

Jerzy DZIECIUCHOWICZ, Karolina DMOCHOWSKA-DUDEK

THE SHAPES OF LAND LOTS WITHIN METROPOLITAN SPACE. THE ŁÓDŹ CASE¹

Ph.D. Jerzy Dzieciuchowicz, Assoc.Prof. – *University of Łódź*

Correspondence address:

Faculty of Geographical Sciences

Institute of the Built Environment and Spatial Policy

Kopcińskiego 31, 90-142 Łódź

e-mail: jerzy.dzieciuchowicz@geo.uni.lodz.pl

Karolina Dmochowska-Dudek Ph.D. – *University of Łódź*

Correspondence address:

Faculty of Geographical Sciences

Department of Regional and Social Geography

Kopcińskiego 31, 90-142 Łódź

e-mail: karolina.dmochowska@geo.uni.lodz.pl

6

ABSTRACT: This study focuses on the spatial diversity of the shapes of land lots in metropolitan conditions viewed through the example of Łódź. The researchers placed particular attention on the diversity and compact of lot shapes. This issue was preceded by a brief discussion of the distribution, density and sizes of lots. The goal of the study was to assess the spatial variability of lots according to their shapes using GIS tools.

KEYWORDS: land lots, shapes of lots, spatial structure, metropolitan space, Łódź, GIS.

KSZTAŁT DZIAŁEK GRUNTOWYCH W PRZESTRZENI MIEJSKIEJ PRZYKŁAD ŁODZI

ZARYS TREŚCI: W artykule położono nacisk na zróżnicowanie przestrzenne kształtu działek gruntowych w przestrzeni metropolitalnej na przykładzie Łodzi. Szczególną uwagę autorzy zwrócili na zróżnicowanie i zwartość kształtu działek. We wstępnej części pracy poddano analizie rozmieszczenie, gęstość i wielkość działek. Głównym celem pracy jest identyfikacja zróżnicowania przestrzennego kształtu działek przy użyciu narzędzi GIS.

SŁOWA KLUCZOWE: działki gruntowe, kształt działek, struktura przestrzenna, przestrzeń metropolitalna, Łódź, GIS.

¹ The extended version of the article was published as: J. Dzieciuchowicz, K. Dmochowska-Dudek (2014: 149–167).

6.1. Initial remarks

The transformations of the Polish metropolitan space since 1989 have been determined by the changes of the political and economic system. Large cities witnessed both, subdivisions and re-parcelling of lots. Subdivision leads to an increase in the pool of land lots². Re-parcelling, with reverse results, was less significant. Numerous investments, particularly transport, trade and housing investments had a particular influence on the evolution of the metropolitan space. They usually influenced not only the sizes but also the shapes of lots. Today, there is fairly little information regarding the shapes of land lots in large Polish cities.

This study focuses on the spatial diversity of the shapes of land lots in metropolitan conditions as analysed through the example of Łódź. The researchers placed particular attention on their diversity and compact. This issue was preceded by a brief discussion of the distribution, density and sizes of lots. The goal of the study was to assess the spatial variability of lots according to their shapes using GIS tools.

The study is mainly based on land survey material reflecting the situation in early 2013 (January 26th). It was then further amended with information gathered during field studies. Data regarding specific features of land lots were aggregated per geodesic (registration) units (215) (Fig. 1), which enabled the researchers to provide a detailed spatial analysis using GIS tools included in the ArcGIS suite. The quality of the data bears no significant reservations.

When discussing the main research notions, the researchers related to subject literature which is summarised in the study by J. Dzieciuchowicz (2011: 21–22). In the light of previous studies in urban geography in terms of spatial organisation of urban areas, two research paths emerged, both related to urban utilisation of land and city morphology. One of the most important theories related to the characteristics which determine the designation and the value of land is the theory of Thünen's rings according to which there is a relationship between transport costs and the value of land and its rent. When applied to contemporary conditions, the theory implies that the development of road infrastructure results in the lowering of transport costs, an increase of land prices and land rent (Kopczewska 2008). One of the most important achievements of urban morphology studies is the theory of morphological development cycle of lots and urban blocks the foundations of which were created by M.R.G. Conzen (1960, 2002) and which was developed in Poland by, e.g. M. Koter (1969, 1974, 1979, 1994) and B. Miszevska (1979, 1994, 1996).

² Land lot it is a Polish legal term which refers to a part of land which constitutes a separate property. Thus, land is both, a type of property and an object according to the Civil Code.



Figure 1. The division of Łódź into geodesic and residential units

Source: own work.

Detailed studies of the utilisation of urban areas of Łódź were initiated by S. Liszewski (1977, 1979). Later studies in the city focussed on the spatial-functional transformations of industrial areas during the transformation period (Liszewski 1997; Piech 2004). Morphogenetic and morphological studies of Łódź were developed mainly by M. Koter (1969, 1974, 1979). The morphological changes of Łódź industrial areas became the subject of extensive studies by J. Kotlicka (2008). J. Dzieciuchowicz (2011) studied the spatial diversity of properties and their trade within Łódź.

