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ANALYSIS OF THE LEVEL OF PRICES AND NUMBER OF TRANSACTIONS, AND THEIR DYNAMICS ON THE HOUSING REAL ESTATE MARKET – A CASE STUDY IN KATOWICE

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Summary

The development of the real estate market necessitates a continuous need for analyses regarding the distribution of the number of transactions and level of transaction prices of real estate. This information is important for many market participants, such as investors, property owners, creditors, developers, as well as state and local government administration (for fiscal reasons). Transaction price data are systematically collected by administration units and are generally available to citizens. However, prices themselves do not provide sufficient information for the average user. Only when combined with geospatial data, they constitute complete and user-expected information. This publication analyses the distribution of unit transaction prices and the number of housing real estate transactions in the city of Katowice. A publicly available QGIS programme was used for the analysis. The results of the research proved the usefulness of the methodology used. Using the Voronoi diagram, the spatial distribution of the number of transactions in the studied area was presented. Using the methods of graphical data visualisation, the distribution of transaction prices in individual plats and the change in the distribution of transaction prices depending on the distance from the city centre were presented. In the case of the number of concluded transactions, plat 2 dominates, both on the primary and secondary market. In addition, in both cases, 2019 was the year with the most activity. Whereas, the highest transaction prices were recorded in 2020. In secondary trading, it was plat 14, and in primary trading – plat 3. The last year of the analysis is the period in which there was a large jump in prices, with a decrease in the number of transactions.

Keywords

GIS • QGIS • Voronoi diagram • real estate market analysis • spatial analysis

1. Introduction

In spatial terms, the real estate market is an area in which there are similar conditions in which buy-sell transactions are made. The extent of such a market depends on characteristics. The properties involved in the market are distinguished by certain

features that are interrelated and indicate the diversity of the market. We distinguish three groups of features: physical, economic, and institutional and legal. Physical characteristics are primarily the physical complexity of the property, durability over time, diversity and indivisibility. Economic features include real estate deficit, high capital intensity and low liquidity. On the other hand, the institutional and legal features relate to the environment that supervises the functioning cycle of the property. These are institutions dealing with spatial planning, construction and real estate management [Gołąbeska 2007, Bryx 2008, Dydenko and Telega 2018, Dydenko 2020].

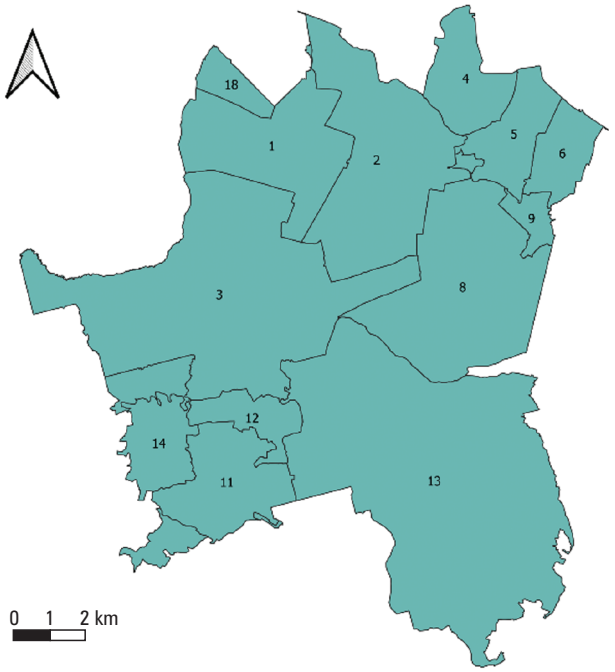
Nowadays, the definition of the real estate market is closely related to economics and means the relationship between the seller and the buyer. The real estate market is therefore a relation between the interaction of demand, supply and price, in such a way that they reach a balance. According to Kucharska-Stasiak [2004], the real estate market is a set of conditions under which real estate rights are transferred and contracts that create mutual rights and obligations, combined with real estate management, are concluded. This definition leads to the conclusion that the real estate market is not homogeneous internally. Several criteria of division can be distinguished here, e.g.: objective (related to the function of real estate), spatial (regarding the scope of impact), acquired rights to real estate, etc. In addition, the real estate market is described as imperfect. This characteristic refers to the limited access to information about the property being traded and the terms and conditions of the transaction. Factors determining the characteristic of imperfection include, among others: stability of real estate, irrational behaviour of buyers and sellers, stability of supply in a short period of time, diversity of real estate, impact of the manner of use on value. The lack of substitutability of real estate and the rigidity of supply caused by the long investment process generates another feature: the low flexibility of demand and supply. A feature that is closely related to the real estate market is the requirement of professional service. The development of the market has led to the emergence of professions necessary for its proper functioning. These include: property appraisers, developers, intermediaries, property managers, notaries and investment advisers. The real estate market is also characterised by its local character, which makes the market sensitive to various external factors: social, economic, political, as well as demographic [Kucharska-Stasiak 2004, Gołąbeska 2007].

