



Original article

The impact of residential suburbanization on changes in the morphology of villages in the suburban area of Wrocław, Poland

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ABSTRACT

Residential suburbanization is one of the most spontaneous processes occurring in the surroundings of large cities in Central and Eastern Europe. In the case of Wrocław, the first phase of suburbanization began as early as the second half of the 19th century. Its spatial scope changed with the expansion of the administrative borders of the city between 1924-28 and 1950-73, when dozens of suburban villages were incorporated into the city. In addition, during the socialism period, the intensity of suburbanization decreased significantly, which was related to the development of the city within the conditions of planned urbanization and industrialization of the country. The second phase of suburbanization began with the system transformation in the 1990s, and its scale and intensity increased in the 21st century. New construction in the hinterlands of the city has contributed to significant changes in the morphology of suburban villages, especially as the growing share of new buildings is multi-family housing. The aim of this article was to identify the most common trends in the morphological changes that affect villages located in the suburban area of Wrocław under the influence of residential suburbanization. Using the analysis of cartographic materials, field research and graph methods, a typology of morphological transformations of villages located in the suburban area was proposed.

KEY WORDS: residential suburbanization, morphology of suburbs, morphological transformations, urban sprawl, construction traffic, Wrocław

ARTICLE HISTORY: received 8 May 2020; received in revised form 26 October 2020; accepted 10 November 2020

1. Introduction

The development of residential housing is one of the distinctive features of contemporary suburban areas. The intensity of construction traffic in suburban areas is a function of size and distance to the urban centre (BAŃSKI, 2008). This is evidenced in studies on the construction traffic and areas surrounding the cities of Lublin (WESOŁOWSKA, 2006), Kraków (JAKÓBCZYK-GRYSZKIEWICZ, 1998; MUSIAŁ-MALAGÓ, 2014; RAŻNIAK & BRZOSKO-SERMAK, 2014), Łódź (JAKÓBCZYK-GRYSZKIEWICZ, 1998; WÓJCIK, 2006), Warsaw (JAKÓBCZYK-GRYSZKIEWICZ, 1998; MAJEWSKA ET AL., 2015; MANTEY & SUDRA, 2019; SUDRA, 2020), Tricity (DZIAŁEK, 2012) or Wrocław (MISZEWSKA, 2001; ZATHEY, 2002; GONDA-SOROCZYŃSKA, 2009;

NAMYŚLAK & SIKORSKI, 2010). Residential construction is centred in the vicinity of the main transportation routes (mainly roads) along which sectors of intensified economic activity emerge, where commerce, services and production activities thrive in addition to construction (WÓJCIK, 2006; BAŃSKI, 2008; BIEGAŃSKA, 2019). This gives rise to changes in the existing spatial layout (morphology) and the physiognomic characteristics of rural-type settlements (MISZEWSKA, 1985; MANTEY & SUDRA, 2019; SUDRA, 2020). The new housing estates in the suburban areas are distinguished by their modernness, and at the same time, typical of the peripheral parts of the city, the character of the buildings. This contributes to the degradation of the traditional rural landscape (GONDA-SOROCZYŃSKA,

2009; STASZEWSKA, 2012). Expansion of the residential function is accompanied by improvements in the living conditions in rural areas and modernization of technical and social infrastructure, coupled with better accessibility to transportation and improved quality of services (BAŃSKI, 2012). Furthermore, urbanization pressures in the suburban areas may also lead to patterns of scattered housing (SUDRA, 2016, 2020) characterized by heterogeneity, fragmentation and low intensity usage of the land (BATTY ET AL., 2002; SOULE, 2006) in the outskirts of the city and in the suburban zone (LISOWSKI & GROCHOWSKI, 2009).

The problem of morphological transformations of villages surrounding Wrocław induced by suburbanization, had already been observed in the eighties (MISZEWSKA, 1985); still, the suburbanization processes intensified after 1989 (MISZEWSKA, 2002; ZATHEY, 2002; GONDA-SOROCZYŃSKA, 2009; MALESZKA & SZMYTKIE, 2009; KAJDANEK, 2011). The suburban zone of Wrocław is currently one of the most rapidly growing areas in the country (see BAŃSKI, 2008; GAŁKA & WARYCH-JURAS, 2011; ZBOROWSKI & RAŻNIAK, 2013; HEFFNER, 2016; ŚLESZYŃSKI, 2016; BIEGAŃSKA, 2019), also in terms of the spatial aspect, as a result of the influx of new inhabitants and the intensive construction traffic in the area (ZATHEY, 2002; GONDA-SOROCZYŃSKA, 2009; NAMYŚLAK & SIKORSKI, 2010; KAJDANEK, 2011; SZMYTKIE, 2019). This area can be considered a model of other suburban areas in Poland because of its long duration and substantial dynamics of the suburbanization processes in the area surrounding Wrocław.

The main aim of this article was to identify the main directions of the morphological transformations of villages located in the suburban zone of Wrocław. The existing spatial layout of the local villages can be attributed to the accumulation of residential suburbanization processes in this area from the end of 19th century onwards. The process can be divided into two core phases which have taken place on either side of the year 1989 which was the starting point of political, social and economic transformation in Poland, and marked the beginning of the contemporary suburbanization processes). This analysis focused on changes in the original spatial layouts of villages induced by intensive construction traffic in the area surrounding the city, leaving aside the physiognomic aspect of those processes. In this context, the article addresses the following questions: (1) Is there a particular standardized pattern that can be used to describe the morphological transformations of villages located in suburban areas? (2) What are the models of morphological transformations of suburban villages? (3) Does intensive construction traffic in

the city's surrounding area lead to unification of the spatial layout of suburban villages?

2. Theoretical background

Construction traffic in Poland in the period 1945-1989 was particularly intense in large cities and in new industrial centres. During the early years after World War II, the cities that had been destroyed had to be rebuilt and the population had to be provided with sufficient housing (see ANDRZEJEWSKI, 1977; KALIŃSKI, 1977; LUBOCKA-HOFFMANN, 1998, JOHNSON, 2000). In the following years, residential construction was orchestrated according to a central planning system typical of the socialist states, and focused on industrialization and urbanization, favouring the development of large cities. Up to 1989, a significant portion of migration was attributed to official governmental policies that promoted the growth of large cities and bigger towns to provide the necessary industrial labor force (DAWSON, 1987; PACIONE, 2001; SZYMAŃSKA & MATCZAK, 2002). It was not until the political transformation of the 1990s and the resulting social and economic transitions (market-oriented growth) that individualized residential construction started to develop (SCHNEIDER-SLIWA, 2006; LEETMAA ET AL., 2009; KUBEŠ, 2013; ZBOROWSKI & RAŻNIAK, 2013). This marked an entry into the second phase, or urban sprawl, in Poland and throughout Central and Eastern Europe, marked by the dynamic and vibrant spatial spread of cities and the development of suburban zones (WĘCŁAWOWICZ, 1992; SYKÓRA, 1999; LOWE & TSENKOVA, 2003; HAMILTON ET AL., 2005; NUISSL & RINK, 2005; SCHNEIDER-SLIWA, 2006; STANILOV, 2007; MARTYNIUK ET AL., 2016). Moreover, the scale and spontaneity of the process may be attributed to the need to catch up with similar processes taking place in Western Europe throughout the post-war era. A number of core suburbanization phases were identified based on observations of the transformations taking place in recent years in the suburban zone of Wrocław (BREZDEŃ & SZMYTKIE, 2019):

1. settling of migrants from a large city into the suburban zone, with the development of residential districts composed of detached houses;
2. emergence of small businesses in suburban districts and transformation of local social structures;
3. emergence of large-surface economic activities (commerce, industry facilities) in the suburban zone, and diversification of residential construction within these areas.

