

Article

Urbanization Chaos of Suburban Small Cities in Poland: ‘Tetris Development’

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Abstract: This paper investigates the phenomenon of spatial chaos in Poland resulting from urban sprawl. The phenomenon is particularly visible in the case of suburban small cities which, in contrast to cities in the EU-15 countries with similar populations, are expanding excessively, causing a growth of urbanized areas exceeding several times the growth of their population. Suburbs of these cities increasingly resemble a badly played Tetris game. The selected study area consists of several cities in the Warsaw suburban zone where an increased dynamic of these processes can be observed. The paper presents detailed studies concerning the selected representative small cities. The morphology of urban tissue was studied as a marker of spatial order including: development intensity, street grid, plots parameters, presence of technical infrastructure, and distance from the functional city center. The analyses were performed based on cartographic archives, the data of the Central Statistical Office of Poland, topographic database and Kernel Density Estimation. ArcGIS ESRI and AutoCad software was used to present the study results. The conducted studies intend to diagnose the changes in the spatial layout in the context of the objectives of spatial order and sustainable development, and to define the indicators which should be taken into account in spatial planning documents drawn up for the studied areas.

Keywords: spatial chaos; urban sprawl; suburban zone; small cities; land use analysis; Poland

1. Introduction

Polish cities, compared to Western European cities, are experiencing specific problems due to their historical conditions (lack of an independent Polish state for a period of more than 100 years, numerous warfare activities, socialist economy). In Poland, cities are classified according to their population size: a small city is up to 20,000 inhabitants, a medium-sized city ranges from 20,000 to 99,000 inhabitants, and a large city has 100,000 inhabitants and more. According to data from the Central Statistical Office from 2020, there are 944 cities in Poland, 726 of which have a population of less than 20,000 inhabitants and 108 have a population between 20,000 and 40,000 inhabitants. These medium-sized cities are inhabited by approximately 22% of the total urban population, i.e., 13% of Poland’s population. About 60% of the Polish population lives in the cities, which indicates that Poland is less urbanized than, for example, Germany, where city dwellers represent 76.4% of Germany’s total population, while in France—80.6% [1].

The process of systemic transformation, after 1989, has reversed the general trends in the development of small and medium-sized cities, which are now evolving towards the dominance of residential areas and basic services. Small cities, in particular those located in suburban areas of large cities, have faced rising challenges and are in a state of stagnation or even decline due to the dominance of large cities. The main challenge for small cities is the outflow of young and educated inhabitants,

and consequently the ageing of the population. The spatial policy of small cities also needs to cope with the process of excessive dispersion of development. Due to the weak spatial planning system and the lack of legal restrictions inhibiting the expansion of urbanized areas only in the last 15 years their surface per capita in Poland has increased by approx. 20% (according to the Central Statistical Office of Poland). Urban structures are becoming increasingly chaotic, which increases the cost of urban infrastructure [2–4]. This often happens as a consequence of abuse of property right, in the name of economic profit [5] (p. 197).

This paper investigates the phenomenon of spatial chaos in Poland resulting from urban sprawl. The phenomenon is particularly visible in the case of suburban small cities which, in contrast to cities in the EU-15 countries with similar populations, are expanding excessively, causing a growth of urbanized areas exceeding several times the growth of their population [6,7].

The urban sprawl is basically a global problem affecting every continent [8–11]. Nevertheless, in different countries, these problems have more or less clear specificity related in particular to the current approach to spatial planning and the settlement history of a given area [12]. Urban sprawl has three dimensions: the surface area of built-up land, the dispersion of built-up areas in the landscape, and the density of population living or working in the urban areas [13]. In Europe [11,14], areas with the most visible impact of urban expansion are found in countries and regions with the highest population density and intensive economic activity (Belgium, the Netherlands, southern and western Germany, northern Italy, Paris area) and/or rapid economic growth (Ireland, Portugal, eastern Germany, Madrid area). New development patterns can also be observed around smaller cities, in rural areas, along transport corridors and along significant parts of the coastline, usually connected to river valleys.

The phenomenon of urban sprawl is a key barrier that hinders the implementation of the concept of sustainable development [15]. Its progression leads, among others, to conversion of agricultural and other land into built-up areas that are no longer available for food production [14], and has resulted in higher energy consumption, higher demand for mobility, higher landscape fragmentation, air pollution, higher spread of invasive species, degeneration or loss of most ecological soil functions, and reduced resilience of ecosystems [16]. From 2012 to 2018, Europe lost 539 km²/year of natural and seminatural areas to urban and other artificial land development. Between 2000 and 2018, 78% of land take in the EU-28-affected agricultural areas, i.e., arable lands and pastures, and mosaic farmlands [17]. Urban sprawl also extensively affects watercourses and their ecosystems, and the more populated the area (e.g., the higher the density of population and built-up areas, networking by transport and technical infrastructure networks), the more difficult and costly it is to restore watercourses [18,19]. In this process of unsustainable urban expansion, the demand for building land and for investment in road infrastructure tend to prevail [13]. This reduces the availability and accessibility of open spaces, which provide multiple environmental and social benefits and are essential for maintaining the health and wellbeing of urban residents [20].

The expansion of low-density, automobile-centric communities in cities throughout the world is widely recognized as a major driver of local environmental change and degradation, with implications for global greenhouse emissions forcing [21]. Climate change brings also challenges for suburbanization. Many cities in Europe (Copenhagen, Rotterdam, Barcelona, or Helsinki) are already working to mitigate the effects of climate change, decrease energy use, and reduce greenhouse gas emissions by shaping sustainable forms of settlement, for example in the construction of sustainable green and blue infrastructure [22]. This tool, associated with strategic planning, offers integrated solutions for improving the ecological connectivity and urban resilience of open spaces, especially those affected by processes of urban sprawl, the abandonment of agriculture, and the territorial fragmentation of habitats and traditional agricultural landscapes [23–25].

With the world population rapidly increasing and urban populations growing, the ‘compact city’ paradigm, also known as the ‘city of short distances’, is widely considered a necessity for controlling significant environmental consequences, and thus has been endorsed as a future development strategy by several leading institutions, like the European Commission [26], the United Nations Global Compact.

The concept of compactness has various aspects, most share the common theme: land being used intensively and the distance between different land uses and users being minimized [27]. The idea of a compact city has been widely discussed not only in Anglo-Saxon countries but also in Poland, mainly in the context of creating sustainable cities, less often suburbs. Jan Gehl [28] (p. 7) writes about strengthening of the idea of sustainable development in cities that advance ‘green mobility’ (walking, cycling, and public transport) which offers benefits for the environment and the economy of these cities.

Another proposal is the concept of ‘smart growth’, which seeks to rationalize the processes of urbanization, leading to economical use of land, more compact development, improved accessibility of key services for pedestrians, reducing the use of the car, and preference for public transport [29] (p. 432). Another trend in contemporary urban planning are ecological, ‘smart cities’ (m.in. [30–33]), ‘digital cities’ [34,35], even ‘slow cities’ (Cittàslow) [36]. Such development strategy is a very good starting point for improving the attractiveness of small cities and increasing their competitiveness, thus providing the basis for their economic existence based increasingly on the development of tourism and recreation [37] (p. 71). In Europe, just like in America [38], efforts are being made to hinder excessive suburbanization and to reconfigure chaotic spatial structures. Some European countries (e.g., the UK) have already made the effort to change negative consequences of suburbanization, while others have not. Poland belongs to the second group. Comparing suburbs of postsocialist countries with their Western counterparts; the former is denser and less widespread, hence the need for retrofitting suburbs is particularly urgent in Central and Eastern Europe [39].

As a country of Central–Eastern Europe, Poland does not have such a rich metropolitan tradition as the Western countries. Intensive suburbanization, which peaked in Western Europe in the 1960s and 1970s, began in Poland only after its political transformation. However, the urban sprawl processes are not yet as advanced in Poland, which may be the result of a favorable starting situation. Cities in socialist states [40–42] were considered relatively spatially compact, which partly resulted from the system of central planning and significant dependence on public means of transport. Unfortunately, Polish cities have not taken advantage of their delayed development benefit in terms of compactness. The country is lacking coherent programs, supported by legislation and equipped with operational urban planning instruments that would increase the effectiveness of spatial policy in preventing the dispersion of development. It should also be emphasized here that the existing planning instruments in Poland are insufficient and restoring spatial order to Polish cities is beyond the capacity of urban planners [43] (pp. 165–166).