6.2. Distribution and density of lots

In early 2013, the area of Łódź was divided into 133,547 land lots. Their spatial distribution throughout geodetic units, as related to their functional-spatial structure (Fig. 2), displayed high variability ($V = 63.1\%$)³ (Fig. 3). The extremely wide empirical area of variability of lot numbers within geodesic units which covers a range from 26 to 1,900 lots is evident. The density of the distribution of lots in those units is a result of spatial diversity of the number of lots, generally rising towards the centre (Fig. 4).

³ Symbols V, A and K correspond to coefficient of variability, asymmetry and kurtosis respectively, while the symbol r corresponds to linear correlation.

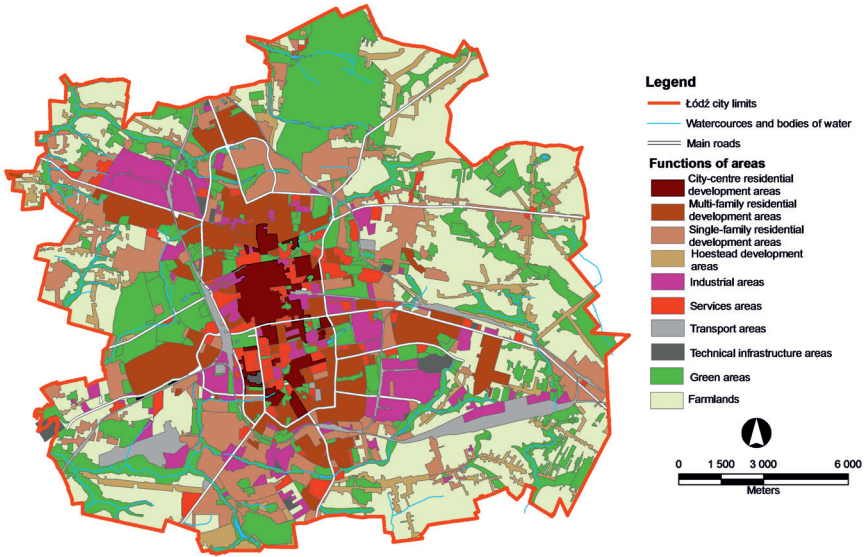


Figure 2. The functional-spatial structure of Łódź

Source: own work based on the Study of conditions and directions of spatial development of the city of Łódź, 2010.

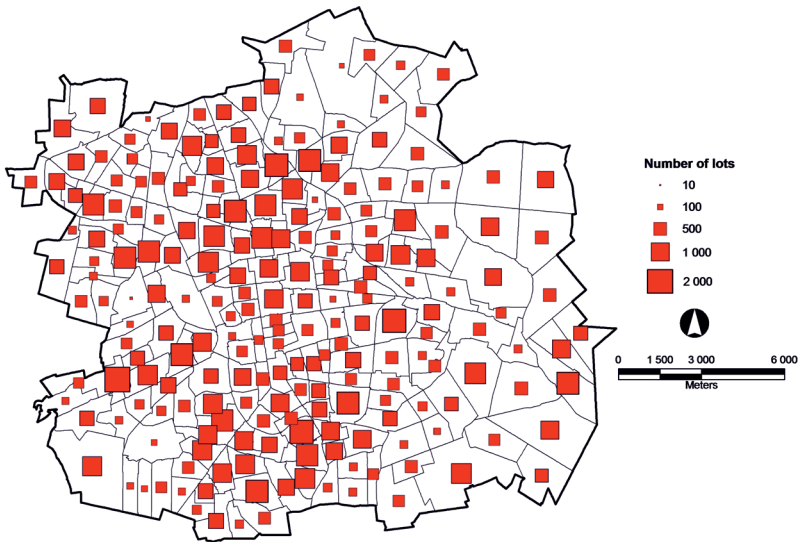


Figure 3. Distribution of lots in Łódź per geodesic unit

Source: land record data (ŁOG); own work.

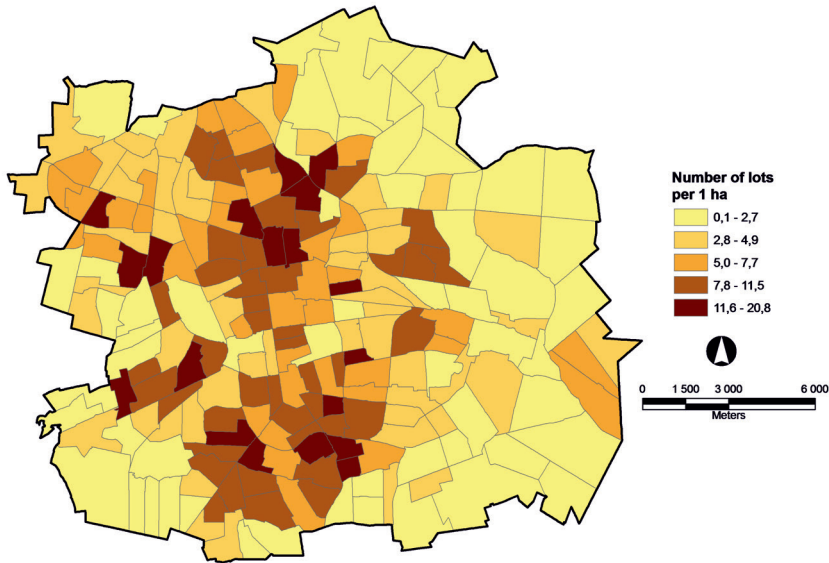


Figure 4. Density of land lots in Łódź per geodesic unit

Source: data of land records in Łódź (ŁOG); own work.