Residential suburbanization is one of the forms of suburban development. It can be defined as the outflow of the population from central sections of cities to new residential buildings in suburban zones. Residential suburbanization affects both locations, the destination sites (suburban areas) and the locations which are left behind (old urban areas and inner-city areas, multi-family housing districts) (OUŘEDNÍČEK, 2007). Residential suburbanization is related to the development of new settlement structures in the suburban zone, which contributes to an increase in the share of built-up and urbanized land at the expense of agricultural areas and green fields (SÝKORA, 2001; MATLOVIČ & SEDLÁKOVÁ, 2007; KUBEŠ, 2015). The main drivers of residential suburbanization include the lower cost of land in the suburban zone, development of roads and individual car transport, rising prosperity of society, decapitalization of urban buildings and the growth of social pathology in centres, a desire to improve housing conditions, the supportive policy of suburban municipalities or pressures imposed by developers (SÝKORA, 1999; MATLOVIČ & SEDLÁKOVÁ, 2007; SÝKORA & OUŘEDNÍČEK, 2007; HEŁDAK, 2010; ZBOROWSKI & RAŹNIAK, 2013; KUBEŠ, 2015; KOVÁCS ET AL., 2019). The negative consequences of residential suburbanization may include shrinking of agricultural areas, increased road traffic on access roads to the cities, underdevelopment of local services in the suburban zone, irrational use of land, soaring costs of infrastructure network construction attributed to ill-thought-out use of space or environmental devastation (see KAHN, 2000; ZBOROWSKI & RAŹNIAK, 2013; HEFFNER, 2016; ŹRÓBEK-RÓŹAŃSKA & WOLNY, 2017; LITYŃSKI & HOŁUJ, 2020).

The most common spatial (morphological) forms of urban sprawl (BRUECKNER, 2000; CARRUTHERS & ULFARSSON, 2003; EWING, 2008; SZYMAŃSKA & BIEGAŃSKA, 2011; GHANI ET AL., 2014; SUDRA, 2016) include:

- low density sprawl – a city surrounded by a ring of suburbs, amorphous spatial structures, blurred city-village transition zones, low floor area ratio, development of infrastructure networks outpaced by intensive construction traffic;
- ribbon sprawl – a development in which buildings are constructed along road ribbons and in nodes joining the ribbons, whereas more remote areas are initially green zones or agricultural areas, which are built-up in the next stage when the value of real estate increases and infrastructure can be led to the remote sites.

- leapfrog sprawl – clusters of new residential buildings are built in the middle of fields or suburban forest areas; this pattern can also be attributed to the surrounding land topography, but also to the prices of land, different policies of municipalities and undertakings of residential developers; leapfrog sprawl leads to landscape fragmentation and increased infrastructure expenditure.

3. Data and methods

The research performed for the purpose of this analysis was divided into several essential stages. The first step was to identify suburbanization processes in the area surrounding Wrocław before 1989. Here, a morphogenetic approach was adopted (KOTER, 1994), which was based on the available cartographic materials (German topographic maps of 1850-1945¹) and literature resources (e.g. MALECZYŃSKI ET AL., 1956; SZULC, 1963; MISZEWSKA, 1985, 1995, 1996, 2001, 2002). The second stage of research was focused on identifying contemporary residential suburbanization processes by analyzing statistical data of the Local Data Bank (LDB) of the Central Statistical Office in Poland (GUS) and archival statistical yearbooks of the former Wrocław Voivodship. Data were collected concerning population figures, the factors of population growth, and the number of flats handed over for use to identify changes in population and construction traffic in the suburban area in the period 1989-2018. The majority of analyses were conducted on a municipal basis due to the limited availability of data (in terms of subject-matter and the time scale). Data on construction traffic in individual statistical localities were also used. These data were only available for the period 2008-2017. The annual number of flats handed over for use in individual localities varies considerably, which is typical for small populations and can also be attributed to the specifics of residential construction, and therefore the figures were averaged for the whole period of analysis.

The main part of the analysis, covering the third and the fourth stage of research, was intended to identify and typify morphological changes in contemporary localities in the suburban area. The third stage of research was dedicated to changes in the morphology (spatial structure) of localities analyzed with the use of graph theory. According to ZAGOŹDŹON (1970), graph theory can be of use in studies on the morphological structure of settlements. The values of synthetic graph

¹Available at <http://igrek.amzp.pl/>

development indexes by SZMYTKIE (2014, 2017) were analyzed, which vary depending on the relative number of edges in relation to the number of nodes (β index) and the number of cycles (street blocks), which denote the complexity of the spatial pattern of individual settlements and are also typical elements of the urban landscape, and the average rank of nodes of a graph, which expresses the degree of complexity of a street network (the rank of nodes should be determined on the basis of an incidence matrix). Cartographic materials presenting the coverage of built-up areas in settlements in the three periods were used in the analysis of morphological elements:

- Messtischblatt topographic maps, at a scale of 1:25000, and dated around 1935, sheets for: Auras, Breslau – Lissa, Breslau [Nord.], Leuthen, Nadlingen, Rothbach, Schmolz, Sibyllenort, Wiese;
- topographic maps presenting the layout in 1965, at a scale of 1:25000, dated around 1975, sheets for: Długoleka, Gniechowice, Lutynia, Radwanice, Środa Śląska, Trzebnica, Wrocław, Wrocław – Fabryczna, Wrocław – Pracze, Zbytowa;
- TOPO background map (www.geoportal.gov.pl) featuring the current spatial data.

The fourth stage of research was to identify the basic models of morphological transformation induced by residential suburbanization, typical for villages located in the suburban zone. Here, as in the first stage of research, a morphogenetic approach was employed based on archival Messtischblatt topographic maps, at a scale of 1:25000, dated between 1875-1945 as well as contemporary digital maps available on geoportals (spatial information systems) for individual districts (powiat)².

4. Time and spatial frames of the analysis

This article presents research limited to the villages located in the suburban area of Wrocław, or the ring of communes bordering the capital city of the Lower Silesia region, based on the definition proposed by STRASZEWICZ (1985). The villages located in this area have been subjected to very intensive suburbanization processes and have been exposed to strong morphological transformations (ZATHEY, 2002; GONDA-SOROCZYŃSKA, 2009; MALESZKA & SZMYTKIE, 2009). The spatial scope of this article

consists of the following communes: Oborniki Śląskie i Wisznia Mała (Trzebnica district), Długoleka, Czernica, Siechnice, Żórawina, Kobierzyce i Kąty Wrocławskie (Wrocław district) oraz Miękinia (Środa Śląska district). The suburban zone analysed covers an area of 1278.5 km² and has a population of 173,000 inhabitants (2018) (Table 1).

The analysis of morphological transformations of villages located in the suburban zone surrounding Wrocław was based on cartographic materials dating back to various periods. It was assumed that the suburbanization processes in the area surrounding Wrocław were initiated in the late 19th century (see SZULC, 1963; MISZEWSKA, 1985, 1995, 2001). The first phase of intensive suburban development of Wrocław was impeded by changes in the political and economic situations after World War II and the territorial development of the city to which over 60 suburban localities (including 3 former towns) were incorporated in the period between 1924-1973³. Widening the city boundaries increased its administrative area from 49.2 to 292.8 km² (SZMYTKIE, 2011, 2019). The second suburbanization phase around Wrocław began in the 1990s and coincided with the political, social and economic transformation in Poland (BREZDEŃ & SZMYTKIE, 2019).

Detailed analyses were conducted for over 34 rural localities⁴ (Fig. 1) where the most notable morphological transformations took place during the post-war period. These transformations included the dynamic development of residential housing (mainly single-family houses; multi-family buildings were less common), and in some cases also with the emergence of large-area economic zones in the local area (close to the village settlement, or in the plains) (e.g. the villages Błonie and Źródła in Miękinia commune or Biskupice Podgórne in Kobierzyce commune).

²<https://www.geoportal.Wroclaw.pl/> (the city of Wrocław);
<https://www.wrosip.pl/> (Wrocław district);
<https://sredzki.webewid.pl/cms/> (Środa Śląska district);
<https://trzebnicki.e-mapa.net/> (Trzebnica district)

³This phase specifically applies to the rural localities which underwent the most profound morphological transformations before the year 1945 (MISZEWSKA, 1995, 1996, 2002).