2. Distinctiveness of Urbanization Processes in Poland

2.1. Historical and Legislative Background

One can see, in the spatial and social features of Polish cities, the distinctiveness of their spatial development processes, as well as the historical continuity which can be described on the basis of their physical and social structures [44] (pp. 47–51). Their state of development has undoubtedly been influenced by historical conditions and specific development problems they have endured, as opposed to similar European cities. However, despite many unfavorable transformations and progressing globalization, Polish cities are still a carrier of a certain image and identification mark which determine their identity and adherence to the European cultural circle, and the inhabitants, identifying with their city, thus identify with every European city [45] (pp. 6–7). Studies on spatial structures of Polish cities and towns (Figure 1) indicate their diverse character depending on their historical legacy, including their geographic location in the territories of the particular partitioning powers (in the years 1815–1918, the state of Poland did not exist and its territories were divided into three parts: Russian Partition (with Warsaw), Austrian Partition (Galicia), and Prussian Partition (Greater Poland)). The cities of Galicia and Prussia, regulated by the legal framework imposing the construction of compact cities, were planned differently than the cities in the territories occupied by Russia (the modern suburban zone of Warsaw is located in this area). These cities, between 1815 and

1830, were arranged according to simplified regulatory urban plans (very schematic, usually focusing on the straightening out of meandering main passageways), but often without paying attention to existing historical features [46] (p. 42). In the years that followed, as a result of postuprising repressions, urban planning measures were halted and urban policy was linked only to economic development. These cities were organized according to the model of Polish–Jewish society, deprived of self-governance rights and strongly controlled by tsarist autocracy, which resulted in intensive, unplanned, and uncoordinated urbanization [47] (p. 15). It was not until after Poland regained independence in 1918 that the unification of the construction law in different parts of Poland began. An innovative system of spatial planning was introduced (Act of 1928 on the Construction Law and Housing Development), which promoted the creation of dense development, forming street frontage, as well as guidelines for subdividing and consolidating plots of land [48]. Unfortunately, the outbreak of the Second World War in 1939 precluded its full implementation. Many new regulations in the area of ownership and spatial structure were introduced after 1945 as a result of the change of political system to socialism [49] (pp. 91–92). During the Polish People’s Republic, urban growth was associated in politicians’ minds mainly with territorial expansion. Urban space did not have economic value, and its construction was subservient to political power.



Figure 1. The contemporary city plan of the center of Góra Kalwaria, the structure of historical land divisions (into ‘semiagricultural’ plots of land in the form of long narrow strips) is marked in red.

In the Polish legal system at the local level, the following legal documents (instruments) are used for spatial planning [50]: (i) studies of conditions and directions of the spatial development of municipalities (including, among others, defining local development rules and directly binding guidelines for local spatial development plans); (ii) local spatial development plans (acts of local law defining the use of land and the conditions of its development). However, these instruments are not mandatory for local authorities to adopt, hence only about 30.8% of the country’s area has valid local development plans (Central Statistical Office of Poland, as at the end of 2018); (iii) decisions on building and land development conditions (in short: land development decisions): individual administrative acts most often concerning individual infrastructure investments, issued for areas without valid local plans. The existing legal instruments have been developed in the course of works on improving the Polish spatial planning system started after Poland’s political transformation. However, it was after the transformation that, despite the adoption of two spatial planning laws, the principles of spatial order were increasingly disregarded and development of urban areas went out of control.

In addition, virtually all applications from rural inhabitants for their farmland to be removed from agricultural production and converted to building use were accepted. Local municipal authorities allocated in the planning studies many times more land for building development than it resulted from the actual needs [51] (p. 49). With population density ratios for 1 ha of residential area adopted

at the level of approx. 40 people in single-family housing and 200 people in multifamily housing, the population absorptive capacity across the country was calculated in local spatial development plans as 62 million people, and in communes' studies as over 200–300 million people [52] (p. 34). The analyzed demographic forecasts prepared for Poland suggest, in turn, that in 2050 its population will decrease by about 11% compared to 2019, while by the end of the 21st century its population may decrease by as much as 45% [53]. The increase in the surface of land designated for residential use while the population size is actually decreasing only shows how wrong and cost-intensive the current approach to spatial planning is.

According to Krystyna Solarek [54] (p. 69), planners should have much stronger legal tools enabling them to properly shape the functional and spatial structure of different areas. Due to the pressure from municipalities—heads of municipalities, mayors, municipal councils, and landowners—urban planners need more than just their knowledge, good intentions, or awareness of the effects of spatial planning decisions.

Spatial planning in Poland can be broken down into two stages: Polish People's Republic (1945–1989) and the political transformation after 1989. The period of the Polish People's Republic concerned first the nationalization of land in the post-war Poland, then reliance on central planning of the economy, imposing a distance between the location of a building and the plot boundary, which led to extensive development (1961), and finally, in 1984, enabling the conversion of the excess of agricultural land, within city limits, for housing and investment purposes. The period of political transformation introduced the supremacy of market economy (1994) and the devolution of spatial planning to local governments. The consequences of such actions are excessive investment expansion and urban sprawl [55] (p. 367), conversion of former rural areas within the city limits into urban development by municipalities in order to respond to residents' real needs [51] (p. 490). The introduction of the Act in 2003 failed to improve the condition of spatial policy, and failed to halt the processes of development dispersal in urban and rural areas, i.e. by preserving the administrative decision, i.e., the land development decision [55] (p. 367–378). The tools obtained have not influenced properly the shaping of space or the protection of natural systems and landscapes.

Looking at the state of preparation of local plans, it can be seen that there are still too few of them, they only cover one-third of the Polish territory, and they are often executed for individual plots of land, at the request of the land owner, taking the form of fragmentary drawings which fail to follow the principles of spatial order (e.g., the Żelechów municipality in Mazowieckie voivodeship has decided to draw up a local plan including 45 appendices, with plans covering a single plot, or several plots). The Planning Act of 2003 preserved the land development decision as a legal instrument (in areas not having an adopted local plan), without requiring the decision to be consistent with the study. When analyzing the provisions regarding the issue of such development decisions, their effect on the suburbanization of cities and the expansion of residential development into rural areas can be clearly seen. From the point of view of planners, it is a tool that does not help improve space, nor does it shape it in any way, but rather contributes to the destruction of the environment and landscape and to development of excessive technical infrastructure.

2.2. Contemporary Problems of Urban Development in Poland Generating Spatial Chaos

Intensified urbanization processes, which have occurred especially in suburban areas of large cities, include the transformation of existing compact urban structures into dispersed clusters of settlement units, urbanization of typically rural areas, as well as new, dispersed clusters of development within the administrative boundaries of cities. Polish cities are usually too spread out in relation to their number of inhabitants, and their contemporary spatial structures are characterized by functional and morphological chaos [52] (p. 43) and extensive development. This is particularly striking in the case of small cities, where 22% of the Poland's total urban population lives, i.e., approx. 13% of the Polish population. Small cities in Poland differ in their character and spatial structures, but share similar problems, including demographic, transport (excessive car traffic), spatial (like the degradation of

historical centers), or economic ones [56]. Urban transformations should be aimed at harmonizing spatial development of urban areas [57] and improving the quality of life of their inhabitants.

In order to correctly understand the situation with regard to a trend observed since the 1990s on the construction market, the increase in the area of urbanized and built-up areas in Poland should be analyzed (Table 1). Comparing the changes in the surface of built-up areas that occurred in the years 2002–2018, it can be seen that in Poland the surface of these areas increased by over 12%, while in the case of land designated solely for residential development, it increased by almost 48%. Further calculations have shown that in the analyzed period in Poland new urbanized and built-up areas increased by about 100 ha every day. For example, in Germany, around the year 2000, the area of land designated for residential and commercial use, industrial use, roads and car parks increased daily by 74 hectares. Efforts have been made since 2015 to limit this number to 64 ha per day and to only 30 ha by 2020 [58].

Table 1. List of urbanized and built-up land with residential function in Poland and its voivodeships in the years 2002–2018.