Taking into account the features presented, new tools are being sought, to enable a clear way of presenting the trends occurring in the real estate markets. GIS tools seem to be the most common, common and available. They give the opportunity to perform analyses on the basis of data obtained from various sources (property price registers, geoportals, spatial information systems, etc.) and visualisation of the obtained results on map bases in the form of choropleth maps and cartodiagrams [Siejka 2017, Siejka and Relidzyński 2019, Siejka 2020].

The aim of this paper is to analyse the distribution of the price level and the number of transactions in the studied area using the tools available within the GIS environment. The study covered residential real estate as the largest group of commercial real estate.

2. Research area

The research was carried out on the basis of residential premises sold in the city of Katowice in 2016–2020. The choice of the research area was dictated by the fact that it is the capital of the most industrialized Voivodeship in the country and an important transport and communication hub. Katowice is the seat of many foreign companies. The development of industry (mines, smelters, industrial plants) has contributed to the creation of many large housing estates, and the increase in the wealth of residents translates into an increase in demand for new housing. Currently, Katowice is also an important scientific and cultural centre. Katowice is divided into 13 plats (Fig. 1): 1 – City centre-Załęże; 2 – Bogucice-Zawodzie; 3 – Ligota; 4 – Dąbrówka Mała; 5 – Roździeń; 6 – Szopienice; 8 – Mysłowice Las; 9 – Janów; 11 – Podlesie; 12 – Piotrowice; 13 – Górne Lasy Pszczyńskie; 14 – Zarzecze; 18 – Tysiąclecie [Resolution No. XLVI/449/97 of the Katowice City Council of 29 September 1997].



Source: Authors' own study

Fig. 1. Map of the city of Katowice divided into plats

3. Material and research methodology

The research was carried out using Microsoft Excel spreadsheets and QuantumGIS and ArcMap programmes. Microsoft Excel spreadsheets were used for data mining. In

this way, a coherent database was obtained, used for further analysis. QantumGIS and ArcMap are part of a group of geoinformation systems. GIS is a geographic information system used for acquiring, collecting, updating, managing, analysing, and sharing spatial data. GIS consists of a set of tools that allow to combine geographical and descriptive data, perform their analysis and present in cartographic form [Bielecka 2006, Iwańczak 2016, Adamska-Kmieć and Kowalczyk 2017]. Geographic information systems are used in public administration, surveying records of utilities networks, rapid response services (police, ambulance, fire brigade), water management and forestry. In the data structure, we distinguish spatial data: raster, vector (points, lines, polygons), vector-raster, and descriptive data [Mitchell 2005].

The research material was obtained from the Real Estate Price Register kept by the city of Katowice. The register, in the form of a PDF file, consisted of 5,910 pages containing information on transactions concluded in 2016–2020. Each transaction contained information such as: ID of the document, ID of the premises, ID of the plot, area, transaction price, number of premises, type of right to the facility, area of the premises, number of rooms, floor, type of market, property function, transaction date, selling party, purchasing party, encumbrance. Data was exported to *.xlsx format (Microsoft Excel). As a result, information on 10,435 transactions that were subject to verification (removal of erroneous transactions or transactions with incomplete information) was generated. As a result of the verification, 8,859 data units were qualified for the second stage, which was the basis for further analysis.