⁴Siechnice, a locality which became a town in 1997, was also included in this group.

Table 1. Basic data about communities in suburban zone of Wrocław

Community (gmina)	Area (km ²)	Population		Growth of population	Population density	
		1989	2018		1989	2018
Czernica	83.6	6903	15573	125.6%	83	186
Długołęka	212.8	16241	32153	98.0%	76	151
Kąty Wrocławskie	176.7	16655	24639	47.9%	94	139
Kobierzyce	149.3	11117	21097	89.8%	74	141
Miękinia	179.5	10725	16175	50.8%	60	90
Oborniki Śląskie	154.3	15745	20209	28.4%	102	131
Siechnice	98.7	12182	21960	80.3%	123	222
Wisznia Mała	103.4	6621	10370	56.6%	64	100
Żórawina	120.3	7721	10865	40.7%	64	90
Suburban areas	1278.5	103910	173041	66.5%	81	135

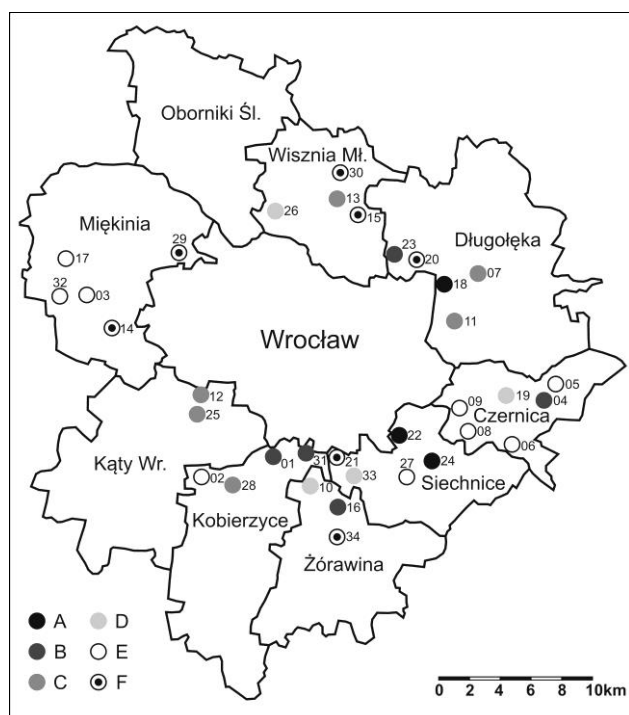


Fig. 1. Settlements in the suburban zone of Wrocław for which morphological changes were analyzed

1) Bielany Wrocławskie, 2) Biskupice Podgórne, 3) Błonie, 4) Chrzastawa Mała, 5) Chrzastawa Wielka, 6) Czernica, 7) Długołęka, 8) Gajków, 9) Kamieniec Wrocławski, 10) Karwiany - Komorowice, 11) Kietczów, 12) Krzeptów, 13) Ligota Piękna, 14) Lutynia, 15) Malin, 16) Mędłów, 17) Miękinia, 18) Mirków, 19) Nadolice Wielkie, 20) Prusowice, 21) Radomierzce, 22) Radwanice, 23) Ramiszów, 24) Siechnice, 25) Smolec, 26) Szewce, 27) Święta Katarzyna, 28) Tyniec Mały, 29) Wilkszyn, 30) Wisznia Mała, 31) Wysoka, 32) Źródła, 33) Żerniki Wrocławskie, 34) Żórawina. Morphological types of settlements mentioned in the text.

5. Suburbanization around Wrocław in the period 1870-1989

The borders of the city of Wrocław were demarcated by the city walls and a moat in the Middle Ages until the 19th century. The city walls

were surrounded by a ring of suburbs (Oławskie in the east, Świdnickie in the south, Mikołajskie in the west, Odrzańskie and Szczytniki in the north), which were closely linked with the city itself⁵. Vegetable, peasant, farming and fishing villages, whose morphologies date back to medieval times, were located a greater distance from the borders of the city. The spatial development of the city began in 1807 with the decision of Napoleon Bonaparte to demolish the city walls (MALECZYŃSKI ET AL., 1956). Suburbs were incorporated into the borders of Wrocław in 1809. As a result, the administrative area of the city increased from 3.5 to 20.5 km², and the population rose to 78,100 in 1819. Due to the significant increase in the number of inhabitants, the areas incorporated into the city were characterized by increased construction traffic. With the dynamic development of the local industry, Wrocław attracted numerous migrants from rural areas who settled mainly in tenement houses outside the Old Town. The development of the city accelerated even further after the first railway line reached Wrocław in 1842. The total population size in 1852 was 120,100. By that time Wrocław was overcrowded and rapidly expanding, and new areas for real estate development were badly needed (SZMYTKIE, 2019). Hence, the so-called vegetable villages located to the south of the city (MISZEWSKA & SZMYTKIE, 2015) as well as the villages of Rybaki and Szczytniki located on islands on the River Oder which were incorporated into the borders of Wrocław city in 1868. As a result, the area of the city increased to 30.2 km², and the population soared to 208,000 in 1871. The development of the city of Wrocław was accompanied by the dynamic growth of suburban localities, in particular the villages adjacent to the city borders. Each extension of the city borders has resulted in the extension

⁵ Suburban population was often included in the city population.

of the dynamically developing suburbs (SZMYTKIE, 2019).

A map of the Wrocław district (powiat) of 1893 (Fig. 2) presents suburban villages of various morphologies to the south (Dürrgoy – Tarnogaj, Herdain – Gaj, Kleinburg – Borek), west (Pöpelwitz – Popowice) and north (Rosenthal – Różanka, Carlowitz – Karłowice, Friedewalde – Kowale) of the compact city, which later underwent transformations as a result of their close proximity to the city centre. The city borders were again extended in the period between 1895-1911 to include suburban villages undergoing urbanization, and the city area grew to 49.2 km². However, this failed to significantly reduce the population density within the borders of the city as at that time the population of Wrocław increased to 335.200 in 1890 and to 526.200 in 1911; the population density reached 10.700 per 1 km². The city did not suffer any major damage, or population loss, during the First World War. There was a significant increase in the city population in the 19th century, and the growing wealth of society, the development of services and the increasing demand for housing fueled demand for free space. Wrocław was overcrowded, densely populated, and was virtually bursting at

the seams. There was a scarcity of green areas and free space, which prompted a wider-scale extension of the administrative borders of the city in the period between the two World Wars. The village of Sępólno was incorporated in 1924, two former towns (Leśnica and Psie Pole) and 30 villages were incorporated in 1928 (Fig. 3). Thus, the city area increased to 175.1 km², and the population grew to 625.200 in 1933. In response to the overcrowding, there were city-gardens (Karlowitz – Karłowice) and tenement residential districts (Kl. Gandau – Gądów Mały, Pilsnitz – Pilczyce, Zimpel – Sępólno, Bischofwalde – Biskupin) erected on the outskirts of the city, in addition single-family housing areas for workers in former villages were incorporated into the city (Neukirch – Żerniki, Pilsnitz – Pilczyce, Kosel – Kozanów, Goldschmiedem – Złotniki, Stabelwitz – Stabłowice, Masselwitz – Maślice) or in the suburbs (Klettendorf – Klecina, Opperau – Oporów, Wasserborn – Radwanice) (Fig. 4). As a result, the morphology of the villages incorporated into the city has changed significantly (MISZEWSKA, 1996, 2002; KOTER & KULESZA, 2010). However, agricultural land accounted for a vast share of these localities (SZMYTKIE, 2019).