Years/ha	2002	2004	2006	2008	2010	2012	2014	2016	2018	Increase
POLAND	235,992	212,506	245,247	256,578	278,479	296,600	315,578	333,296	348,555	47.70%
LOWER SILESIAN (DOLNOŚLĄSKIE)	29,530	16,428	18,961	19,064	19,928	20,496	21,057	22,432	23,242	−21.29%
KUJAWSKO-POMORSKIE	9028	12,843	14,246	14,942	15,862	16,778	17,775	20,764	21,206	134.89%
LUBELSKIE	11,625	10,092	7427	7910	8633	9490	10,264	10,962	11,307	−2.74%
LUBUSKIE	10,317	7723	7916	7922	8271	8591	9093	9431	10,002	−3.05%
ŁÓDZKIE	13,613	16,605	17,420	17,300	18,410	19,044	20,170	21,479	22,840	67.78%
MAŁOPOLSKIE	11,982	14,919	12,653	14,214	16,999	19,663	22,389	24,557	26,366	120.05%
MAZOWIECKIE	25,883	28,115	35,547	37,715	42,902	45,702	50,102	52,697	54,251	109.60%
OPOLSKIE	6672	5029	8033	8828	9319	9753	10,374	10,513	10,733	60.87%
PODKARPACKIE	32,543	7191	8555	9622	10,826	12,415	13,554	15,073	15,922	−51.07%
PODLASKIE	15,293	7082	7352	7107	7374	7645	7967	8144	8441	−44.80%
POMORSKIE	12,732	12,642	16,718	16,184	17,782	18,859	19,739	20,768	21,737	70.73%
ŚLĄSKIE (SILESIAN)	23,633	31,618	38,909	40,613	43,544	46,174	47,818	49,706	51,015	115.86%
ŚWIĘTOKRZYSKIE	3943	4050	6879	7275	7567	8022	8775	9062	9375	137.76%
WARMIŃSKO-MAZURSKIE	9438	10,283	11,131	11,420	12,016	12,478	13,175	14,157	14,477	53.39%
WIELKOPOLSKIE	10,802	19,133	23,447	26,015	28,112	29,666	31,215	32,911	34,530	219.66%
ZACHODNIOPOMORSKIE	8959	8752	10,054	10,447	10,935	11,824	12,111	10,640	13,111	46.34%

Source: own study based on the data of the Central Statistical Office, Local Data Bank (geodetic surface of Poland according to land use classes).

According to Table 1, among 16 voivodeships (provinces) of Poland, only four have noted a decrease in the surface of urbanized and built-up areas, while the remaining 12 have noted an increase in such areas. The largest increase occurred in Wielkopolskie Voivodeship, by as much as 219%, Świętokrzyskie Voivodeship (by 137%), Kujawsko-Pomorskie Voivodeship (by 134%). The Masovian Voivodeship has seen an increase in urbanized and built-up residential land at the level of 109%. Such an increase in the surface of built-up land over the course of 16 years shows the continuous expansion of development into agricultural areas.

Further statistical analyses regarding the Masovian Voivodeship show that for such a dynamic increase in the surface of urbanized areas, there is no matching increase in land allocated for public roads (Figure 2). While some increase in land allocated for roads can be observed, it is not as dynamic as that of land allocated for building development, as it amounts only to 5% in 2018 compared to 2002, showing a scarcity of public roads serving newly urbanized areas. The shortage of new roads results, among others, from local development plans which fail to create an adequate number of streets to service residential areas. The reason for this is limited funds of municipalities, as new roads encumber their budgets. The municipality must first acquire land, build technical infrastructure and then maintain the roads. Accordingly, local authorities are not interested in designing new roads, which results in excessive number of dead-end access roads or narrow internal roads.

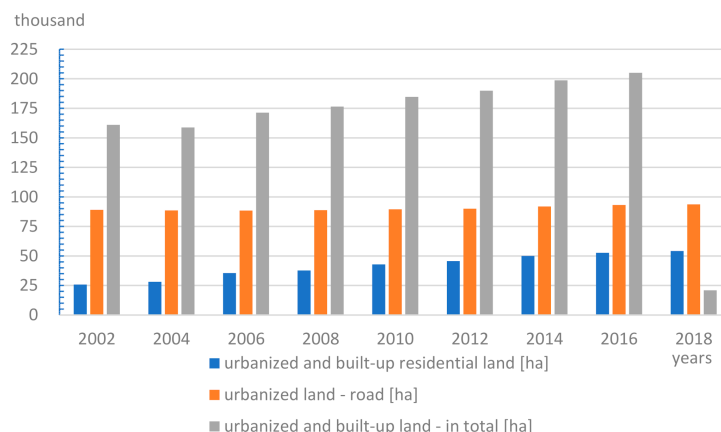


Figure 2. Changes concerning built-up land and roads in Mazowieckie Voivodeship in the years 2002–2018. Source: own study based on numerical data for specific years according to Table 1.

3. Materials and Methods

3.1. Study Area

The Warsaw suburban zone, delineated within the external borders of Warsaw's metropolitan area (which includes several municipalities within a radius of up to 50 km conveniently connected with the city center by public transport), was selected as the study area. Warsaw's metropolitan area has not been legally approved; its borders have been adopted according to the delimitation carried out in 2010 by the Mazovian Office for Regional Planning in Warsaw (Mazowieckie Biuro Planowania Regionalnego, MBPR). Historically, Warsaw has always been, and continues to be, the most important city in the area, which is why, since the 19th century, cities located within the zone of its influence have often been marginalized and have not developed as quickly as urban centers further afield. This zone is currently under very strong urbanization pressure, which causes numerous spatial conflicts [59]. In the area defined above, there are currently 35 cities (apart from the capital city of Warsaw), including 14 medium-sized and 21 small cities. It was assumed that small cities (up to 20,000 inhabitants) will be the object of the study, as there are still many undeveloped former rural areas within their administrative boundaries (in contrast to medium-sized cities, with similar surface area, but already mostly urbanized). These cities are at considerable risk of development dispersal, but a proper urban policy, supported by a reliable assessment, could halt these processes. In total, 8 out of 21 small cities were selected for the detailed study, all located in Warsaw's suburban zone and meeting 3 criteria, the first of which was a similar population (in a given range). The second priority criterion assumed that these would be the cities that obtained town privileges in the process of granting incorporation charter, before 1939, and have preserved a historical spatial layout, with a developed urban central zone (including a market square), as opposed to the remaining small towns in the Warsaw suburban zone, whose structure consists of 'patched' areas, parceled at different times, without a developed urban center. This is particularly important when comparing the morphological structures of these cities. According to the third criterion each studied city should be a local administrative center—the seat of a municipality. This criterion was adopted in order to obtain comparable analysis parameters, as cities of higher administrative rank are subject to stronger urbanization pressure, are better accessible by public transport and have a richer service offer for the inhabitants, which distinguishes them from other small centers.

In the study area (Figure 3), 8 cities met the presented study criteria (Błonie, Góra Kalwaria, Karczew, Mszczonów, Radzymin, Serock, Tarczyn, and Zakroczym). All had fewer than 13,000 inhabitants. Out of the remaining 13 small towns, only Grójec met the "historical" criterion and preserved the spatial layout with the market square, however, due to a larger number of inhabitants (17,000) and higher rank as a district center, it was excluded from the study. Selected cities were located about

20–40 km from Warsaw (i.e., at a distance where the stage-coachman had to make the first stop to feed horses), close to the ancient trade routes which radiate from the capital city. These cities were granted town privileges in the period from the 14th to 17th century and are characterized by a preserved (residually) medieval urban structure, with the market square still functioning as the city square and defining the city center (as opposed to chaotically developed cities which were granted town privileges already after World War II).

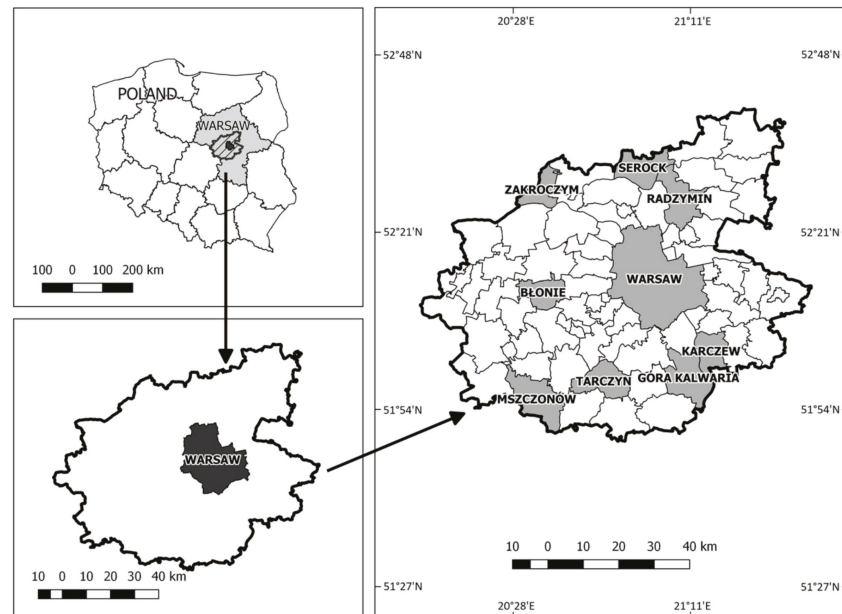


Figure 3. The Warsaw Metropolitan Area (Obszar Metropolitalny Warszawski, OMW) with cities marked for detailed analyses. Source: own study.

