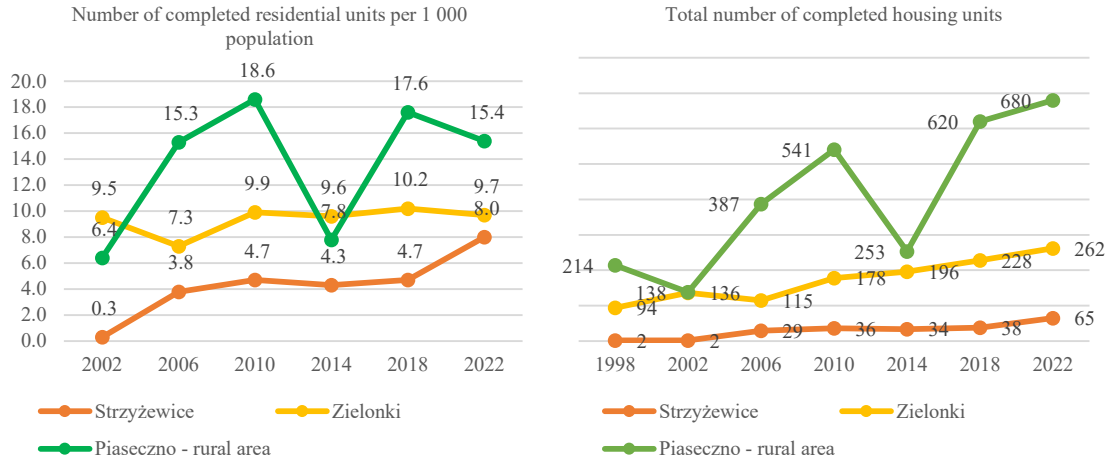

Fig. 4. Line graph demonstrating the quantity of residential units constructed per 1000 people and total number of completed housing units
Source: Own study based on: Statistics Poland, 2023b

of Strzyżewice, with the lowest indicators, was classified as a rural area, achieving rank 1.

Analysing the curves illustrating data distribution in individual charts (Fig. 2 to Fig. 4), similarities in the trend of individual indicators across municipalities are evident. These correlations occur at different time intervals, potentially indicating the appearance of similar phenomena during successive stages of development or transformation of rural areas into urbanised units.

3.3. Spatial characteristic and transformation analysis of the development structure in selected communes

The results of the cluster analysis, conducted using the DBSCAN algorithm and followed by standard deviation ellipse analysis, indicate that the number of clusters of development is highest in Strzyżewice Commune, which also has the lowest average and total area of ellipses (Table 5). Simultaneously, the dispersion analysis for Strzyżewice resulted in the lowest DIS index, at 44.85 (UPU/m^2). This indicates the presence of a relatively compact development pattern, albeit one that does not manifest as large clusters. Instead, there is a notable prevalence of smaller, more concentrated development clusters (Fig. 5c). The smallest number of clusters was identified in Zielonki Commune. Their average area of ellipses is the highest (Table 5). Concurrently, the highest value of DIS is observed at 48.37 (UPU/m^2). This suggests the existence of a limited number of larger, more concentrated development clusters. In this instance, the Zielonki Commune serves as a case study of a dispersed development layout (Fig. 5b). In Piaseczno Commune, a trend towards

Table 4. Summary of indicators characterising rural–urban transformation, using statistical data

Name of commune	Population growth, 1998–2022 [%]	Increase in population density, 2002–2022 [%]	Average number of new dwellings completed per 1,000,000 population, 2002–2022	Multiples of dwellings delivered in 2022 compared to 2002	Rank
Piaseczno	187%	80	13.5	5	**3**
Zielonki	115%	86	9.4	2	**2**
Strzyżewice	5	9	4.3	32	**1**

Source: own study based on: Statistics Poland, 2023b

Table 5. Spatial characteristic of development structure

Commune	Spatial dispersion characteristics of development			
	Standard Deviation Ellipse (based on DBSCAN cluster analysis)			Urban Sprawl Metrics
Parameter	Number of clusters (ellipses)	Average area of 1 ellipse (m^2)	Area of all ellipses (m^2)	Degree of Urban Dispersion (DIS) (UPU/m^2)
Piaseczno	108	546,497.98	59,021,782	48,01
Zielonki	39	788,153.83	30,737,999	48,37
Strzyżewice	227	36,124.60	8,200,284	44,85

Source: Own study

creating larger development clusters is observable (Fig. 5a). In this case, the number of clusters is 108 – an intermediate value compared to the other municipalities. Similarly, intermediate values were obtained for the average and total area of ellipses (Table 5). Despite the presence of larger clusters of development, the DIS rate of 48.01 (UPU/m²) is indicative of a dispersed development pattern.