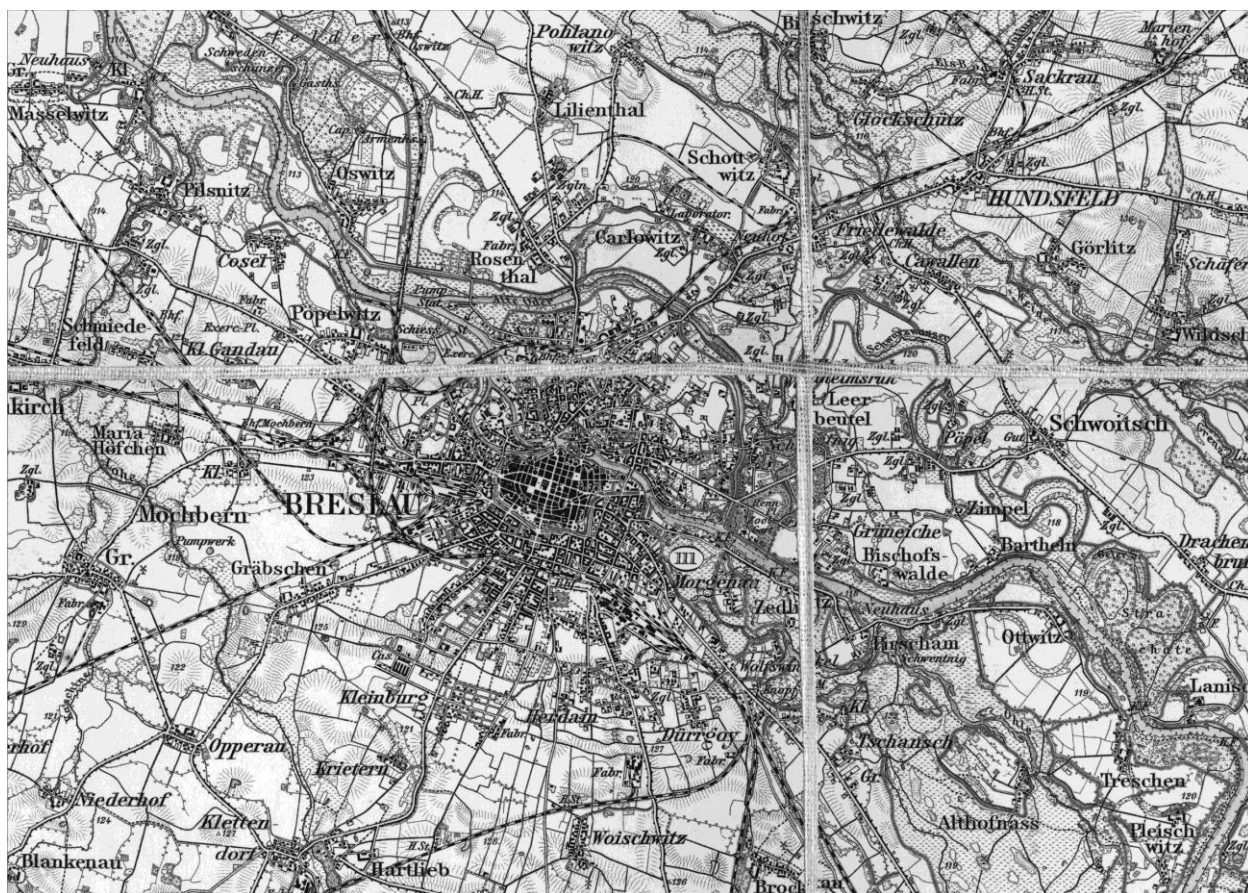


Fig. 2. Wrocław district in 1893



Fig. 3. Wrocław in 1928



Fig. 4. Wrocław district in 1939

In the post-war period, Wrocław continued to expand its territory, although at a slower pace than in the interwar period. This was mainly attributed to the huge damage suffered during World War II – around 70% of buildings were destroyed or damaged, mainly in the central districts. The majority of the city's population was evacuated during the siege of the Festung Breslau. After the war, the German population was forced to leave the city and was replaced by incoming Polish citizens, but the city was resettled gradually (the population of Wrocław in 1946 was only 170,700). In the subsequent years the population grew rapidly to 308,900 by 1950, 430,500 in 1960, and 526,000 in 1970. New residential buildings were mainly erected in the place of buildings destroyed during the war, and new developed areas (high-rise blocks of flats) were built predominantly in the peripheral districts of the city. Agricultural areas continued to account for a considerable share of the urban land. Nevertheless, the town of Brochów and 9 more villages were incorporated into the city in 1951, located mainly to the south of Wrocław and forming a strongly urbanized suburban area closely linked to the city. The administrative borders of the city changed again in the period 1970-1973. A total of 14 villages were incorporated into the city over this period (located in the south-western and western outskirts of the city), and the city area grew to 292.8 km², and the population rose by 9,179 inhabitants (SZMYTKIE, 2019). With such a significant expansion of the administrative borders of Wrocław in the 20th century, the suburban zone was shifted 3 to 7 km away from the compact urban development, which essentially coincides with the city territory of 1911. Beyond this area, there is a zone of island-like peripheral residential districts. Some of the incorporated villages preserved the rural characteristics as they are far away from the city (10-13 km) and have poor functional and spatial links to the city centre (SZMYTKIE, 2011). Another group of villages are those where large residential estates were built after the villages were annexed (which was accompanied by a significant growth in the local population); hence, the villages were transformed into large genetic centres surrounded by new residential developments (MISZEWSKA, 1996, 2002). MISZEWSKA (2001) argues that the morphological transformations of residential estates located next to the main traffic routes to and from the city were more profound than in the residential estates located more peripherally in relation to the compact urban development.

The period 1945-1989 was marked by stagnation in the development of the suburban zone, which was predominantly used as a food-producing area

for the city. This can be attributed to the relocation of the suburban area away from the compact urban development, but also to the philosophy of accelerated social and economic development of the country pursued after World War II, based on the process of planned industrialization and urbanization. Central industrial investments were allocated mainly to large cities (DZIEWOŃSKI, 1990). It may be argued that the system of central planning focused on industrialization and that urbanization in fact impeded the suburbanization processes in the socialist states of Central and Eastern Europe (FISHER, 1962; FRENCH & HAMILTON, 1979; BERTAUD & RENAUD, 1997; CROWLEY & REID, 2002; BERTAUD, 2006). Wrocław was not an exception – the first suburbanization phase was visibly inhibited by the new political and economic situation after World War II, as evidenced in the studies by MISZEWSKA (1985), or the analyzes of population changes in suburban villages (MALESZKA & SZMYTKIE, 2009). Not only the intensity, but also the spatial scope of morphological transformations decreased during this period, and the changes were limited to single villages located in the suburban zone, usually within a close distance to the city, e.g. Bielany Wrocławskie, Długołęka, Kiełczów, Mirków, Wisznia Mała or Radwanice.

6. Contemporary residential suburbanization around Wrocław

The development of suburbanization processes after 1989 in the area surrounding Wrocław is best illustrated by an analysis of demographic changes in the suburban area. The population of 9 communes located in the first ring of the suburban zone steadily increased from 103,900 in 1989 to 173,000 in 2018 (by 66.5% and 2.29% annually). In addition, the rate of population growth has been on the rise, from 0.4% per annum in the period 1989-1993, to 0.8% per annum in the period 1994-2001, and 1.4% in the period 2002-2005. Since 2006, the rate of population growth remains at a level of over 2.0% (2.9% on average). The highest increase in population growth was recorded in the rural communes (municipalities, gminas in Polish) of Czernica (125.6%), Długołęka (98.0%) and Kobierzyce (89.8%), and the urban-rural commune of Siechnice (80.3%) in the western and south-western outskirts of the city of Wrocław. The lowest population growth rate was recorded in the commune of Oborniki Śląskie (23.3% in the town and 32.8% in the rural part of the commune), in the town of Kąty Wrocławskie (40.6%) and the rural commune of Żórawina (40.7%) (Table 1). An analysis of the drivers of demographic changes in

the suburban zone (Fig. 5) provides us with interesting information. The rate of population growth in the first years of the transformation period progressively declined from 5.1‰ in 1989 to -0.9‰ in 2003, it then increased to 5.0‰ in 2018. The net migration rate dynamically increased from -6.8‰ in 1989 to 24.0‰ in 2007 to stabilize at around 20.0-25.0‰ per annum. According to the WEBB typology (1963), this marks the transit of suburban space to type H in 1989, via type A in the period 1990-1993, to type C from 1994 onwards

(with a year's break to type D in 2003). The main driving force of demographic changes in this area was the positive net migration rate from 1994, denoting a significant (and increasing) influx of migrants to the suburban area. Is it also accurate to say that the population growth in the suburban area of Wrocław until 2003 reflected country-wide tendencies, and the increase in birth rates in recent years can be interpreted as a consequence of migratory flow and rejuvenation of the population in the suburban zone.