The average area of lots within Łódź geodesic units, which depends on, e.g. their location and each lot's conditions, is extremely diverse (Fig. 5). This in turn results in a huge range of this area (481–98,199 sq. m) and very high rightward asymmetry of its spatial distribution. There has been a general tendency for the area of lots to increase towards the outer parts of the city, yet the smallest lots are not collecting only in central areas but on their northern and southern borderlines (central-southern part of Bałuty, Chojny Zatorze, Ruda) which are also characteristic for their high numbers of lots. From the point of view of the organisation of the city space of Łódź, numerous very small land lots which are difficult to develop properly or sell constitute a particular problem. The problem of developing the largest land lots may also pose another important issue in individual units. Units located within the intermediate zone display a particularly high level of area of lots variability unlike those located in the peripheral zone of Łódź.

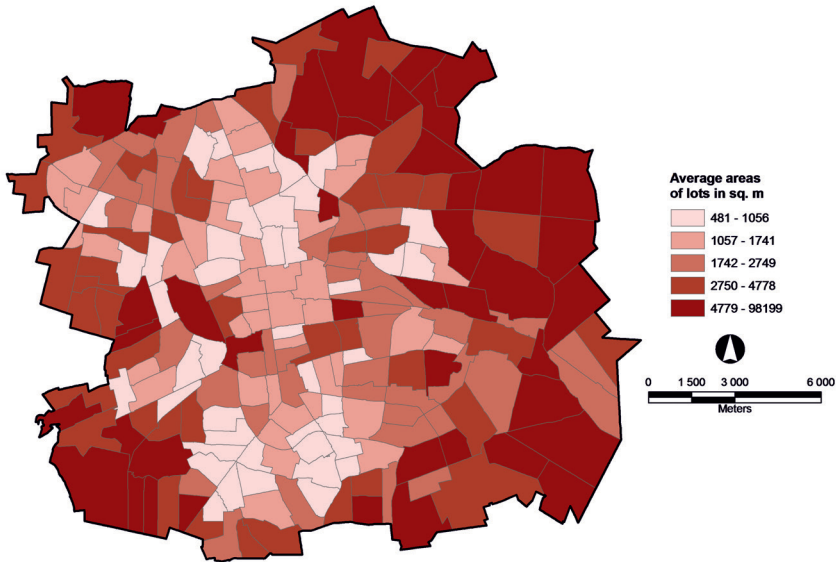


Figure 5. Average area of lots in Łódź per geodesic unit

Source: data of land records in Łódź (ŁOG); own work.

6.3. Shapes of lots

Studies of shapes of lots within geodetic units included measurements of lot borderlines and their area. Two measures were used, both developed by J. Dzieciuchowicz. The first one, which specifies the diversity of the shape⁴, is the ratio between the average length of lot borderlines (d_j) and their average area within a given geodesic unit (p_j):

$$K_j^z = d_j/p_j \times 100.$$

The more sections of diverse directions a given lot borderline has, the longer its length per a given land area unit. Thus the discussed indicator increases with the increase of the diversification of lot shapes within specified territorial units.

The second indicator defines the ratio between the average actual length of lot borderlines (d_j) within a given geodesic unit and the hypothetical length of those borderlines L_j which relates to the circumference of a circle if its area was equal to the average actual area of lots in that unit:

⁴ I. Jażdżewska (1999) used a similar measure proposed by B. Kosturbiec (1972) to study the shape of lots in Rzgów.

$$K_j^h = d_j/L_j,$$

where $L_j = 2 \pi r$, for a circle of average area lots within j units.

This indicator expresses the degree to which the actual shape of lots differs from a circle. Its values increase proportionally to the indicated difference. At the same time, the increase indicates a decrease of the lots' territorial compactness. Thus, it specifies both, to what extent the actual average length of lot borderlines within a given unit differs from the minimum length equal to the circumference of a circle corresponding to the average area of lots in that unit.

The starting point for the discussion of the shape of lots was the average length of their borderlines in individual geodetic units. It needs be said that there is a general outward rising tendency in the case of this measure. The average area of lots in those units also rises in the same direction. The average length lot borderlines in all units was 252.2 m ranging from 96.4 to 966.4 m. The distribution of the lengths was highly diverse ($V = 60.7\%$) with a high positive asymmetry ($A = 2.1$).