An analysis of the transformation of Piaseczno Commune's development structure has shown that the newest investments have been made in towns bordering Warsaw, i.e. Józefosław, Julianów and Piaseczno (Fig. 6a). Strong investment pressure is also evident in Głosków village, situated in the western part of the municipality.

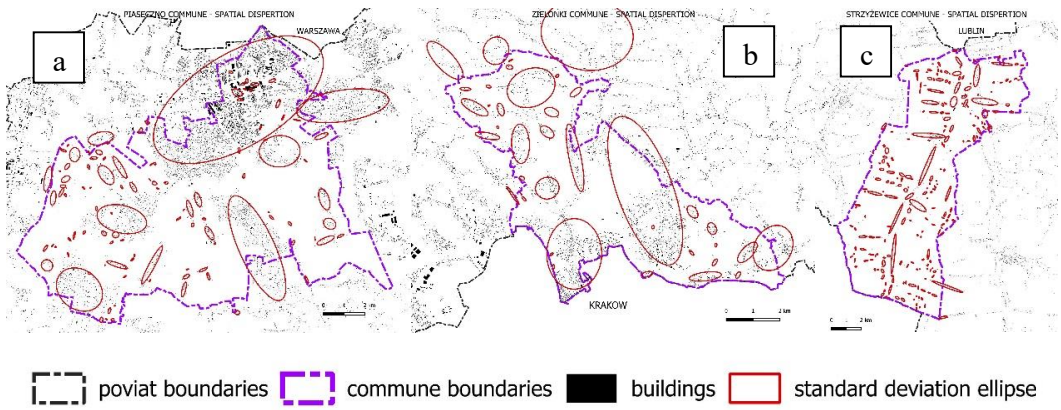

Fig. 5. Changes in the development structure in the period 2014–2023 in the communes of: a – Piaseczno, b – Zielonki, c – Strzyżewice
Source: Own study based on: BDOT10k data

In the Zielonki Commune, the development surge is most marked in the southern villages of Węgrzce, Zielonki and Marszowiec, which are close to Kraków city (Fig. 6b). Notably, extensive clusters of buildings have sprung up here, whereas in other villages the expansions comprise mainly of