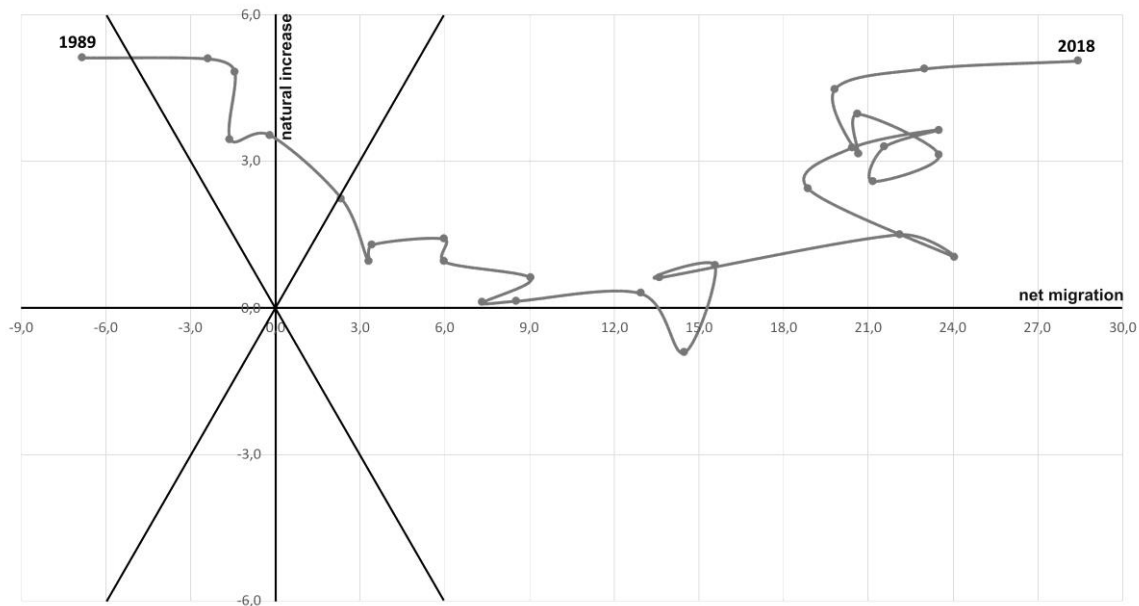


Fig. 5. Dynamic WEBB (1963) diagram for the suburban zone of Wrocław (1989-2018)

The migratory flow and significant rise in population numbers are the natural consequences of construction traffic in the suburban area. In the period analyzed, the population of communes in the first ring of the suburban zone steadily increased from 25,800 in 1989 to 63,400 in 2018 (by 145.9%) (Fig. 6). This may indicate that the actual increase in population numbers in this area was even higher than indicated in the official statistical data, even assuming that the mean number of inhabitants per flat has decreased. The highest increase in the number of dwellings was recorded in the town of Siechnice (259.2%) and in the rural communes of Czernica (232.3%), Długołęka (206.6%) and Kobierzyce (188.1%), and was the lowest in the commune of Oborniki Śląskie (68.0% in the town and 66.5% in the rural part of the commune). It is interesting to note that the construction traffic in the suburban area of Wrocław was low until 1996 (below 100 flats annually) and started to grow dynamically in the following years to stabilize at around 2000 flats per annum since 2009. The

differences in the scale and intensity of residential suburbanization in the close suburban zone of Wrocław were also revealed in the analysis of data on the construction traffic broken down into individual settlements. In the period 2008-2017, the highest number of flats were commissioned for use in the town of Siechnice (1973) and in the villages of Kiełczów (1971), Wysoka (1558), Smolec (1139) and Bielany Wrocławskie (669), while the highest intensity of construction traffic was recorded in the villages of Iwiny (924 dwellings per 1000 inhabitants), Mędłów (835), Karwiany (812) and Krzeptów (725) (Fig. 7). During this period, no flats were handed over for use in 9 villages of the first suburban ring; as well as in 70 other villages there were less than 10 dwellings completed per year. The size and intensity of residential suburbanization were shaped by two major factors: distance to Wrocław (expressed as the travel time to the city centre) and the location of the main communication routes – roads and railway lines (MALESZKA & SZMYTKIE, 2009).

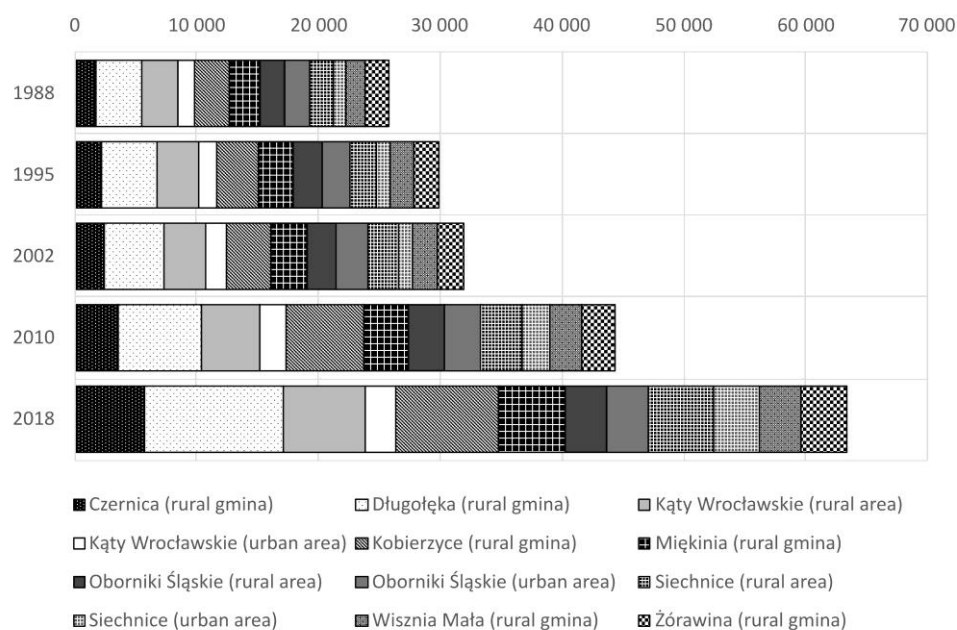


Fig. 6. Number of dwellings in communes in the suburban zone of Wrocław (1989-2018)