The distribution of the values of the lot shape diversification indicator within geodesic units displays different properties when compared to previously analysed lot characteristics. It is almost perfectly symmetrical ($A = 0.07$) with average diversity ($V = 33.7\%$) and strong leptokurtosis ($K = 2.88$). The average value of the indicator was 10.3 m per 100 sq. m. The distribution of its values throughout the geodesic units was largely similar to the distribution of the density of lots ($r = 0.888$) (Fig. 6). Higher density is accompanied by a higher diversification of the shapes of lots. Such conditions offered also more opportunities for multiple divisions of primary lots. At the same time, the diversity of the shapes of lots is highly negatively correlated with the average area of lots⁵ ($r = -0.876$) (Fig. 7). The values of the lot shape diversity indicator which exceeded the city average were mostly identified in units located in the central and intermediate zones: Śródmieście, Stare Miasto, Stare Bałuty, Julianów, Marysin, Rogów, Stoki, Sikawa, Stare Chojny, Ruda, Retkinia, Złotno (Fig. 8). Peripheral agricultural areas located mainly in the eastern part of the city display low lot shape diversity.

The second indicator of lot shapes used which defines their compactness does not indicate high diversity within Łódź geodesic units ($V = 22.8\%$) (Fig. 9) even though there is a rather high positive skewness ($A = 2.57$). It does not, however, depend on the density and the sizes of lots or their shapes diversity. Low compactness defined through high values of the indicator used is mainly displayed by lots located in peripheral areas: Wzniesienia Łódzkie (Łódź Hills), Mileszki, Feliksin, Wiskitno, Łaskowice, Chocianowice, Smulsko, Złotno, Romanów, Kochanówka. They mostly include agricultural land still undeveloped by ongoing urbanisation. The same measure records rather high values, which indicate low

⁵ This applies to logarithmic area values.

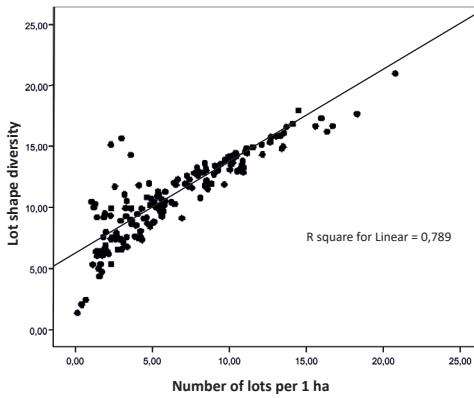


Figure 6. The relationship between lot shape diversity and the density of lots within geodesic units in Łódź

Source: own work.

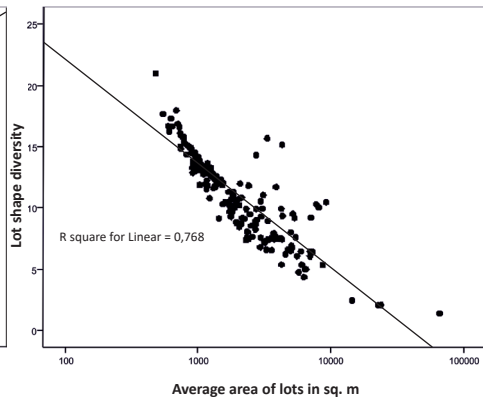


Figure 7. The relationship between lot shape diversity and their average area (logarithmic) within geodesic units in Łódź

Source: own work.

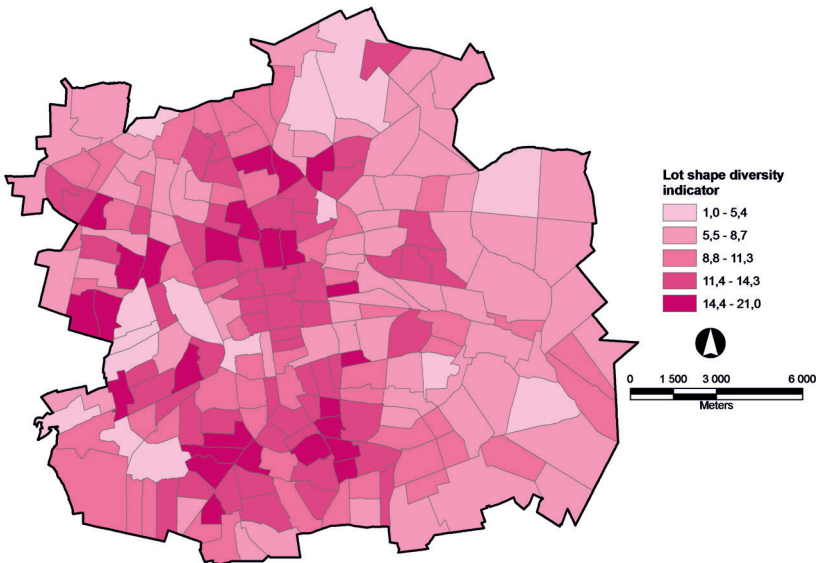


Figure 8. The diversity of the shapes of land lots in Łódź per geodesic unit

Source: data of land records in Łódź (ŁOG); own work.