3.2. Methods of Obtaining Data

Urban sprawl has been defined and measured in various ways. To quantify urban growth, sprawl, and fragmentation, spatial (landscape) metrics are commonly used [60]. Spatial metrics are numeric measurements that quantify spatial patterning of land-cover patches, land-cover classes, or entire landscape mosaics of a geographic area. There are numerous types of spatial metrics that are found in the existing literature. Tsai [61] has classified the spatial metrics that are used in urban sprawl studies into 3 classes: density, diversity and spatial-structure pattern. Galster et al. [62] has identified 8 conceptual dimensions of land-use patterns for measuring the sprawl. These dimensions are density, continuity, concentration, clustering, centrality, nuclearity, mixed uses, and proximity. Under the name of sprawl metrics, Angel et al. [63] have presented 5 metrics for measuring manifestations of sprawl: main urban core, secondary urban core, urban fringe, ribbon development, scatter development, and 5 attributes for characterizing the sprawl: urban extent, density metrics, suburbanization metrics, contiguity and openness metrics, compactness metrics. Under each attribute they have used several metrics to measure the sprawl phenomenon. Jiang et al. [64] has proposed 13 attributes under the name of geospatial indices for measuring the sprawl in Beijing. Some studies have used up to 42 metrics [65]. Some of the researchers also have contributed to measuring sprawl by establishing multi-indices by GIS analysis or descriptive statistical analysis [66,67]. These indices cover various aspects including population, employment, traffic, resources consumption, architecture aesthetics, and living quality, etc. Relationship between population change and land conversion to urban uses may be determined by sprawl measurements based on remote sensing data [68,69]. Among the different methods available for the measurement of urban sprawl, the entropy method is perhaps the most widely used technique to measure the extent of urban sprawl with the integration of remote sensing and GIS [70,71].

In order to plan sustainable urban development, at city and agglomeration scale, one of the most important measures is density, i.e., the surface of spatial structure elements per surface of the studied area (density of development, housing density, population, intensity of development, land occupancy rate) [72] (p. 23), [73] (pp. 5–8). An important tool for studying the development of areas at different scales is population density, but its results differ depending on the assumed boundaries of the studied area, because from the scale of an urban block to that of a metropolitan area density can decrease a hundred-fold [74]. Therefore, population size to administrative area size is a measure that is not reliable for comparison, as density will vary depending on the definition of administrative boundaries [75]. More precise data can be obtained from studying satellite images by calculating the respective surface of urbanized areas and generating comparable statistics for different cities. The link between urban population density and the environment is also important due to the so-called environmental costs, because although urban centers use land more efficiently, their ‘ecological footprint’ goes beyond the spatial boundaries of a city [76]. Since buildings account for more than 20% of greenhouse gas emissions, density indicators are one of the main factors shaping sustainable development of cities [77] (p. 10). According to Gottdiener and Budd [78] (p. 153), any doubling of the average population density of a studied area may result in a 20–40% decrease in the use of vehicles in a household, which will accordingly reduce greenhouse gas emissions, and the consumption of gasoline per capita decreases with the density of cities [79]. High density of urban population and its economic activity can help achieve ‘economies of scale’, as the proximity of homes and businesses can encourage walks, cycling and the use of public transport instead of private motor vehicles [80]. The appropriate location for development along with the infrastructure supporting it, especially the road network, is also crucial from the point of view of optimizing spatial development and sustainable development [52] (p. 29).

The research methodology presented in the article drew on the international literature on the subject by using some commonly applied spatial metrics, i.e., built-up areas increase, population increase, development intensity, population density, determined by the analysis of planning and cartographic documents. In Poland, the methodology for indexing spatial planning and its effects at the local scale is still insufficiently developed [81]. The presented methodology meets these needs.

The starting point for the study analysis was the assumption that spatial chaos in Poland is particularly visible in the case of smaller cities (with sizeable area of yet undeveloped land) whose suburbs are starting to resemble a mosaic of mismatched fragments as in a poorly played Tetris game. For the purposes of the study, the authors indicated the main criteria defining ‘Tetris development’. These are:

- urban and spatial dysfunctions: lack of grid street plans, poor parameters of roads and plots, lack of harmony of spatial structures,
- low economic efficiency: considerable distances between places of residence, work and services,
- extensive development: low population density in built-up areas, low intensity of development, especially in the suburban zones of cities,
- reversal of the traditional urban planning model (the highest intensity in the center, decreasing as the distance from the center increases): the intensity of development in the center, as a result of leaving ‘urban voids’, is lower than the intensity of development of plots in the suburban zones where multifamily or terraced developments are built.

In order to determine the scale of the ‘Tetris development’ phenomenon in Poland, the paper employed several research methods, including:

1. theoretical method, based on literature review, in order to set the criteria for sustainable cities, good to live in cities and to identify good practices, as well as corrective measures,
2. analytical method, which used retrospective studies of development of selected cities.

The analytical part of the paper was carried out according to the following plan:

Stage I.

- (a) Analysis and interpretation of archival cartographic documents and aerial photographs of the studied cities in the years 1939, 1946, 1961, 1978, 1992, 2018, based on the authors' own calculations of the surface of urbanized areas in specific periods, which were made using the ArcGIS ESRI and AutoCad software.
- (b) Analysis of changes in the demographic structure in different studied periods, based on archival statistical yearbooks and websites of the Central Statistical Office of Poland: Local Data Bank and Poland in Numbers.
- (c) Comparative analysis of the increases in the surface of urbanized areas based on own calculations (Stage I.a) correlated with the changes in population size (increase/decrease) in the studied years. The authors' own comparative analyses, comparing the existing urbanized areas with the areas designated for development in the studies of conditions and directions of spatial development of municipalities.
- (d) Own calculations of population density in urbanized areas and population density within the administrative boundaries of cities since 1939. Own calculations of the surface of urbanized areas and changes in the population size. To this end, the BDOT10k topographical database and Kernel Density Estimation were used.

Stage II. Case study

- (a) Analysis of the stages of spatial development (since 1939) of the most representative city, made on the basis of own calculations and interpretation of cartographic documents.
- (b) Comparative analysis of the ownership structure of the studied cities in view of the 'Tetris development' defining criteria.
- (c) Determination of the development intensity for selected, characteristic plots developed in different in the studied periods of the cities' development, plot area, the total area of development, and the number of floors. To this end, the BDOT10k topographical database, Kernel Density Estimation and the geoportal.gov.pl site were used.

4. Results

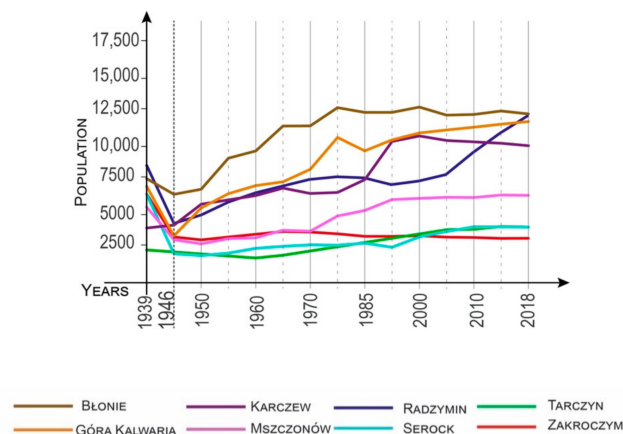
4.1. Decline in Population Density

The population of the studied cities (Table 2) is in the range of up to 15,000 inhabitants, with four centers characterized by the number of inhabitants below 10,000 (Mszczonów, Serock, Tarczyn, Zakroczym) and four cities by 10–12,000 inhabitants (Błonie, Góra Kalwaria, Karczew, Radzymin). After the war (1946), all cities in the suburban zone lost about 50% of their population (with the exception of Karczew, whose population slightly increased as a result of the influx of residents from the ruined Warsaw), such loss caused, among others, by the extermination of the Jewish population (Jews in 1939 constituted from 40 to 60% of the population of these cities). Currently, with the exception of Zakroczym and Serock, the studied cities exceeded the population threshold of 1939, with the largest increase in the number of inhabitants since then (approx. 170%) noted by Karczew. The peak of population growth of these centers took place before the 1980s, and the current largest increases are recorded only in cities which are connected with Warsaw by public bus transport (i.e., Góra Kalwaria, Radzymin) (Figure 4).