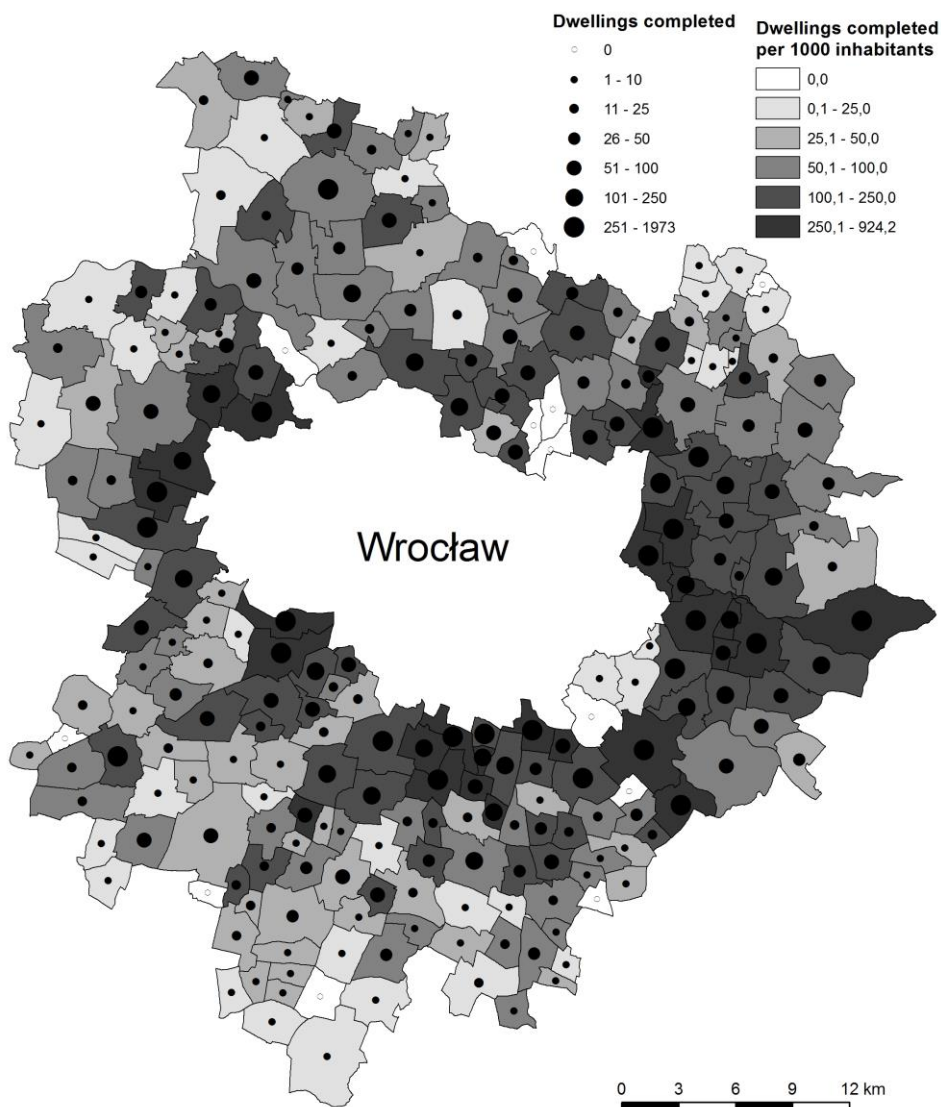


Fig. 7. Construction traffic in statistical units in suburban zone of Wrocław (2008-2018)

7. Morphological transformation of suburban villages

Residential suburbanization manifested by intensive construction traffic in the suburban zone contributes to significant changes in the morphology of suburban villages. Analysis of the layout of selected localities in the first ring of communes surrounding Wrocław using graph theory (SZMYTKIE & NOWAK, 2017) revealed only minor morphological changes in the first years of the post-war period, as evidenced in a deceleration of the suburbanization process in the socialist era. Substantial changes in the spatial layout of villages were observed since 1970s throughout the first decade of the 21st century. During this period the total number of nodes, edges and cycles increased by 92.0%, 119.2%, and 214.6%, respectively. This has contributed to an increase in the mean graph development index from 1.64 to 2.07. This is an indication of the accelerated pace of suburbanization around Wrocław after 1989 (MISZEWSKA, 1985, 2001; ZATHEY, 2002; GONDA-SOROCZYŃSKA, 2009; MALESZKA & SZMYTKIE, 2009; KAJDANEK, 2011), but also of the changes in the

suburban landscape. Simple settlement forms typical of rural areas have been transformed into complex and multiple complex forms characterized by the prevalence of edges over nodes and a considerable number of cycles, for which the graph development index often exceeds 2.50. These forms differ considerably from the specifics of a rural landscape and are more typical of areas surrounding big cities. The graph development index in some villages increased by over 50 per cent (Bielany Wrocławskie, Chrzastawa Mała, Długołęka, Krzeptów, Smolec, Kamieniec Wrocławski), which is the evidence for a significant transformation of the local spatial layouts. Localities immediately adjacent to Wrocław and located along the main exit roads from Wrocław (located in communes of Długołęka, Czernica, Siechnice, Kobierzyce and Kąty Wrocławskie) were subject to the most profound morphological transformations. In areas where the suburbanization processes started with some delay (e.g. Radomierzyce in Siechnice commune, Lutynia and Wilkszyn in Miękinia commune, Malin and Wisznia Mała in Wisznia Mała commune), more scattered buildings were erected.

Table 2. The specificity of morphological transformations in villages located in the suburban area of Wrocław in the post-war period

Types of villages	First period (1940-1970)				Second period (1970-2010)			
	Change in the number of			GDI change	Change in the number of			GDI change
	edges	nodes	cycles		edges	nodes	cycles	
type A	188,3	211,1	450,0	139,6	179,4	216,4	327,8	139,3
type B	105,6	107,8	100,0	102,5	305,3	401,0	1520,0	170,3
type C	152,7	139,3	116,7	89,0	212,8	267,6	519,0	155,5
type D	124,4	115,9	100,0	92,9	260,7	289,5	337,5	110,2
type E	114,7	116,9	138,5	104,8	154,2	183,0	283,3	131,6
type F	109,4	107,4	109,5	99,3	181,7	163,0	121,7	84,8

GDI – Graph Development Index (Szmytkie, 2014, 2017)

Based on the specificity of the morphological transformations in areas surrounding Wrocław in the post-war era, the following six types of suburban villages can be distinguished (Table 2):

- Type A – localities whose spatial layout expanded significantly in the post-war period and consequently it became significantly more complex (a faster increase in the number of edges and cycles than the number of nodes), e.g. Mirków, Radwanice and Siechnice;
- Type B – localities which underwent profound expansion after the 1970s and consequently their spatial layout became significantly more complex, e.g. Bielany Wrocławskie, Chrzastawa Mała, Mędłów, Ramiszów and Wysoka;
- Type C – localities which expanded only slightly in the post-war period, which has contributed to dispersion of the spatial layout, which later became significantly more complex (the number of nodes increased mainly in the initial period, and the number of edges and cycles increased mainly in the second period), e.g. Długołęka, Kiełczów, Krzeptów, Ligota Piękna, Smolec and Tyniec Mały;
- Type D – localities which expanded only slightly in the first period, resulting in dispersion of the spatial layout, which became slightly more complex in the second period, e.g. Nadolice Wielkie, Szewce, Karwiany – Komorowice and Żerniki Wrocławskie;

- Type E – localities which expanded only slightly in the post-war period and did not experience any significant spatial transformations; the spatial layout became more complex in the second period, e.g. Chrzastawa Wielka, Czernica, Gajków, Kamieniec Wrocławski, Miękinia and Święta Katarzyna;
- Type F – localities where the spatial layout expansion (mainly in the second period) contributed to a decrease in the spatial complexity (a significant increase in the number of nodes accompanied by a slight increase in the number of edges and cycles), e.g. Lutynia, Malin, Prusowice, Radomierzyce, Wilkszyn, Wisznia Mała and Żórawina.