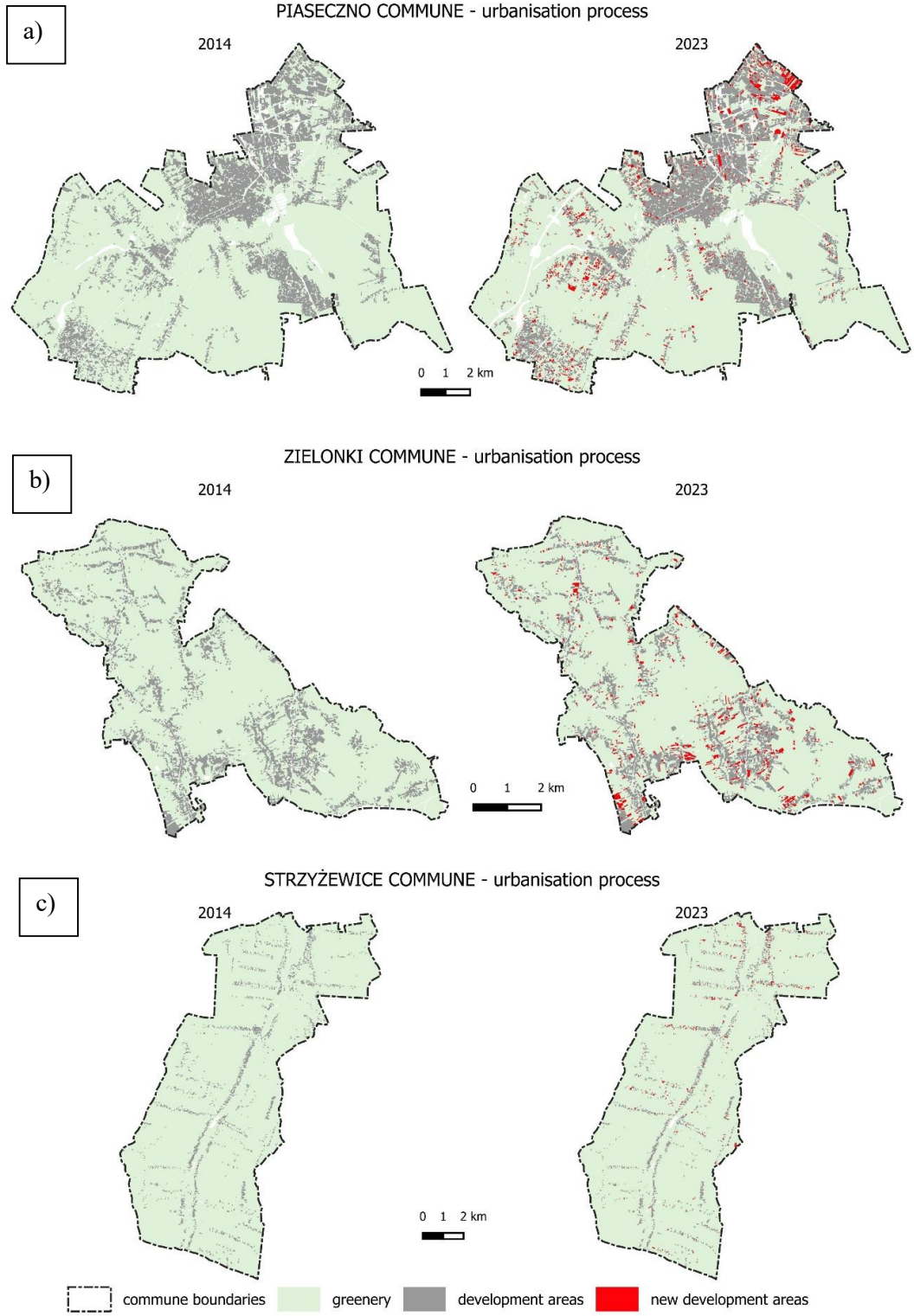

Fig. 6. Changes in the development structure in the period 2014–2023 in the communes of: a - Piaseczno, b - Zielonki, c - Strzyżewice
Source: Own study based on: BDOT10k data

individual buildings alongside pre-existing roads. The latter constructions display a scattered and chaotic structure.

The municipality of Strzyżewice is the least urbanised area, as shown in Figure 6c. The new development consists of single, small building additions that follow the existing fabric and roads. The development structure is linear, with minor clusters only observed near Żabia Wola and Piotrowice, where small groupings of non-linear building layouts can be found.

Between 2014 and 2023, a rise in built-up areas of 11–18% of the municipality's total area was observed in all examined examples (Table 6). Particularly, the municipality of Zielonki demonstrates the largest increase, accounting for 17.8% of the existing development in 2014. Meanwhile, the remaining municipalities show growth at the level of 11.9% (Piaseczno) and 10.7% (Strzyżewice). Given that Strzyżewice is primarily an agricultural municipality, the observed change suggests that there is immense investment pressure. Furthermore, areas of greenery decreased in every municipality during this period, with Piaseczno and Zielonki showing the largest loss at nearly 4% and Strzyżewice displaying the smallest decrease at 1%. It is worth noting that the decline in green spaces is not solely linked to building development, but also to new road construction, including the S7 expressway in Piaseczno municipality.

A graph illustrating the change in the number of buildings over time (Fig. 7) was constructed using data from the BDOT10k. It should be noted that the dataset is not without limitations, as there were years for which the number of buildings was not updated. Nevertheless, they provide a basis for determining development trends. The results of the analysis indicated that the annual trend of change in the number of buildings was as follows: 0.0543% in the Piaseczno Commune, 0.0507% in the Zielonki Commune, and 0.0553% in the Strzyżewice Commune. These values are comparable and relatively low. Nevertheless, the data show an increase in development in the aforementioned municipalities. The municipality of Strzyżewice exhibits the most significant growth. In contrast, the lowest observed trend is evident in the Zielonki Commune. Nevertheless, these differences are insignificant. It can thus be concluded that the gradual growth of development in these municipalities is at a similar level.

A comparison of land uses in a given commune allows for the determination of the municipality's profile and its comparison with other communes. To this end, pie charts were constructed, with 100% representing the area of the entire municipality. The municipality was divided into three categories: built-up areas (development areas), greenery and agricultural areas, and other areas. The respective shares were presented in percentage terms. A comparison of the ratio of built-up areas to green areas indicates the level of urbanisation in the municipality (Fig. 8) The study confirms that Strzyżewice Commune is predominantly agricultural, with the lowest level of urbanisation, whereas Piaseczno Commune has the highest level of urbanisation. The commune of Zielonki represents an intermediate level of urbanisation.

3.4. Spatial transformations

The analysis of the fragments of the village structure with the highest number of new developments in the surveyed communes shows the variety of forms and pace of development of the respective areas. In the municipality of Piaseczno, Józefosław is currently one of the largest villages in Poland. In 1998, the village had a population of 568 people; however, within the subsequent four years, this number increased more than fourfold, marking the beginning of an epoch of dynamic transformation and development in the area.