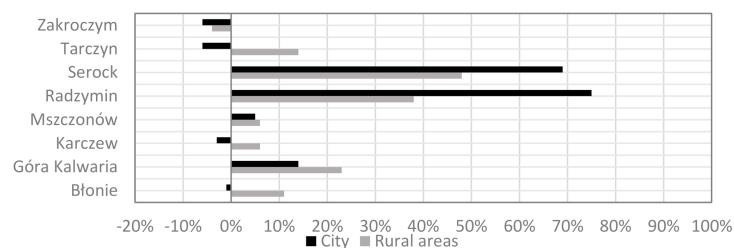
Table 2. Changes in the population of selected cities.

Years/the Number of Residents	1939	1946	1961	1978	1992	2018
Błonie	8800	6410	9674	12,850	12,500	12,392
Góra Kalwaria	7400	3687	7151	10,681	11,010	11,848
Karczew	3950	4158	6327	6560	10,300	9960
Mszczonów	5550	3161	3297	4891	6100	6433
Radzymin	8600	4360	6670	7770	7200	12,600
Serock	6500	2123	2527	2754	3362	4353
Tarczyn	2900	1640	1810	-	3904	4105
Zakroczym	6114	3358	3560	3588	3443	3211

Source: own study based on the data of the Central Statistical Office of Poland, Local Data Bank and [82].

**Figure 4.** Changes in the population of selected cities in the years 1939–2018 (the lack of data for Tarczyn in 1978 results from its lack of city rights at that time). Source: own study based on the data of the Central Statistical Office of Poland, Local Data Bank and [82].

All studied cities are seats of local government. Comparing the increase in the number of inhabitants in the years 1995–2018 (after the political system transformation) in rural and urban areas (Figure 5), it can be seen that increases in rural areas are higher (which is not matched by an increase in employment in agriculture). This may indicate that these municipalities are becoming ‘Warsaw’s sleeping districts’—areas that offer lower prices for real estate.

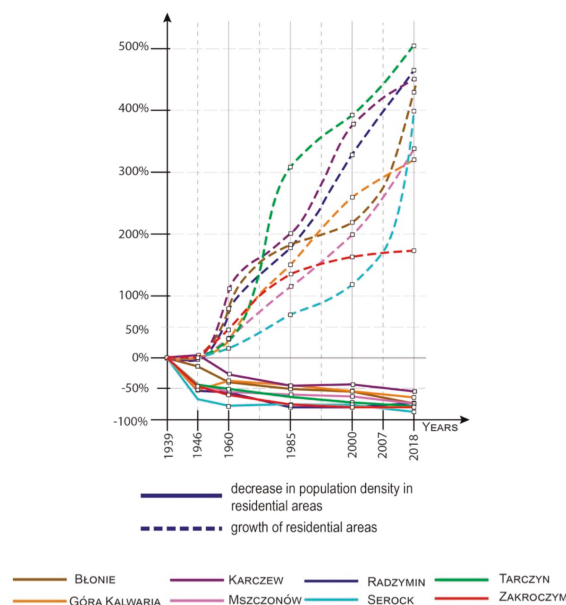
**Figure 5.** The change in the number of inhabitants in the studied cities and in their rural areas in the years 1995–2018 (for Tarczyn, the analysis concerned the period 2002–2018). Source: own study based on the data of the Central Statistical Office of Poland, Local Data Bank.

Changes in the number of inhabitants and significant increases in building land have made the population density in the studied cities significantly decrease compared to 1939 (Table 3—parameter C), but also to the times of Polish People’s Republic, when the lack of individual cars forced the creation of compact cities with a range of services accessible within a walking distance.

Table 3. Changes in population density in the studied cities in the years 1939–2018 (for Tarczyn, the analysis concerned the years 2002–2018).

Studied Cities	*	Units	1939–1946	1946–1960	1960–1985	1985–2000	2000–2018
Błonie	A	Persons per ha	142/104	87	71	65	38
	B	%	–27	–39	–18	–9	–42
	C	%	–27	–39	–50	–54	–73
	D	Persons per ha	10/7	11	14	14	14
Góra Kalwaria	A	Persons per ha	127/63	81	73	61	48
	B	%	–51	+28	–10.5	–17	–20
	C	%	–51	–36	–43	–53	–62
	D	Persons per ha	5.4/2.7	5.2	7.8	8.1	8.7
Karczew	A	Persons per ha	119/126	88	65	68	55
	B	%	+6	–30	–26	+5	+19
	C	%	1	–26	–45	–43	–54
	D	Persons per ha	1.4	2.2	2.3	3.8	3.5
Mszczonów	A	Persons per ha	152/86	68	62	56	40
	B	%	–43	–21	–9	–13	–29
	C	%	–66	–84	–90	–96	–112
	D	Persons per ha	6.5/3.7	+3.9	+5.7	+7.2	+7.5
Radzymin	A	Persons per ha	118/60	52	38	24	31
	B	%	–51	–56	–27	–37	+4
	C	%	–51	–56	–80	–80	–73
	D	Persons per ha	3.7/1.9	2.9	3.3	3.2	5.4
Serock	A	Persons per ha	143/47	33	36	34	19
	B	%	–67	–30	+9	–6	–44
	C	%	–67	–77	–75	–76	–87
	D	Persons per ha	4.8/1.6	2.2	2.1	2.5	3.2
Tarczyn	A	Persons per ha	136/77	65.6	-	37	32
	B	%	–43.5	–14.8	-	–43	–15
	C	%	–43.5	–51.8	-	–73	–77
	D	Persons per ha	5.6/3.1	3.5	-	7.5	7.9
Zakroczym	A	Persons per ha	114/62	46	29	24	22
	B	%	–46	–27	–37	–17	–8
	C	%	–46	–60	–75	–79	–81
	D	Persons per ha	3.1/1.7	1.8	1.8	1.7	1.6

* Explanations: A. Density in residential and commercial areas; B. Decrease/increase in density in residential and commercial areas; C. Decrease in density in residential and commercial areas compared to 1939 (the same data is presented in Figure 6); D. Density in cities and in their rural areas in the years 1939–2018. Source: own study.

**Figure 6.** Changes in population density in the studied cities in the years 1939–2018 (for Tarczyn, the analysis concerned the period 2002–2018). Source: own study based on numerical data for specific time periods according to Table 3.

In all cities, a similar decrease in density was observed at the level of approx. 80% compared to 1939 (the largest in Mszczonów—112%, the smallest in Góra Kalwaria—62%). The largest decreases occurred in the last 30 years after the political system transformation (with the largest in Błonie). Only two cities (Karczew and Radzymin) increased their density, which indicates that densification of the population took place along by filling of vacant urban plots originating from the second half of the 20th century.

Figure 7 shows a comparison of the density of development in two contrasting cities. Significant differences can be observed. Błonie represents the type of dispersed city, with several island-like clusters of buildings outside the center, Karczew has a more homogeneous structure.

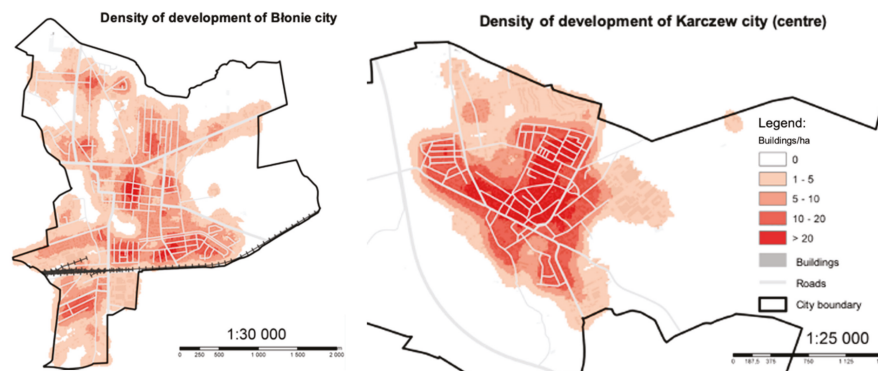


Figure 7. Comparison of development density (number of buildings per hectare of land) for the cities of Błonie and Karczew. Source: own study.