compactness, within the area of the city centre, where existing lots were initially devised for the needs of clothiers, weavers and linen and cotton spinners. Their shapes did not undergo any radical changes. Lots which shape resembles a circle

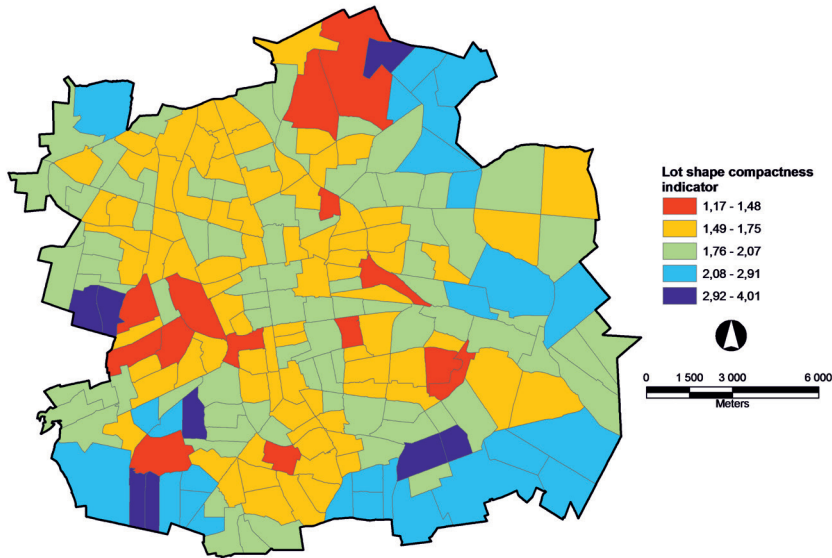


Figure 9. The compactness of the shapes of land lots in Łódź per geodesic unit

Source: data of land records in Łódź (ŁOG); own work.

the most ($K^h < 1.74$) are located usually in the intermediate zone: Radogoszcz, Łągiewniki, Julianów, Doły, Radiostacja, Niciarniana, Dąbrowa, Olechów, Stare Chojny, Brus, Zdrowie, Politechniczna. In those areas lot transformation processes were most intensive during the peak of urbanisation which started in the 19th c.

6.4. Types of areas according to lot shapes

Considering values lower or higher than the average values of both lot shape indicators discussed, one might identify four types of units (Fig. 10) featuring lots with: 1. Low (below the average) shape diversity and low compactness; 2. Low shape diversity and high (above the average) compactness; 3. High shape diversity and high compactness; 4. High shape diversity and low compactness. The distribution of lots according to the specified types is illustrated with fragments of registry maps of specific units.

Type 1: low shape diversity and low compactness of lots. This type has become most common in the peripheral parts of the city but its range is not extensive (33 units). Unit W-36 is specific for this type. Rectangular lots are predominant in the selected part (Fig. 11) but there are also small lots of highly irregular, e.g. triangular, shapes, which are located on the Olechówka and which were created as a result of river engineering works.

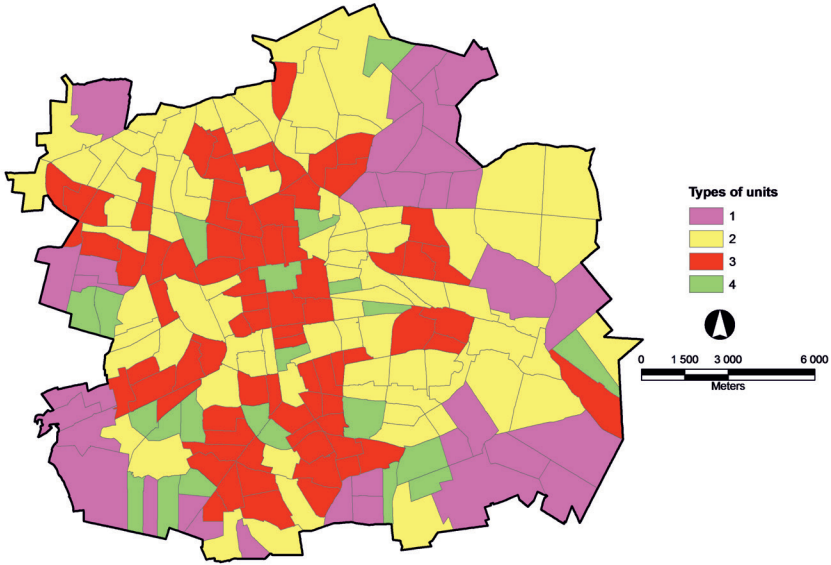


Figure 10. Types of geodesic units per shape diversity and compactness of land lots in Łódź

Source: data of land records in Łódź (ŁOG); own work.