Between 2002 and 2021, the population increased six-fold, reaching 14,809 in 2021. The first Local Development Plans for individual areas of the

Table 6. Land use change in individual local authorities between 2014 and 2023

	Piaseczno		**Zielonki**		**Strzyżewice**	
	2014	2023	2014	2023	2014	2023
Municipal area (km^2)	**128.25**		**48.58**		**108.79**	
Area of development sites (km^2)	26.43	29.58	7.34	8.65	5.42	6.00
Area of green spaces (km^2)	94.11	90.58	39.51	37.97	101.11	100.45
Growth of development sites	**11.9%**		**17.8%**		**10.7%**	
Decline of greenery	**3.75%**		**3.90%**		**1.00%**	

Source: Own study

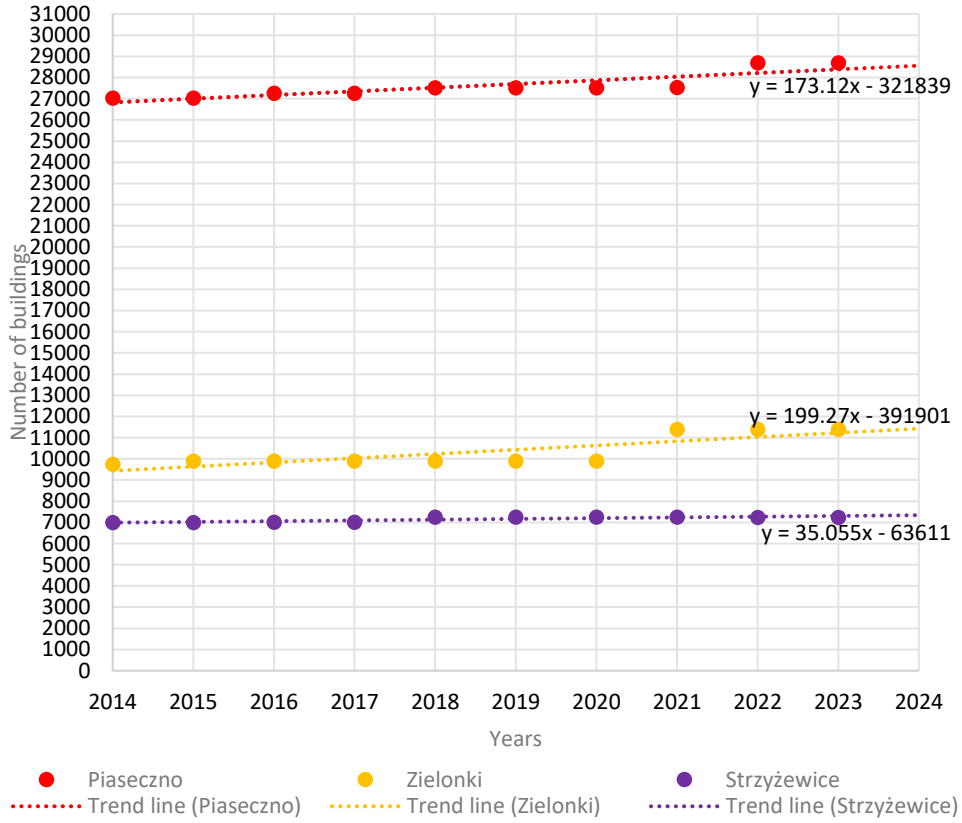

Fig. 7. Change in the number of buildings over the years
Source: Own study

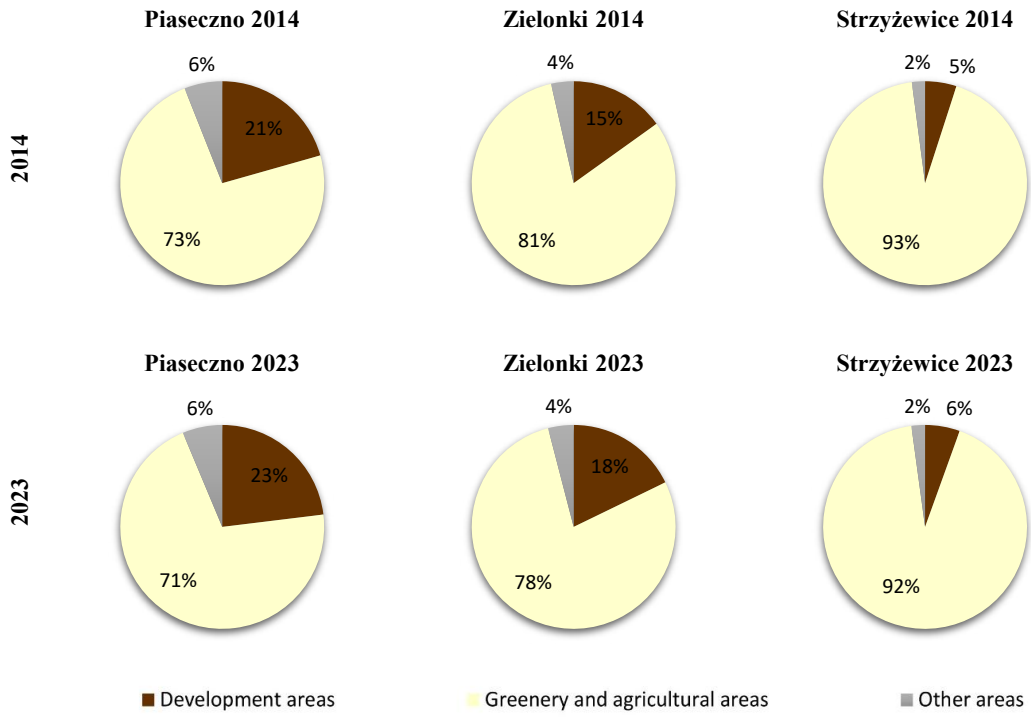

Fig. 8. Change in land cover structure within communes between 2014 and 2023
Source: Own study

Fig. 9. Spatial transformation of a fragment of Józefosław between 2002 and 2023
Source: Own study based on Google Earth Pro, 2023, Maxar Technologies, Landsat / Copernicus

village in 1994 and 1998 were in keeping with the character of the village through suburban character development, a clear street layout, provision for open space and green space (Gmina Piaseczno, 2017). Following the law amendment in 2003, investments were executed based on development conditions until the adoption of another local plan in 2006. In consequence of investors' requests and pressure on attractive areas, numerous changes were implemented that reduced quality parameters and urban planning indicators. Furthermore, there has been an under-investment in public spaces, landscaped green areas or road and pedestrian/ bicycle infrastructure (Mantey, 2014). Only the actions of the local community (Józefosław 2.0, 2023) and the Local Development Plan adopted in 2018 (Gmina Piaseczno, 2018) resulted in a new approach to the shaping of urbanised space – especially public space. Over the course of two decades, Józefosław has undergone significant developmental changes and as a result, its spatial image has been completely transformed. The area has evolved from an urbanising village to a continuous urban–rural