The next step was to group the data due to the year of the transaction and the plat. The initial transaction database from the Real Estate Price Register contains information about transactions concluded in 2016–2020. Therefore, for the purposes of some analyses, it was required to update the prices to the date of the last transaction, which occurred in December 2020. The update was carried out on the basis of a linear regression model, which is defined by average values and standard deviations in boundary distributions, determined on the basis of the results from the sample and taking into account the complete correlation coefficient (Pearson's). The correlation coefficient determines the direction and strength of the relationship between variables, thus allowing to assess whether an update is required [Czaja 2001]. The strength of correlation is described on four levels: $|r| \leq 0.3$ – weak correlation; $0.3 \leq |r| \leq 0.6$ – average correlation; $0.6 \leq |r| \leq 0.9$ – strong correlation; $|r| \geq 0.9$ – very strong correlation. In the case of the analysed base, the value of the coefficient is 0.36, which means an average correlation (Table 1). The regression coefficient was then calculated according to the formula:

$$B = r \cdot \frac{\sigma(c)}{\sigma(t)} \tag{1}$$

where:

r – correlation coefficient,
$\sigma(c)$ – standard deviation of the unit price,
$\sigma(t)$ – standard deviation of time expressed in months.

The update of unit transaction prices was carried out according to the formula:

$$c_{i(t)} = c_i + B \cdot (t_\alpha - t_i) \tag{2}$$

where:

c_i – transaction price of the i-th property,
B – regression coefficient,
t_a – update date (in months),
t_i – transaction date (in months).

Table 1. Coefficients of price variation

r correlation coefficient	$\sigma(c)$ standard price deviation [PLN/m^2]	$\sigma(t)$ standard time deviation [PLN/m^2]	B regression coefficient [PLN/m^2]
0.36	1281.84	13.53	34.12

The process of updating prices to the date of the last transaction eliminates the time-differentiating element. The database prepared in this way was used for further analysis in the GIS environment.

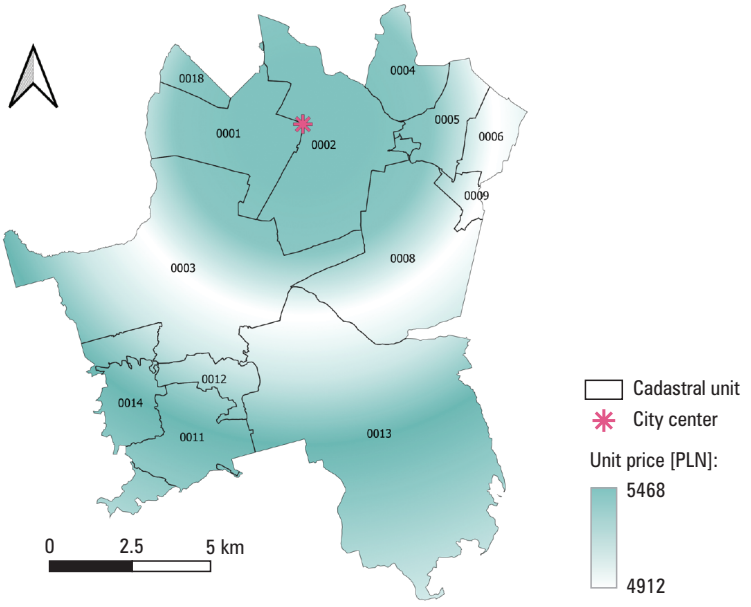
The last step before proceeding with the analysis was to combine descriptive data with spatial data obtained from the Central Office of Geodesy and Cartography.

4. Results and discussion

Distribution of updated unit transaction prices in relation to the city centre

Due to the lack of a specific point constituting a centre in the city of Katowice, for the purposes of the analysis it was assumed that it is the gen. Jerzy Ziętek roundabout, located in the vicinity of the Spodek Sports and Entertainment Area. The distance of individual plots from the centre was measured in a straight line, the updated unit transaction prices are subject to analysis (Fig. 2).

The highest unit prices (PLN 5,468/m^2) occur in the area up to 4 kilometres from the adopted centre, then there is a sudden price drop up to PLN 4,900/m^2. On the other hand, in areas more than 8 kilometres away from the centre, there is a significant increase, which results from the fact that new, prestigious housing estates were created in this area in the southern part of the city of Katowice. A further increase in distance from the centre causes a decrease in price.