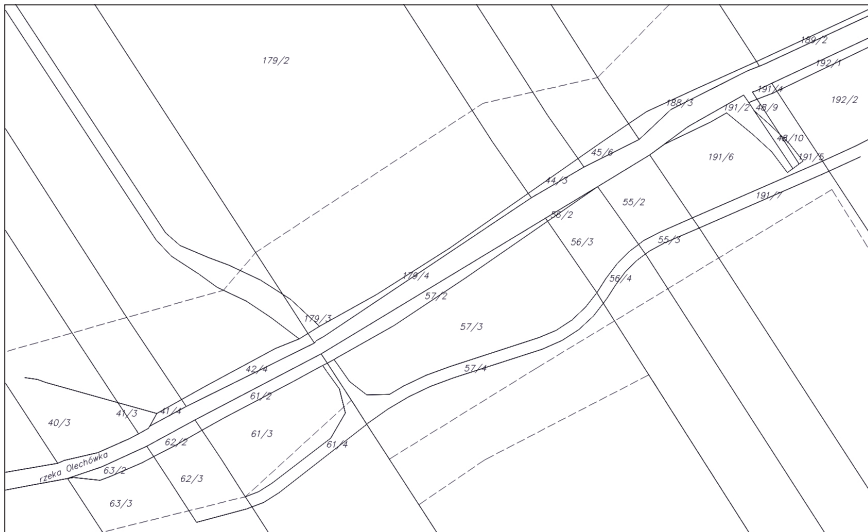


Figure 11. Fragment of the valley of the Olechówka with surrounding lots

Source: map of the W-36 geodesic unit (ŁOG).

Type 2: low shape diversity and high compactness of lots. This type covers many units (81) which are located mostly in the peripheral and intermediate zones. To illustrate the distribution of the lots of this type the authors used fragments of the registry map of the W-35 unit (Fig. 12). It covers a part of the residential area in Mieszka I Street and Zakładowa Street in Olechów. It includes many small lots of regular rectangular shapes. Semi-detached single storey buildings are most common. Lots with similar areas (0.0218–0.0230 ha) form rectangles with aspect ratio of 1:6.

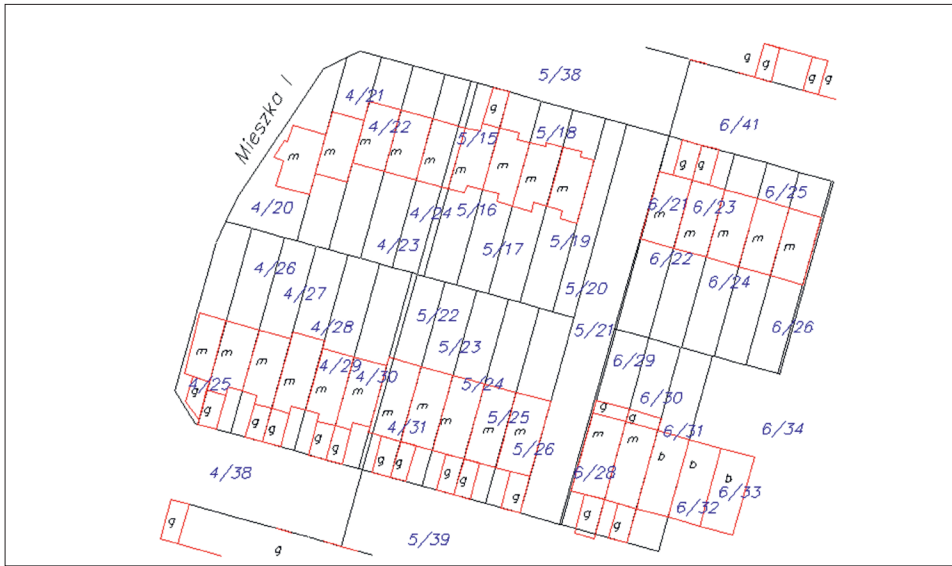


Figure 12. A fragment of the residential complex in Mieszka I Street and Zakładowa Street in Olechów

Source: map of the W-35 geodesic unit (ŁOG).

Type 3: high shape diversity and high compactness of lots. Similarly to the previous one, this type is also common (79 units). It mainly occurs in the central zone but it also appears in the intermediate zone while it is rare in the peripheral zone. This type includes i.a. the P-09 unit located in the north-western part of city center (Fig. 13). The distribution of lots in the blocks between 1-go Maja, Próchnika, Żeromskiego and Lipowa Streets is specific for this type. The shapes of lots are not regular. They include high-intensity dense developments composed of tenement houses which are often accompanied by utility buildings and they surround completely or partly small courtyards. Some lots feature buildings which perform the same functions but include different numbers of storeys.