continuum, which can now be considered a mature form of dispersed city (Fig. 9, Fig. 10). It is characterised by high-density (1.1–1.5), urban-style residential growth, manifested as compact, gated single-family estates (Fig. 11) of mainly terraced, semi-detached and multi-family housing built on a patchwork of agricultural plots. The result of spontaneous urbanisation is a chaotic arrangement of many small, ordered fragments that do not form a coherent overall spatial composition. Public spaces, particularly green spaces, are significantly underdeveloped, except for the surroundings of the implemented and transformed main street, (Note 6) which is the only arranged urban space.

In 1998, Zielonki had a population of 2,362. The population then rose to three and a half times that, to reach 8,240 in 2021. Throughout this period, the village has been transformed from a farmstead and single-family villa structure into a scattered, chaotic form without logical building layouts, traffic routes or public pedestrian connections (Fig. 12).

Fig. 10. The remaining agricultural areas between housing estates and the character of Cyraneczki Street, the main communication route of Józefosław
Source: Own Photographs

Fig. 11. Dense single-family housing estates located on agricultural plots – as the basic form of the urban fabric of Józefosław
Source: Own Photographs

Urbanisation intensified in the early 21st century (Fig. 13, Fig. 14), and areas close to the border of Kraków became attractive to developers, who began to invest intensively here (Blazy & Ziobro, 2023). Single-family developments frequently do not meet the required standards outlined in the local plan since 2007, such as a minimum of 50–60% biologically active areas allocated for residential development. The undeveloped areas are primarily used for residential or residential-service purposes without any services or green space available.

Agriculturally used areas are in direct proximity to newly constructed gated, quasi-urban settlements of varying degrees of intensity. In certain areas, their layout and structure are starting to resemble the mosaic and haphazard urban form of Józefosław.