MISZEWSKA (2001) initiated studies on the morphological transformations of suburban villages surrounding Wrocław induced by residential suburbanization at the macro level. Based on further research on this topic, a typology of morphological transformations of suburban villages was developed, consisting of eight transformation models:

- Model # 1 – the original spatial layout is blended with contemporary residential estates; these types of transformations usually take place in small villages, and are often the initial phase of expansion of the spatial layout of a village, as in Krzeptów in Kąty Wrocławskie commune (Fig. 8), where two clusters of detached housing have emerged, creating regular urban blocks, to the west of the original linear village.
- Model # 2 – extension of the original spatial layout of a village; this model is the most common and reflects the scale and intensity of morphological transformations of suburban villages; the original village settlement (linear village, row village, oval-shaped village) is the genetic core of the spatial layout; over time, the original farmyard buildings are progressively replaced, as in Kiełczów in Długołęka commune (Fig. 9), where the original settlement (linear village) became the axis of the spatial expansion (to a multi-street layout), and the settlement also expanded along a side road to Wilczyce;



Fig. 8. Morphological transformation in Krzeptów Kąty Wrocławskie commune)



Fig. 9. Morphological transformation in Kiełczów (Długołęka commune)

- Model # 3 – spatial expansion of a village in the direction of a city; this model is typical for villages directly adjacent to a city at a distance of around 2 to 4 km from the city's administrative borders; new buildings are erected along the road to the city, as in Smolec in Kąty Wrocławskie commune (Fig. 10), which used to be a multi-street village next to a railway station; after 1989 the village expanded along roads leading to the Wrocław residential estate of Muchobór Wielki; detached and terraced houses were built in the new district of the village (Osiedle Leśne); multi-family residential buildings were also erected in recent years, including new buildings to the south of the railway station;
- Model # 4 – city expansion to suburban villages – new construction is located in the plains as a natural extension of the central city and is referred to as an adurbanization (or overurbanization) zone (TURZYŃSKI, 2014), as in Wysoka in Kobierzyce commune (Fig. 11), which was originally a small farm village, but the expansion of the adjacent Ołtaszyn residential estate in recent years has resulted in the spread of multi-family housing in a north-east direction of the original village settlement;
- Model # 5 – a new part of a village is built beyond the original settlement to form a village consisting of two sections, as in Mirków in Długołęka commune (Fig. 12), where a residential estate of single-family dwellings is built to the north-east of the original linear village in the post-war period for workers of an armaments factory in nearby Psie Pole (MISZEWSKA, 2001); after 1989, the spatial layout of both sections of the village expanded.
- Model # 6 – isolated new residential estates outside the original spatial layout; this model is typical for areas dominated by the residential function; here, residential estates of detached or row housing are built in the plains, at a distance to the original settlement, as in Chrzastawa Wielka in Czernica commune (Fig. 13) where several island-like residential estates were built to the north and to the east of the original village settlement.



Fig. 10. Morphological transformation in Smolec (Kąty Wrocławskie commune)



Fig. 11. Morphological transformation in Wysoka (Kobierzyce commune)



Fig. 12. Morphological transformation in Mirków (Długoleśka commune)



Fig. 13. Morphological transformation in Chrzastawa Wielka (Czernica commune)

- Model # 7 – merger of two (or more) villages with new construction; this phenomenon is rare, but is usually the final stage of the expansion of villages located close to each other, and a stage where residential estates occupy the remaining plains; this model is also where a residential estate is built between settlements belonging to two different villages, as in Karwiany i Komorowice in Żórawina commune (Fig. 14), where the original village settlements were combined by a joint residential estate with semi-detached houses and multi-family dwellings.
- Model # 8 – an economic activity zone established in proximity to a village settlement as a manifestation of economic suburbanization, resulting in a change of the suburban landscape; the original village settlement remains unchanged, but large-surface industrial or commercial buildings are erected in the plains

surrounding the village, as in Biskupice Podgórne in Kobierzyce commune (Fig. 15), where a large industrial complex (LG factory) was built to the south-east of the village settlements.

It also needs to be borne in mind that two (or more) models of morphological transformations may overlap and complex spatial layouts may emerge as a result of the scale, intensity and duration of transformations of the suburban villages of Wrocław. A good example of this phenomenon is the village of Bielany Wrocławskie in the commune of Kobierzyce, where a large economic activity zone (model 8) with commercial and industrial functions was established (CZERWIŃSKI ET AL., 2011), in addition to the significant expansion of the spatial layout and replacement of existing buildings in the original village settlement (model 2) (Fig. 16), which was indicated by MISZEWSKA (2001).

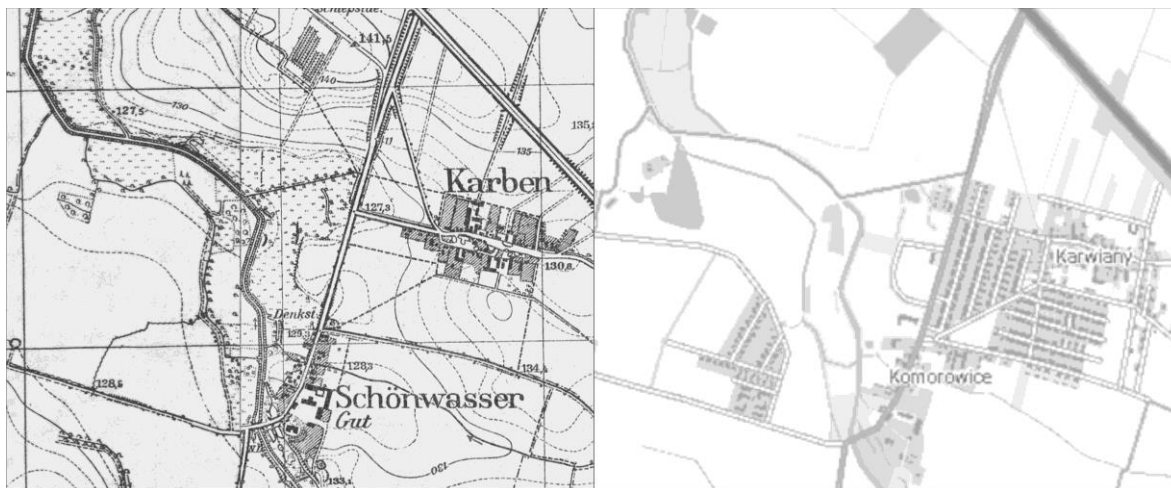


Fig. 14. Morphological transformation in Karwiany and Komorowice (Żórawina commune)



Fig. 15. Morphological transformation in Biskupice Podgórne (Kobierzyce commune)

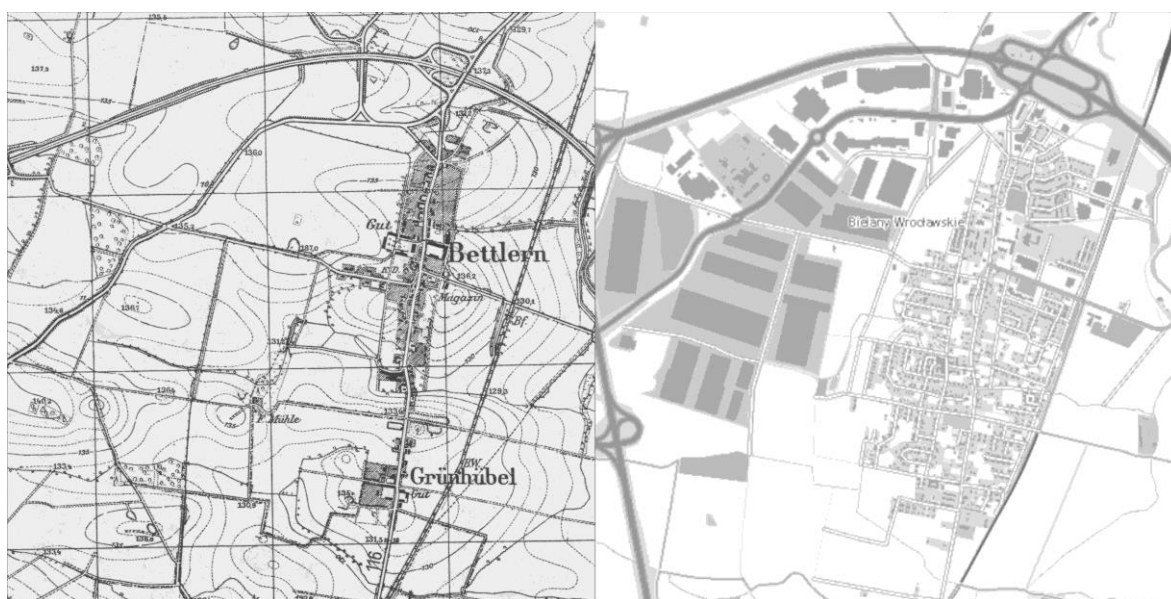


Fig. 16. Morphological transformation in Bielany Wrocławskie (Kobierzyce commune)