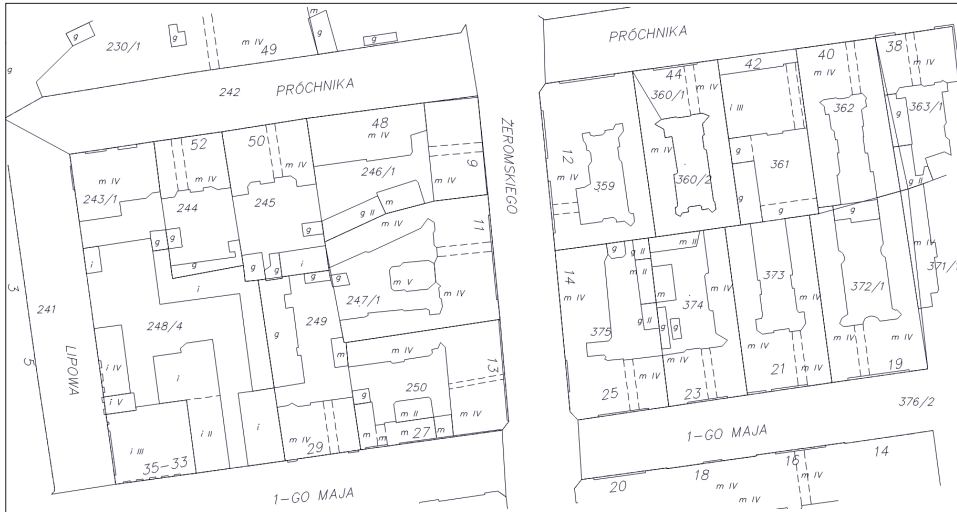


Figure 13. A section of the block within Próchnika, Żeromskiego, 1-go Maja and Lipowa Streets

Source: map of the P-09 geodesic unit (ŁOG).

Type 4: high shape diversity and low compactness of lots. Type four includes the smallest number of units (22) which are scattered throughout the city. This type is represented by, e.g. the S-01 unit (Fig. 14) which is located in the northern part of city center, forming the Nowe Miasto residential unit. The lot occupied by Plan Wolności has an original octagonal shape. The shapes of surrounding lots are not fully regular. Other lots of different shapes, usually two side by side, radiate from the shorter sides of the octagon while street which lots are nearly rectangular radiate from the longer sides of Plac Wolności. The building located in 5 Plac Wolności occupies nearly the entire area of the lot and its courtyard occupies already another lot. A similar situation exists in 7–8 Plac Wolności. The diverse nature of lot shapes negatively influences their compactness.

6.5. Conclusion

The political and economic changes after 1989 have played a special role in the transformations of metropolitan space in Poland. The transition to market economy stimulated numerous investments, particularly in transport, trade and residential. They usually influenced both the re-parcelling and subdivision of various lots and resulted in changes of their sizes and shapes. The goal of this study was to assess the degree of diversification of the spatial structure of lots formed in market economy according to their shapes and utilising GIS tools.

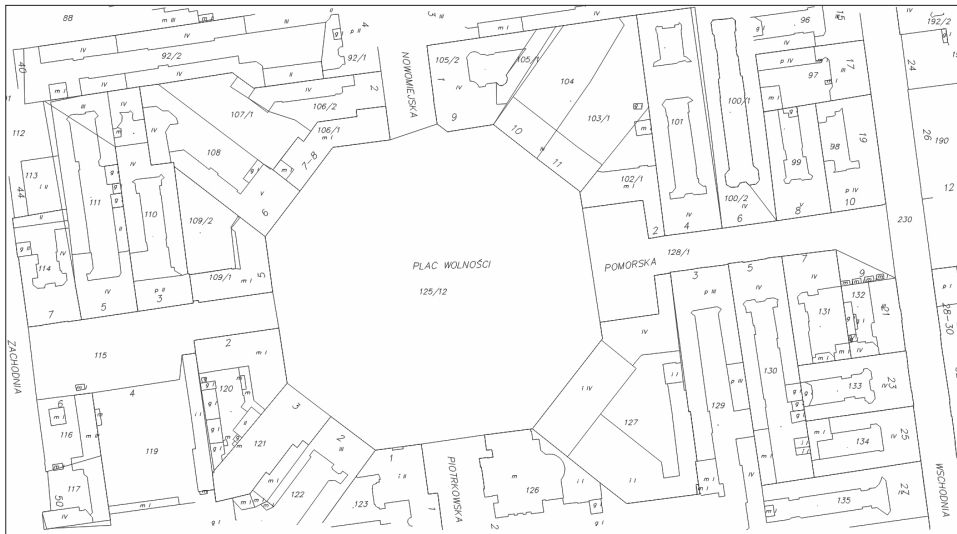


Figure 14. Plac Wolności and neighbouring lots

Source: map of the S-01 geodesic unit (ŁOG).

In early 2013, the area of Łódź was divided into 133,547 land lots. As a result of conducted studies the authors established that their spatial distribution throughout geodesic units displays high variability. The density of the distribution of lots in those units is a result of spatial diversity of the number of lots, generally rising towards the centre.

The average area of lots within Łódź geodesic units, which depends on, e.g. their location and each lot's conditions, is extremely diverse. There has been a general tendency for the area of lots to increase towards the outer parts of the city, yet the smallest lots are not collecting only in central areas but on their northern and southern borderlines (central-southern part of Bałuty, Chojny Zatorze, Ruda) which are also characteristic for their high numbers of lots.