In 1998, the population of Żabia Wola in Strzyżewice commune was 820. Initially, the population experienced minor fluctuations, followed by a slightly more dynamic growth, culminating in a count of 1,160 inhabitants in 2021. The analysis of changes in the study area indicates a rise in areas of development (Fig. 15), featuring solely detached single-family homes in the new structure. These developments go beyond additions to the existing rural fabric and manifests as isolated housing in the agricultural areas, contributing to dispersion. The provisions of the Local Plan of 2003 and its amendments of 2011–2012 and 2020–2021 (Note 7) (Wdowiarz-Bilska et al., 2022) allow the realisation of low single-family houses with a usable attic and a pitched roof (maximum height 9 m) (Fig. 16) and the preservation of at least 60% of biologically active area. The change of the urban planning indicators in a study adopted in 2022 (Gmina Strzyżewice, 2022b) is worrying due to the increase in maximum building height to 12 m and the decrease in the minimum indicator of biologically active area for residential development to 40%. Its adoption in the Local Plan under preparation (Gmina Strzyżewice, 2022a) may lead to a dynamic process of spatially unfavourable transformations similar to the dispersed and haphazard development in Zielonki or Józefosław.

Fig. 12. Spatial transformation of a fragment of Zielonki between 2007 and 2022
Source: Google Earth Pro, Image 2023 Maxar Technologies, Image 2023 Airbus

Fig. 13. Development at the edge of agricultural areas and along the planned exit route from Kraków to the ring road junction
Source: Own Photographs

Fig. 14. Intensive terrace housing was constructed prior to the passing of the MPZP in 2007, whereas the interior of the estate was built post-2017, in accordance with the MPZP
Source: Own Photographs

Fig. 15. Spatial changes of a part of the Żabia Wola between 2010 and 2021
Source: Google Earth Pro, Image 2023 Maxar Technologies

Fig. 16. The development of the studied fragment of Żabia Wola in Strzyżewice of mixed character – single-family and farmstead development
Source: Own Photograph

4. Planning concept

The author's research project, commissioned by the County of Lublin, on the development of Green Human Space (GHS) (Wdowiarz-Bilska et al., 2022) addresses the dispersed city issue by providing a tool to control development. The tool is an innovative planning concept on a regional scale, covering the area of several neighbouring municipalities linked to the guidelines for the local plan. This view, based on spatial and statistical data, enables the programming and distribution of new multifunctional complexes with a centralising role in the settlement structure. Modelling their distribution on a regional scale influences the realisation of a concentrated layout on a local scale. Such a form of elaboration integrating both approaches "from the general to the detailed and back again" is not used in Poland.

A concept for a regional and local modern technology cluster, based on the principles of sustainable development, has been elaborated on the basis of planning, natural, cultural and social analyses. The proposed solutions aim to strike a balance between the protection of natural and cultural elements and the area's development. It was assumed that the key areas and connections with the Lublin urban area will be arranged meridionally in the proposed plan. The central region of activity is the Green Corridor along the valleys of the Bystrzyca and Kosarzewka rivers, which is protected by various forms of regulations (Fig. 17). The concept involves the distribution of centralising functions, including research and development centres, technology parks, areas with increased economic activity, or tourist attractions that relate to the promotion of the area's endogenous potential. Numerous significant valuable manors and palace-park complexes in the vicinity have been considered in the proposed concept as components to be adapted for new functions, in line with the approach proposed, for example, in "Heritage Planning" (Ashworth, 2015). The clustering of economic activity in certain zones allows for the local concentration of the development of services and production and, consequently, of housing. Thus, the potential for a polycentric design with focused settlement clusters is anticipated. By highlighting the value of the natural surroundings and cultural landmarks, a framework for purposeful urbanisation is established through the creation of a development grid for the southern region of Lublin.

Alongside the dispersal of central urban functions, the second crucial aspect in ordering the area and establishing a structure for urbanisation is the proposed system of green spaces. Open areas will be used to form a network of public spaces, integrating the whole area and providing a grid for subsequent investment. Any development ought to be concentrated in places neighbouring the development drivers – the leading functions. To maintain the landscape's character, its parameters should not surpass the currently appropriate values. At a local level, there are two proposed solutions for the system of public and semi-public spaces, which define the individual areas and the way in which they are delimited.

The areas designated for leisure, recreation and tourism are clearly defined, as is the area associated with the office function – promoting informal contacts within the technology centre community.