4.2. Territorial Dispersion of Cities

The studied cities differ greatly in size (which ranges from approx. 500 to 2800 ha); four of them have preserved the surface area since the Middle Ages; two of them have enlarged it; while another two have reduced it. The area of these cities in the prewar period was included in a circle with a radius of about 0.5–1 km, counting from a centrally located market square, so the most compact built-up area was concentrated on an area of about 1–2 km². Analyzing the increase in the area of building land between 1946 and 2018, similar characteristic processes can be distinguished in all of the examined cities:

- Until about 1985, the increase in built-up areas consisted of urban infill development within the historic center and on its outskirts (development took shape of multifamily and single-family housing estates corresponding to grid street plans and often initiated a new direction in urbanization) and the increase in built-up areas was connected with a new workplace, often near a new railway stop.
- From around 1985 to 2000, the process of building development along the outgoing roads from the center towards the surrounding villages could be observed (as early as before 1939, in all cities, there were also agricultural homesteads along the outgoing roads, and then single-family houses were built in their vicinity).
- From the mid-1990s to the present day, the process of building new housing units on agricultural areas, the so-called strip-of-farmland-based urban planning, could be observed. Comb-like layouts of cities, unrelated to the historic center and located at a distance of approx. 2–4 km, are delineated. The process of building residential development projects right near the city borders, unrelated to the historic center, could also be observed.

Based on Table 4, the surface area of residential and service areas, compared to 1939, has steadily increased (from 174% to 508%). These increases have not corresponded with population growth (for 6 cities it increased from 152% to 40%, in two of them there was a decrease in population). This shows that the increase in building land has not been justified by the housing needs of the

population and that each of the studied cities has a problem with the dispersion of development (Figures 8 and 9).

Table 4. Increase in building land and population compared to 1939.

Studied Cities	Urbanized Areas in ha		Population Growth/Decline Compared to 1939		Increase in Urbanized Areas Compared to 1939		Increase in Residential Areas Compared to 1939	
	1939	2018	Persons	%	ha	%	ha	%
Błonie	72	394	+3592	+41	+322	+450	+266	+430
Góra Kalwaria	68	358	+838	+58	+291	+429	+187	+322
Karczew	34	271	+6010	+152	+237	+696	+150	+452
Mszczonów	38	247	+883	+16	+209	+544	+124	+339
Radzymin	78	487	+4050	+47	+409	+524	+340	+466
Serock	46	264	−2235	−34	+182	+480	+182	+399
Tarczyn	22	159	+1205	+42	+146	+608	+108	+508
Zakroczym	59	182	−2903	−48	+123	+208	+93	+174

Source: own study.

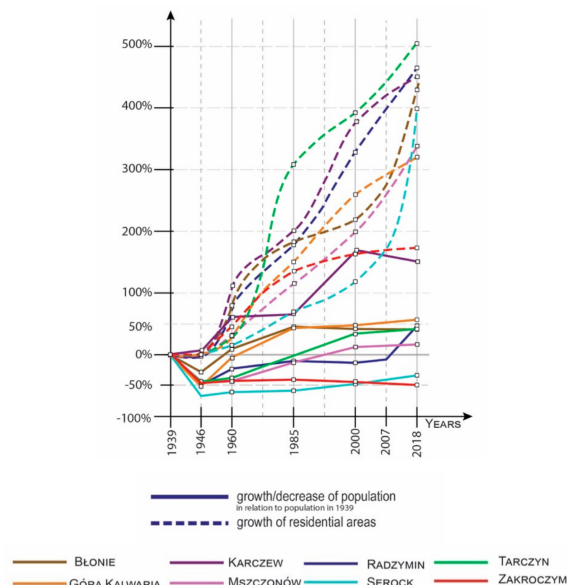


Figure 8. Increase in building land and population in the studied cities compared to 1939. Source: own study based on numerical data for specific time periods according to Figure 9 and Table 4.

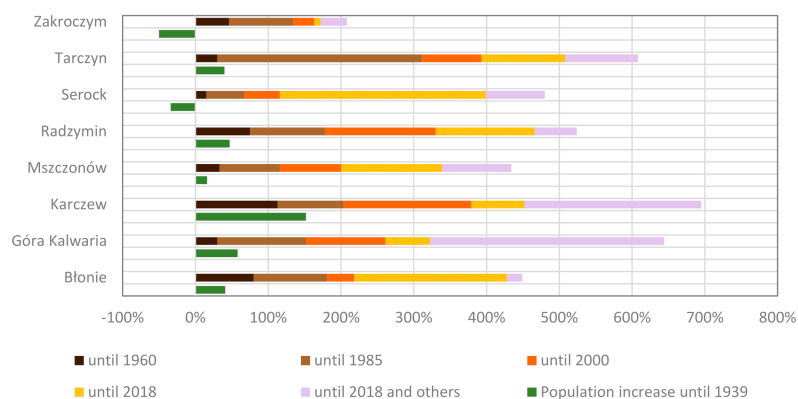


Figure 9. Increase in residential and commercial areas and other areas (industrial, recreational, military) and population since 1939. Source: own study.

Examining the increases in the four time periods (the periods are selected based on the availability of cartographic documents) it can be seen that the largest increases have occurred after 1985 (except for Tarczyn, which developed from a very small city in the 1960s due to the proximity of an industrial plant, and Zakroczym, where the increases are still small). Among the cities, Serock stands out (+399%, with a decrease in the population), due to Warsaw residents building their holiday homes there but without registering as permanent residents.

Other fastest-growing cities by population growth are Radzymin and Błonie. Sample studies of the land division structures of built-up areas developed in the last 30 years in the city of Błonie (Figure 10) show that these structures are very chaotic (example of strip-of-farmland-based urban planning). The land plots are delineated based on former farmland divisions (each plot is a separate property). They have different parameters and the streets, which do not form grid street plans, often abut on the plot from both sides. Some of the former agricultural plots cannot be subdivided as they are too narrow to delineate new streets. Built-up areas are developed on a selective basis (the average development intensity does not exceed 0.2). An additional difficulty is that the area is cut off from the commercial and public services section of the city by an expressway (with a limited pedestrian access), which forces residents to use private cars, e.g., to take their children to school. When analyzing the subsequent sections of the city spatial development, one can get the impression that the mismatched sections of the city create a sort of Tetris game (that is why the authors define this form of urbanization as ‘Tetris development’).

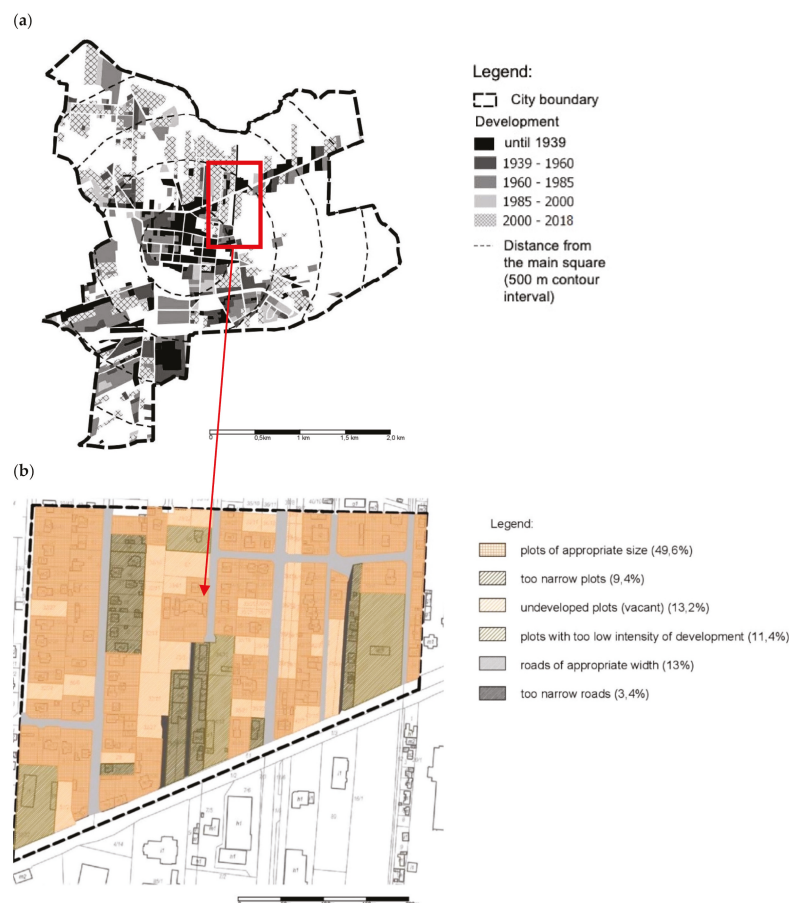


Figure 10. (a) Sample stages of dispersion of the city of Błonie; (b) A highlighted fragment of the development of a part of the city (a), illustrating spatial chaos—‘Tetris’ pattern of development. Source: own study.