8. Discussion

The studies carried out have demonstrated that the process of residential suburbanization in the areas surrounding Wrocław has a long tradition. Two fundamental stages of this process can be distinguished. The first stage is linked to the industrial and modernist development of the city (from mid-19th century to 1945), and the second stage coincides with the post-socialist development (after 1989). An analysis of archive cartographic materials confirmed that the suburbanization processes in the area surrounding Wrocław date back to the second half of the 19th century, as demonstrated in previous articles (SZULC, 1963; MISZEWSKA, 1985, 1995, 2001). At that time, suburbanization was the consequence of the dynamic spatial development of the city itself, induced by the influx of migrants from rural areas, seeking employment in the industry (MALECZYŃSKI ET AL., 1956). The spatial scope of suburbanization has evolved with the subsequent stages of the territorial expansion of Wrocław, during which villages immediately adjacent to the city were incorporated into its administrative borders. With each expansion of the city borders, the zones of dynamically developing suburbs were shifted away from the city, resulting in temporary deceleration of the suburbanization processes, during which the new available lands were developed and later incorporated into the city. This pattern of transformations corresponds well to the concept of cyclical territorial expansion of the city (SZMYTKIE, 2019), or the concept of fringe-belt development (WHITEHAND, 1967, 1988). The spatial (and territorial) expansion of Wrocław was mainly possible due to advances in transportation. What is more, the development of the suburban zone may also be traced to easy access to the city. The most profound morphological transformations have been observed in villages immediately adjacent to Wrocław or located along main transportation routes to the city (particularly along railway lines).

Suburbanization processes around Wrocław considerably slowed down after World War II. There is no doubt that this can be attributed to the policy of accelerated social and economic development typical for the socialist states of Central and Eastern Europe, based on planned industrialization and urbanization, favouring the development of large cities and industrial centres (FISHER, 1962; FRENCH & HAMILTON, 1979; BERTAUD & RENAUD, 1997; CROWLEY & REID, 2002; BERTAUD, 2006). This trend was even more pronounced in Wrocław due to two factors: the massive scale of destruction during World War II and the

administrative expansion of the city in the period 1924-1973, during which the area of Wrocław increased almost six-fold. As a result, many areas designated for development were incorporated into the city (agricultural land and areas devastated during the war), which stimulated construction traffic within the city. Residential districts consisting of large blocks of flats or detached dwellings were built in the plains of former villages (MISZEWSKA, 1995, 1996). Incorporation processes are one of the most important drivers of the development of large cities in Poland (SZYMAŃSKA ET AL., 2009; SZMYTKIE & KRZYSZTOFIK, 2019) and other states of the Central and Eastern Europe (SÝKORA, 1999; SOÓS & IGNITS, 2003; SÝKORA & OUŘEDNÍČEK, 2007; SWIANIEWICZ, 2010). Territorial expansion of socialist cities often exceeded the capacities of the local spatial development, and therefore poorly urbanized peripheral residential districts (former villages) preserved their original character, featuring a vast share of non-developed and non-urbanized land. Today, these are investment areas where internal suburbanization takes place (ZBOROWSKI & RAŻNIAK, 2013; SPÓRNA, 2018; SZAFRAŃSKA ET AL., 2018).

The political transformation of the 1990s and the resulting social and economic transitions initiated the second phase of suburbanization around Wrocław (see SCHNEIDER-SLIWA, 2006; LEETMAA ET AL., 2009; KUBEŠ, 2013; ZBOROWSKI & RAŻNIAK, 2013). The scale and dynamics of this process are, worthy of note (BREZDEŃ & SZMYTKIE, 2019), manifested by the intensity and spatial scope of the construction traffic in the suburban zone of Wrocław, and the resulting degree of landscape transformation. The emergence of a specific (transitional) suburban landscape with features of both urban and rural landscape has already been referred to in literature some years ago (BAŃSKI, 2008; GONDA-SOROCZYŃSKA, 2009; STASZEWSKA, 2012). The analyses conducted revealed the complexity and diversification of the main trends in morphological transformations of contemporary suburban villages. The construction traffic near Wrocław contributes to the concentration and dispersion of construction layout. Similar processes can be observed in other suburban zones (see SUDRA, 2020). It can also be concluded that the suburban landscape is by no means homogenous or coherent. Its distinctive features include architectural contrasts, chaotic spatial layout and landscape fragmentation (e.g. BAŃSKI, 2008; GONDA-SOROCZYŃSKA, 2009; STASZEWSKA, 2012; KĘPKOWICZ, 2013). GONDA-SOROCZYŃSKA (2009) argues that contemporary residential housing and service build-up areas are not in harmony with the rural landscape, are out of proportion and beyond the scale of the existing buildings and the locality itself

and are not interconnected with the existing village layout. The discussed models of morphological transformations of spatial layouts of villages are examples of such heterogeneity. Initially, a few dominating morphogenetic types of villages could be distinguished in the area surrounding Wrocław (row villages, linear villages, oval-shaped villages, farm villages, multi-street villages), which were essentially uniform in physiognomic terms. Currently, multi-street villages prevail, but they differ in the degree of preservation of farmstead housing and the original village settlement, the level of interconnection with the new development, the compactness of the building pattern, the scale of morphological transformations, and the degree of complexity of their spatial layout.

9. Conclusion

The following conclusions can be drawn from the analysis of changes in the morphology of localities in the suburban zone of Wrocław:

- The first phase of suburbanization began in the mid-19th century and was hampered by the political and economic transformations after 1945. The intensity of the morphological transformations dropped in the post-war period, and the spatial scope was limited to single localities. The second phase of intensive suburbanization coincided with the social and economic transformation of 1989. This has led to profound changes in the suburban landscape attributed to intensive construction traffic. Simple forms of settlement typical for rural areas have been transformed into complex (or even) multiple complex forms different from the specifics of a rural landscape, more typically associated with the areas surrounding large cities.
- Morphological transformations of villages in suburban areas vary considerably in terms of their nature and intensity. Significant expansion of the spatial layout in some of the villages increased its complexity (following a notable increase in the number of urban blocks). The graph development index of other villages decreased significantly, which proves the progressive dispersion of the settlements. Introduction of similar urban patterns to the suburbs (residential estates uniform in morphological and physiognomic terms, featuring detached, semi-detached and multi-family housing) failed to contribute effectively to unification of the spatial layout of villages. The scale and spatial scope of these

transformations also vary. This is reflected by the discussed models of morphological transformations of villages.

- The differentiating factors of the specifics and dynamics of spatial transformations in the suburban area of Wrocław include: distance to the city and location relative to the main transportation routes, affecting transport accessibility and time of travel to the city centre. The original morphogenetic type of individual localities and topographic conditions (which are considerably diversified in the suburban area of Wrocław between the left-bank and right-bank part of the Oder basin) are also the fundamental factors that affect the capacity for expansion of the spatial layout.

The main consequences of intensive construction traffic in the suburban zones include: transformation of the original spatial layouts of suburban villages, physiognomic changes resulting from the introduction of new types of housing to suburban areas (WÓJCIK, 2006; BAŃSKI, 2008; GONDA-SOROCZYŃSKA, 2009; KAJDANEK, 2011), and elimination of the original character (morphology) of villages by transformation of the rural landscape into a suburban landscape, characterized by the coexistence of forms typically associated with rural areas as well as peripheral parts of large cities (BAŃSKI, 2008; GONDA-SOROCZYŃSKA, 2009; STASZEWSKA, 2012).

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