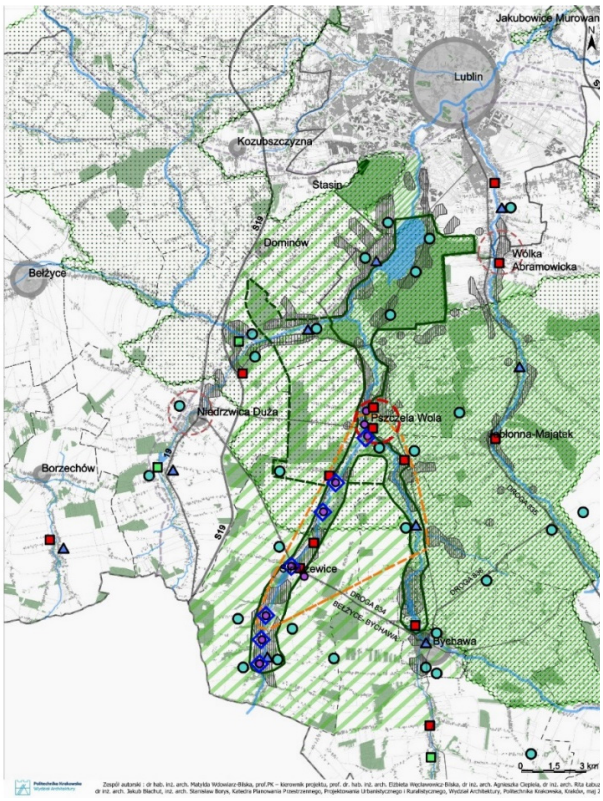

Fig. 17. The concept of compositional and functional connections of GHS on a regional scale
Source: Wdowiarz-Bilska et al., 2022

The public green space, which forms the nucleus of the investment, acts as a central system and controls traffic flow with the creation of pedestrian and bicycle circulation routes. Furthermore, green access links and corridors are established as a result (Fig. 18). Their presence in the village structure sets the framework for possible urbanisation. The shaping of the intimate zones has been planned in such a way as to offer the possibility of creating a network of spaces of new quality linking the centralising components of the GHS with the neighbouring villages and integrating the leading functions of the whole development. The location and selection of the "drivers of development" were proposed, bearing in mind the nature of the existing spatial structure, including small-scale residential development. By creating the core of the spatial structure as a system of public spaces integrating central functions, an attempt was made to enable its guiding values for the surrounding areas.

5. Discussion and conclusions

The presented study focuses on the economic, social and spatial changes that occur in municipalities located at the city edge, which are often those most favoured as residential areas (Jansen, 2020). Therefore, it is important to identify and solve problems related to peri-urban development by creating effective tools and strategies. In accordance with the conclusions of other studies (Korwel-Lejkowska, 2021), this study used a comparison of statistical data and BDOT10k vector data to observe transformations and related spatial problems. The results of the study provide an overview of the problem of rural transformation in the urban areas of selected Polish metropolises.

The presented research suggests that the phenomenon of development dispersal results in an urbanised area with a disordered, random and continuous structure. The largest aggregations of development are typically situated close to a major urban centre – as larger clusters or arranged linearly along transportation roads. The subsequent replication of this process in neighbouring villages leads to the development of a diverse, complex and mosaic-like dispersed urbanised structure. It has undefined spatial form, constituting a rural centre with urban structural and functional characteristics. The proliferation of developmental settlements and the density of buildings in the village transform its spatial, social and functional character. The phenomenon of uncontrolled dispersed development is widely reported. However, recent studies indicate that this spatial chaos is not the result of uncontrolled development, but rather the consequence of the inadequate planning tools, including land development and zoning policies, that have been in place in Poland to date (Zawadzka & Czochański, 2024). The findings of our research substantiate this assertion. The municipalities in question have had local zoning plans in place for approximately two decades. Nevertheless, the development patterns observed are characterised by a dispersed arrangement. In light of these findings, it is evident that further work and proposals for alternative planning tools are necessary. Such tools (documents) may be regarded as non-mandatory, reflecting a soft planning approach (Belof, 2013).

The comparison of the three municipalities and villages shows that the studied units are on identical or similar paths of development. The process of rural–urban conversion takes different forms in each of these communes, reflecting the different stages of development of the dispersed city: initial, advanced