Source: Authors' own study

Fig. 2. Distribution of updated unit prices in the city of Katowice

Distribution of the number of transactions

The analysis of the location of the properties being the subject of the transaction was based on a structure created from grouped points located in a given area, called the Voronoi diagram [Iwańczak 2016]. Figure 3 shows the distribution of the number of transactions in the city of Katowice. The use of Voronoi diagrams gives the opportunity to indicate the areas with the highest number of transactions, as evidenced by the size and density of polygons. In the studied area, the largest number of transactions was concluded within plats 2 and 3.

In order to assess the development of the real estate market in the studied area in 2016–2020, a comparative analysis of the number of transactions was carried out in two groups: for the secondary and primary markets (Fig. 4 and 5). In 2016 (Fig. 4a) most transactions were concluded within plats 1, 2 and 3. In each of these areas, the number of transactions exceeds 300. The second group consists of plats 8 and 18 with slightly more than 100 transactions. The lowest number of transactions (below 40) was recorded in the north-eastern and south-western parts of the city. In the next year (Fig. 4b), increase in the number of transactions can be observed. However, the distribution is similar to the previous year. Plats 1, 2 and 3 still dominate. A similar situation can be observed in 2018 (Fig. 4c). Another significant increase in the number of transactions, by almost 20%, is worth noting. In 2019 (Fig. 4d), another increase in the number of transactions by ca. 15%, 536 transactions, within plat 2 was recorded. The most attrac-

tive plats are still 1, 2 and 3. In the next group, in terms of the number of transactions, plats 8 and 18 persist. The plats located at the north-eastern and south-western ends of the city are the least popular. A dissimilar situation was observed in 2020 (Fig. 4e). This year, the number of transactions decreased by about 20% compared to the previous year and amounted to 431 within plat 2. The same three plats are still the strongest in this respect. According to the data presented in Fig. 4, in 2016–2019 there was a continuous increase in the number of transactions, which proves the increase in the activity of the local real estate market. The decrease in the number of transactions in 2020, and thus the decrease in market activity, was caused by a disturbance in economic stability. It can be assumed that it was the result of the pandemic.

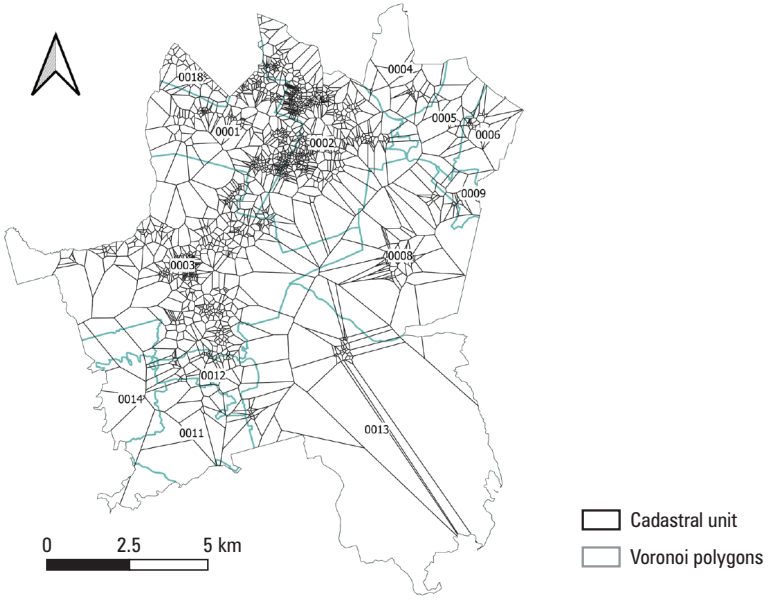


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Fig. 3. Distribution of the number of transactions in the studied area

The number of primary market transactions depends significantly on the number of investments. A small number of transactions on the primary market indicates a small number of new multi-family buildings (Fig. 5). In the first analysed year, the largest number of transactions was recorded within plats 1 and 2 (Fig. 5a). However, it does not exceed ca. dozen transactions. In the next year, 2017 (Fig. 5b), the situation repeated. However, in 2018 (Fig. 5c) there is a twofold increase in the number of transactions within plat 2 (49 transactions). In addition, the number of plats in which no transaction was recorded decreased. For the remaining eight plats, the number of primary market transactions does not exceed 10. In 2019 (Fig. 5d), the largest number of transactions