The cities spreading outward reduces the intensity of development in urbanized areas (calculated as the ratio of a building's footprint $\times$ the number of floors to the total area of the plot of land), both at a city-scale level and at the level of individual plots of land (Table 5). As a result of war damage to buildings, the development intensity in the city center decreased after 1945 and increased in suburban zones, as new houses were built there. Until the 1980s, the urban compactness in the city center was increased by urban infill development. Single-family development zones were being constructed ($I = \text{approx. } 0.3\text{--}0.4$) closely linked to the city center. Outside them, along the outgoing roads, there was an extensive suburban zone (with agricultural homesteads) with the development intensity of approx. $0.1\text{--}0.15$. This relatively regular model existed until about the 1990s but due to the subdivisions of agricultural land in the peripheral zone, the proportions of the intensity of development have been reversed. The residential areas on the outskirts of the city are not yet fully built-up and many plots are vacant. The question arises, whether there is any chance that houses will be built there? It is possible that with the changing trends, as well as the onerous commuting hardships, these areas will be developed in a very extensive manner. However, there may also be a situation like the one in Zakroczym, where a quarter of urban development in the suburban zone will have a higher intensity of development than the city center. Terraced housing units ($I = 1.15$) and single-family houses consisting of detached and semidetached houses, as well as multi-family housing estates (e.g., Radzymin $I = 0.6\text{--}0.9$) are being built intensively on the outskirts of towns and cities, on small low-budget plots ($I = 0.4\text{--}0.6$). This type of urban development makes cities expand 'outward', with a less developed city center, which multiplies the costs of maintenance of the technical infrastructure and generates car traffic.

Table 5. Types of use of plots of land since 1939 and the intensity of their development.

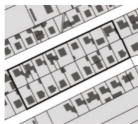
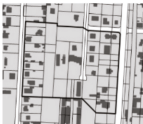
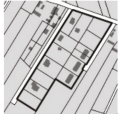
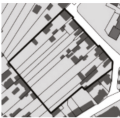
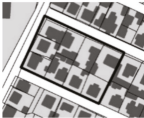
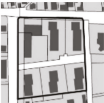
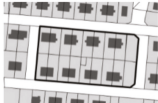
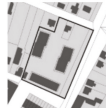
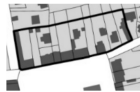
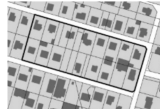
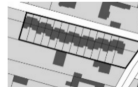
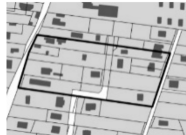
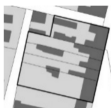
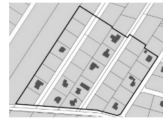
	1939 Development of Historic City Center	Years 1960–1990 Multi-Family Housing Development	Years 1960–1990 Single-Family Housing Development	After 1990 Intensive Multi-Family and Single-Family Housing Development	After 1990 Single-Family Housing Development
Błonie	 I = 1.02	 I = 1.27	 I = 0.37	None—multi-family buildings complement the urban tissue of the center. No new residential developments.	 I = 0.21
Góra Kalwaria	 I = 0.75	 I = 1.07	 I = 0.25	 I = 1.15	 I = 0.14
Karczew	 I = 0.10	 I = 1.34	 I = 0.31	 I = 0.35	No dispersed development along historical strip-of-farmland-based divisions.
Mszczonów	 I = 0.75	 I = 1.18	 I = 0.31	 I = 0.67	 I = 0.18

Table 5. Cont.

	1939 Development of Historic City Center	Years 1960–1990 Multi-Family Housing Development	Years 1960–1990 Single-Family Housing Development	After 1990 Intensive Multi-Family and Single-Family Housing Development	After 1990 Single-Family Housing Development	
Radzymin	 I = 1.03	 I = 1.04	 I = 0.37	 I = 0.55	 I = 0.13	
Serock	 I = 0.62	 I = 0.56	 I = 0.29	 I = 0.67	 I = 0.15	
Tarczyn	 I = 0.38	 I = 0.96	 I = 0.35	 I = 0.95	 I = 0.1 (0.3)	
Zakroczym	 I = 0.37	 I = 0.43	 I = 0.18	No new multi-family and terraced developments		 I = 0.21 (0.36)

Source: own study based on [83].

4.3. Territorial Dispersion of Cities and Spatial Planning Documents

Within the administrative boundaries of the studied cities, some undeveloped, vacant areas can be seen, which are currently used as agricultural fields, but part of them is vacant land awaiting conversion to building land. Spatial order should be guarded by planning directives which should serve to reduce the building development dispersion ([84], p. 19). The planning instrument for the entire area of a municipality is a document named the study of the conditions and directions of spatial development (hereinafter referred to as the study), which in the case of all the studied cities covered also the rural areas within the boundaries of municipalities. The areas of the cities were mostly designated (excluding only the protected and active natural areas) as: urbanizable areas (for residential, services, and industrial development). Assuming the hypothetical development of the city area allowed in the study, it is possible to calculate a potential increase in the number of inhabitants presuming that the existing population density in urban areas will remain as it is today [43] (pp. 85–86). The results obtained (Table 6) show that, taking into account Polish demographic forecasts, such scale of development is not likely, as it would require a doubling of the population or even its five-fold increase. Rather, it is more probable that dispersed clusters of buildings will be created in undeveloped areas, where entrepreneurial owners will decide to divide them into building plots (the effects of spatial planning conditions, corruption-generating decisions, investors for whom the determinant is not spatial order but maximizing their profit, irrational divisions into building plots without population forecasts and without adequate urban structure, are more broadly described in the paper by Kowalewski, Markowski, and Śleszyński [85]).

Table 6. List of urbanized areas in 2018 and areas intended for urbanization according to the planning documents of the studied cities. Source: own study.

	1	2	3	4	5	6	7	8
Błonie	912	392	126	786	394	31.5	24.8	98%
Góra Kalwaria	1367	336	655	712	376	33.1	23.4	99%
Karczew	2812	265	2041	771	506	36.9	28.5	186%
Mszczonów	856	270	103	753	483	26.0	19.6	204%
Radzymin	2349	601	1187	1162	561	26.0	30.2	140%
Serock	1343	240	316	787	547	16.5	13.0	198%
Tarczyn	523	154	20	503	349	25.8	13.0	216%
Zakroczym	1997	184	829	1168	984	17.6	19.9	520%

Explanations: 1. Area of the city (ha); 2. Urbanized areas in 2018 (ha); 3. Protected green areas (ha); 4. Areas designated for urbanization (ha); 5. ‘Empty’ areas, currently not built-up, but designated for development according to the planning documents (ha); 6. Calculated development intensity in urbanized areas (persons/ha); 7. Potential population of the city in the case of settlement in areas designated for development in the planning documents (in thousands); 8. Potential population growth as from 2018 (%).