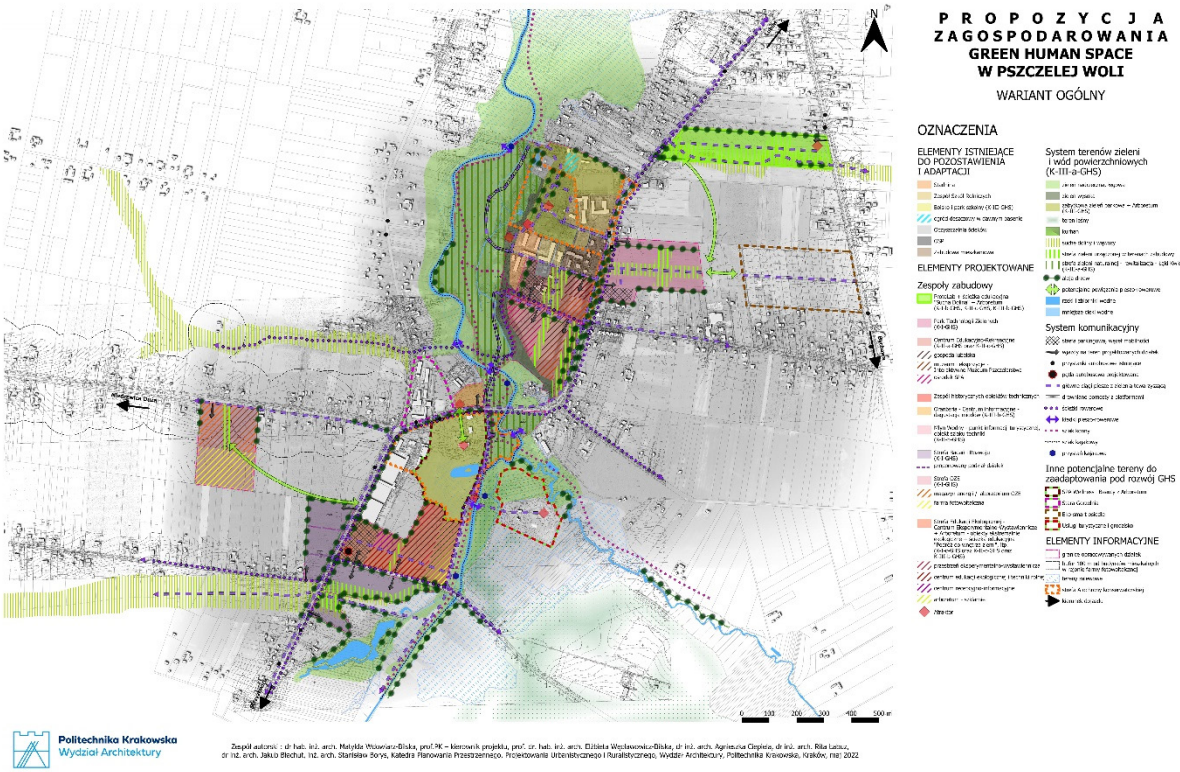

Fig. 18. Concept for the Development of Green Human Space in Pszczela Wola
Source: (Wdowiarz-Bilska et al., 2022)

and completed. Therefore, the transformation of rural landscapes into urbanised areas is merely a matter of time, implying that the current spatial planning mechanisms are inadequate to guarantee spatial coherence and orderly development. On the contrary, the dispersal and emergence of chaotic and sub-standard urban layouts have been observed in all analysed examples with the current local plan in force. To achieve a proper, sustainable and balanced spatial development pattern, local authorities should use dedicated and specialised design instruments. One such instrument is the authors' regional planning concept, which involves distributing centralising functions in a controlled and optimal way. This strategy presents the potential to form new, multifunctional units in the settlement structure, merging various urban and rural functions in a harmonious system. Sufficient targeting at the regional level has the potential to produce tangible implementation on a local scale.

Notes

1. In 2023, the proportion of Poland's population residing in urban areas totaled 60.2%, as opposed to 61.8% in 2000. (Szymańska, 2002) The trend of decreasing urbanisation is characteristic of post-socialist countries. Out of the 230 surveyed countries, only 12 experience a population outflow from cities, including Poland, as well as Bulgaria, Estonia, Latvia, Lithuania, Romania, Ukraine, and Japan, after: https://www.cia.gov/the-world-factbook/field/urbanization (7 October 2023).
2. Division adopted from the methodology of Prof. Rudolf Giffinger's team for the project "smarteuropeancity" (European Smart Cities, 2015).
3. Classification of local administrative units made by measuring population density and geographical continuity of grid cells with a 1-km^2 resolution and then assigning them according to a specific methodology to one

of three groups of units: cities, small towns or suburbs, rural areas (Eurostat, 2014).
4. Values exceeding 300 people/km^2 Source: Regional typology according to Eurostat: https://bdl.stat.gov.pl/bdls/metadane/agregaty (Accessed: 02 October 2023).
5. For Piaseczno between 1998 and 2006, and for Zielonki between 2002 and 2006.
6. The main street of Jozefoslaw is formed by Kuropatwy and Cyraneczki streets.
7. The amendment to the local plan, for clusters of individual plots, concerned 95 areas in Żabia Wola, which constituted 20% (the largest share) of all local plan changes in the entire municipality.

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