The study of the shapes of lots within geodesic units was based on two measures. The first defined the lots shape diversity while the second expressed the degree to which actual lot shapes differ from the shape of a circle. The distribution of the values of the lot shape diversity indicator within geodesic units is nearly symmetrical with average variability and high leptokurtosis. It largely overlaps the distribution of lot density. At the same time, the diversity of the shapes of lots is highly negatively correlated with the average area of lots. The diversity of the shapes of lots which exceeds the average city level mainly exists in units located in central and intermediate zones. Peripheral agricultural areas located mainly in the eastern part of the city display low diversity.

The second lot shape indicator used, which illustrates the compactness of the lots, did not display high diversity within the city space and does not depend on the density or sizes of lots or the diversity of their shapes. Low density is mainly represented by lots located in peripheral areas as well as in the central zone. Lots which shape resembles a circle the most are located usually in the intermediate zone: Based on the values of both lot shape indicators discussed the authors identified four types of geodesic units.

Literature

- Conzen M.R.G., 1960, *Alnwick, Northumberland. A study in town-plan analysis*, The Institute of British Geographers, „Publication”, 27.
- Conzen M.P., 2002, *From Alnwick to Cincinnati: Teasdale property cycles in Old World and the New*, „Urban Morphology”, 6(1).
- Dzieciuchowicz J., 2011, *Środowisko mieszkaniowe wielkiego miasta. Przykład Łodzi*, Wydawnictwo Uniwersytetu Łódzkiego, Łódź.
- Dzieciuchowicz J., Dmochowska-Dudek K., 2014, *Wielkość i kształt działek gruntowych w Łodzi*, „Acta Universitatis Lodzianensis. Folia Geographica Socio-Oeconomica”, 16: 149–167.
- Jażdżewska I., 1999, *Przemiany funkcjonalne i morfologiczne przestrzeni geograficznej wsi Rzgów w świetle metod numerycznych*, ŁTN, Łódź.
- Kopczewska K., 2008, *Renta geograficzna a rozwój społeczno-gospodarczy*, CeDeWu, Warszawa.
- Kostrubiec B., 1972, *Analiza zjawisk koncentracji w sieci osadniczej*, „Prace Geograficzne IG PAN”, 93.
- Koter M., 1969, *Geneza układu przestrzennego Łodzi przemysłowej*, „Prace Geograficzne IG PAN”, 79.
- Koter M., 1974, *Fizjonomia, morfologia i morfogeneza miasta. Przegląd rozwoju oraz próba uściślenia pojęć*, „Zeszyty Naukowe Uniwersytetu Łódzkiego”, Seria II, 55.
- Koter M., 1979, *Struktura morfogenetyczna wielkiego miasta na przykładzie Łodzi*, „Acta Universitatis Lodzianensis”, Seria II, 21.
- Koter M., 1994, *Od fizjonomii do morfogenezy i morfologii porównawczej. Podstawowe zagadnienia teoretyczne morfologii miast*, [w:] Koter M., Tkocz J. (red.), *Zagadnienia geografii historycznej osadnictwa w Polsce. Conference materials*, NCU, UŁ, Toruń –Łódź.
- Kotlicka J., 2008, *Przemiany morfologiczne terenów przemysłowych Łodzi*, ŁTN, Łódź.
- Liszewski S., 1977, *Tereny miejskie a struktura przestrzenna Łodzi*, „Acta Universitatis Lodzianensis”, Łódź.
- Liszewski S., 1979, *Zróżnicowanie przestrzenne użytkowania ziemi w Łodzi*, „Acta Universitatis Lodzianensis”, Seria II, Folia Geographica, 21.
- Liszewski S., 1997, *Przemiany funkcjonalne i przestrzenne terenów przemysłowych Łodzi*, „Zeszyty Instytutu Geografii i Przestrzennego Zagospodarowania PAN”, 47, Aglomeracje miejskie w procesie transformacji, VI.

- Miszewska B., 1979, *Elementy struktury morfologicznej Wrocławia*, „Acta Universitatis Wratislaviensis”, 438, Prace Instytutu Geograficznego, Seria B, Geografia Społeczno-Ekonomiczna, 3.
- Miszewska B., 1994, *Bloki urbanistyczne Wrocławia w różnych fazach cyklu miejskiego*, [w:] Koter M., Tkocz J. (red.), *Zagadnienia geografii historycznej osadnictwa w Polsce. Conference materials*, NCU, UŁ, Toruń–Łódź.
- Miszewska B., 1996, *Struktura morfologiczna peryferyjnych osiedli Wrocławia*, „Acta Universitatis Wratislaviensis”, 1904, Prace Instytutu Geograficznego, Seria B, Geografia Społeczno-Ekonomiczna, XIV.
- Piech M., 2004, *Przemiany funkcjonalne terenów przemysłowych w latach 1988–1996 (w granicach kolei obwodowej)*, ŁTN, Łódź.

Article history

Received 25 May 2017

Accepted in revised form 26 July 2017