The provisions of the studies of conditions and directions of spatial development in each of the studied cities completely exclude from the functional structure agricultural land which is still currently used for farming. These provisions do not seem fully justified. In the era of climate change, development of ‘city farming’ movements, development of gardening on balconies and rooftops, these areas should be used, for example, for horticulture [86] (p. 235). Permitting such a significant dispersion of building development (especially for industrial purposes) may cause degradation of undeveloped areas and their setting-aside, awaiting development. Dispersion of building development also increases the costs of construction, modernization, and maintenance of line and site infrastructure. In the case of the water supply network, in large cities, in order to ensure the level of coverage of over 90% of the population, the rate per capita is approx. 2 m, in suburban zones this rate increases to 8.5 m per person [52] (p. 70). For example, Błonie in 1980 had only 1326.5 m of water supply network, currently this length is approx. 160 km, which is approx. 13 m per capita. The sewage system, on the other hand, has a length of approx. 80 km, i.e., approx. 6.5 km per inhabitant—which shows that many

areas are not served by it. Many plots must therefore use individual sewage tanks (cesspools), which are not always tight and pose a threat to the environment.

The scale of the phenomenon of the increase in the surface of built-up areas compared to the planning laws introduced since 1945 (see Section 2.1) indicates that during the period of centralized socialist planning and disregard for property rights, these increments were much smaller (controlled). A dramatic change took place after 1989 as a result of the liberalization of regulations, the devolution of planning power to local authorities, and the abandonment of state-imposed national and regional policies. In the name of the economic gain of private landowners, there has been an uncontrolled urban sprawl (this can be seen in Figures 8 and 9, which show for most cities the increase in the surface of building land).

5. Discussion and Conclusions

The paper diagnosed the current land use in selected small cities in the suburban zone of Warsaw with regard to their spatial disorder—referred to by the authors as ‘Tetris development’. In all studied cities, morphological and functional chaos can be observed, characterized by chaotic development structure, as well as urban and spatial dysfunctions [52] (p. 43). This affects the development and the costs of providing utility services to these areas and also poses a threat to sustainable development. The causes of spatial chaos include:

- Historical background and lack of legal guidelines shaping the development of Polish towns and cities at the turn of the 19th and 20th century.
- The principles of socialist economy associated urban development with territorial expansion, and the land had no economic value.
- The imperfect planning laws during the Polish People’s Republic made the distances between buildings equal for cities and villages. This has resulted in a situation, especially in small and medium-sized cities, where a detached single-family house has become the main element of the urban development structure.
- Poor spatial planning after the political transformation resulted in the local governments allocating—in their planning studies—considerably more land for building development than was actually needed; and the system of spatial planning—which was (supposed) to act as guardian of spatial order at a municipal level—turned out to be too weak of a tool.
- Abuse of property rights after the political transformation (as a reaction to the lack of respect for property rights during the Polish People’s Republic) and marginalization of the so-called public interest, in the name of economic gain, has left the urban landscape without protection.
- Lack of cultural heritage education and absence of good aesthetic standards among investors, educated during the Polish People’s Republic, resulted in the emergence of buildings in disharmony with the environment, where the main criteria are the economic gain and the maximum usability of the building.

Small cities, ‘lagging behind’ when compared to larger urban centers, have a great potential which, if supported by good urban policy, can bring positive results and guide their development so that they become better cities to live in. One may wonder whether small towns have a chance to capitalize on their delayed development benefit? The presented image of cities shows the need to take rapid corrective actions, i.e.,:

- restrict the possibility of nonrural population settling in rural areas, redirecting potential residents to the urbanized areas of small towns; that would enable the population of these urban centers to grow and would make the upgrade of service and technical infrastructure economically viable), limit the spread of built-up areas to the city limits;
- delimit a zone of building concentration and the maximum possible development range, so that the urbanized area has a wide range of services accessible within a walking distance

and ensure—through strong planning guidelines (introduction of urban standards to spatial planning)—the creation of rational spatial structures of newly urbanized areas.

However, in order to ‘fix small cities’, a coherent program is needed, supported by legislation and equipped with instruments of operational urban planning to make spatial policy more effective. It should be stressed that the existing spatial planning instruments in Poland are insufficient, and that restoring spatial order in Polish cities is beyond the capacity of urban planners. On the basis of own study [43] (p. 166) and the literature review [87] (pp. 24–25), [88], the following key tools necessary for successful implementation of corrective actions can be listed:

- (1) Planning instruments linking mandatory planning (the study and the local development plan) to planned operations, including:
 - designation of zones and areas (e.g., zone of agreed investment activities, zone with established municipal pre-emption right, heritage protection zones) which, thanks to relevant provisions in local plans, enable e.g., expropriation procedures or procedures for consolidation and division of real property into building plots,
 - creating operational plans for tasks that must be undertaken in the coming years by municipal governments,
 - creating guidelines for the so-called urban planning standards defining the criteria (road width, accessibility of services) that should be met by a property development company or a landowner for new areas to be allocated for residential use,
 - increasing the role of studies of conditions and directions of spatial development of municipalities,
 - verifying the population absorptive capacity estimates that are made for the purpose of drawing up the study of the conditions and directions of spatial development of the commune by the provincial governor (voivode) during the study’s adoption procedure,
 - drawing up of programs for specific activities (e.g., land management, heritage conservation, technical infrastructure, revitalization and rehabilitation),
 - introducing to the local spatial development plans new provisions imposing, when planning new investment areas, the construction of public roads with the appropriate widths to create coherent grid street plans,
 - complete abolition of the decisions on land development conditions and public purpose investments.
- (2) ‘Support’ tools, including:
 - financial tools (including repair and renovation reserves for owners, lower rents, tax credits, betterment levies, property and investment taxes),
 - organizational and legal tools (e.g., the acquisition of decommissioned industrial plants by the municipality, the right of pre-emption of land, the establishment of mixed development zones, exemptions from tenders, land consolidation, and monitoring of the situation in order for the municipality to react quickly),
 - instruments of ‘coercion’ (e.g., limitation of ownership right for public purposes, democratic public consultation procedure),
 - financial and legal assistance to municipalities for compensation payments to landowners during the implementation of local development plans in the event of a change of function from residential to agricultural one.

In order to properly plan a city, the most important thing is to diagnose its condition. The proposed methodology was applied experimentally in eight Polish cities. They were compared in terms of intensity of development, development density, types of existing development, and spatial order.

The ‘Tetris development’ method presented here can be applied for studying the chaotic spatial structure of many Polish cities, by creating an algorithm to determine the state of development of land, which would help to diagnose and improve the structure of urban space. Urban morphological studies of ‘Tetris development’ can be the starting point for further research studies at a microscale. They should be based on numerous examples of different Polish cities, including medium-sized, border zones of large urban centers, and urbanized rural areas. The results of the ‘Tetris development’ studies will help establish common assumptions and identify areas with similar urban parameters. Following such research work, it will be easy to determine whether a given part of a city with the same urban morphology has e.g., 10% of ‘vacant’ undeveloped plots of land or 11% of the plots that can still be subdivided. The ‘Tetris development’ approach can be used in Poland to draw up absorptive capacity estimates for the planning instruments i.e., ‘studies of conditions and directions of spatial development of municipalities’ to improve land records for the studied areas and possibly prevent further chaotic sprawl of built-up areas and uncoordinated plots subdivision in the absence of valid plans.

Worldwide studies on urban dispersal are usually conducted at macroscale, for regions. Suburbanization indicators are studied most often on the basis of methods which quantify spatial patterns of land cover patches by means of descriptive statistical analysis and entropy using remote sensing and GIS tools.

The ‘Tetris development’ method is based on morphological studies on the development of urbanized areas. It addresses the need for rational subdivision of small parts of the city which, in the Polish context, is not implemented (it is not prescribed by the Planning Directive). The specificity of Polish cities is the urbanization carried out without urban planning, which sets them apart from other European urban centers and other postsocialist cities. This is due to the fact that in Poland, despite the socialist system, the right to private property has been preserved to a large extent (and given more priority over public interest in the planning acts implemented after the political transformation). In Europe, the newly parceled areas are created on the basis of local spatial development plans, while in Poland mostly on the basis of land development decisions, which introduces spatial chaos. This is why the proposed method of conducting research studies can be widely applied in Poland, but may also be useful in other countries, such as Greece and Turkey, affected by the uncontrolled suburban development around large metropolises.

The conducted study has identified key conditions for Polish cities to become good places to live in for its inhabitants and has showed the need to monitor urban development and adapt appropriate tools for this purpose. It has also pointed out the possibilities of improving spatial chaos (‘Tetris development’) and of reducing this risk not only with regard to cities in Poland but also cities of similar size with similar spatial problems in other countries in this part of Europe. This methodology will enable the introduction of regional indicators but can be successfully applied in other cities of the world.

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