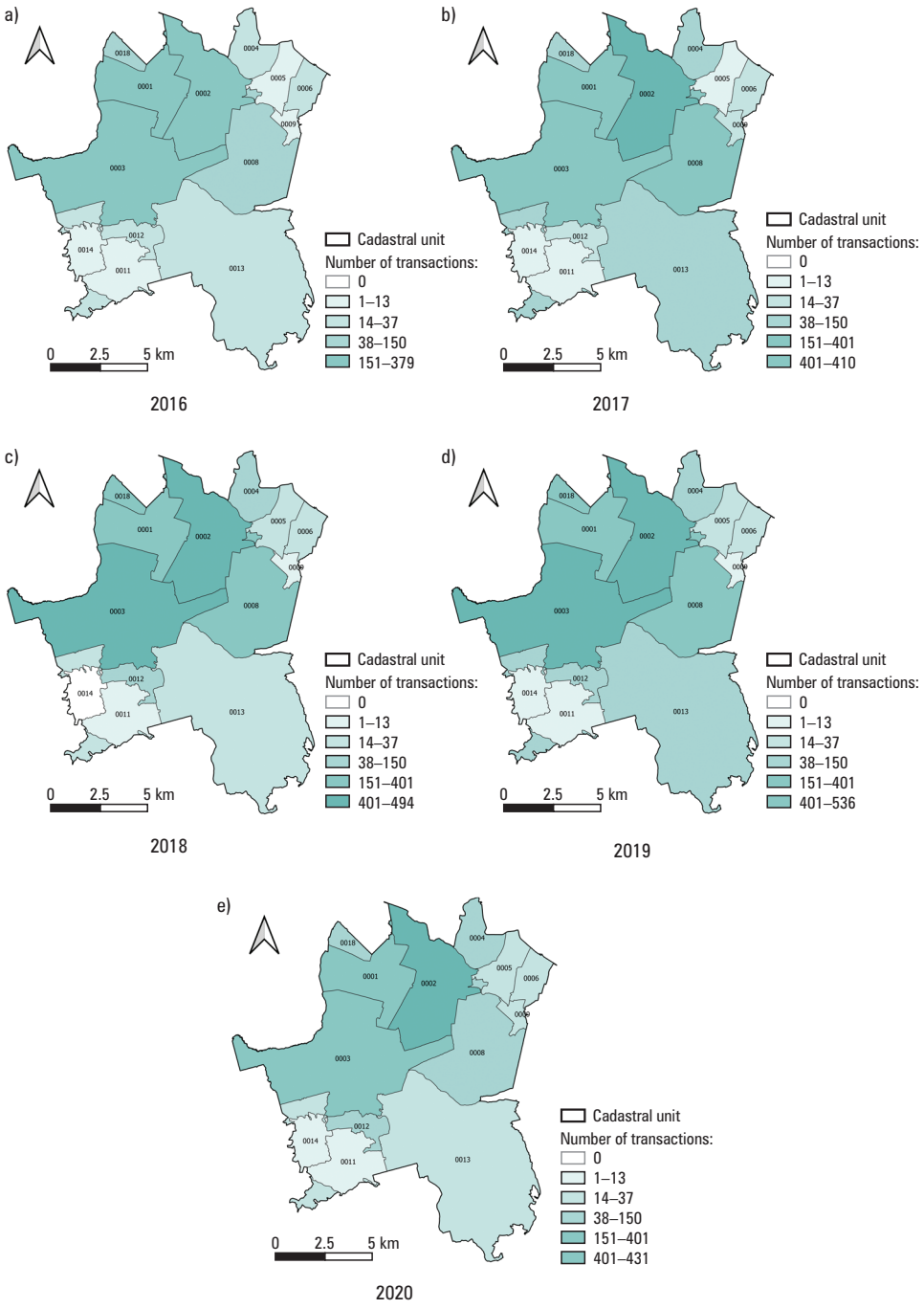

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Fig. 4. Distribution of the number of transactions on the secondary market in individual years

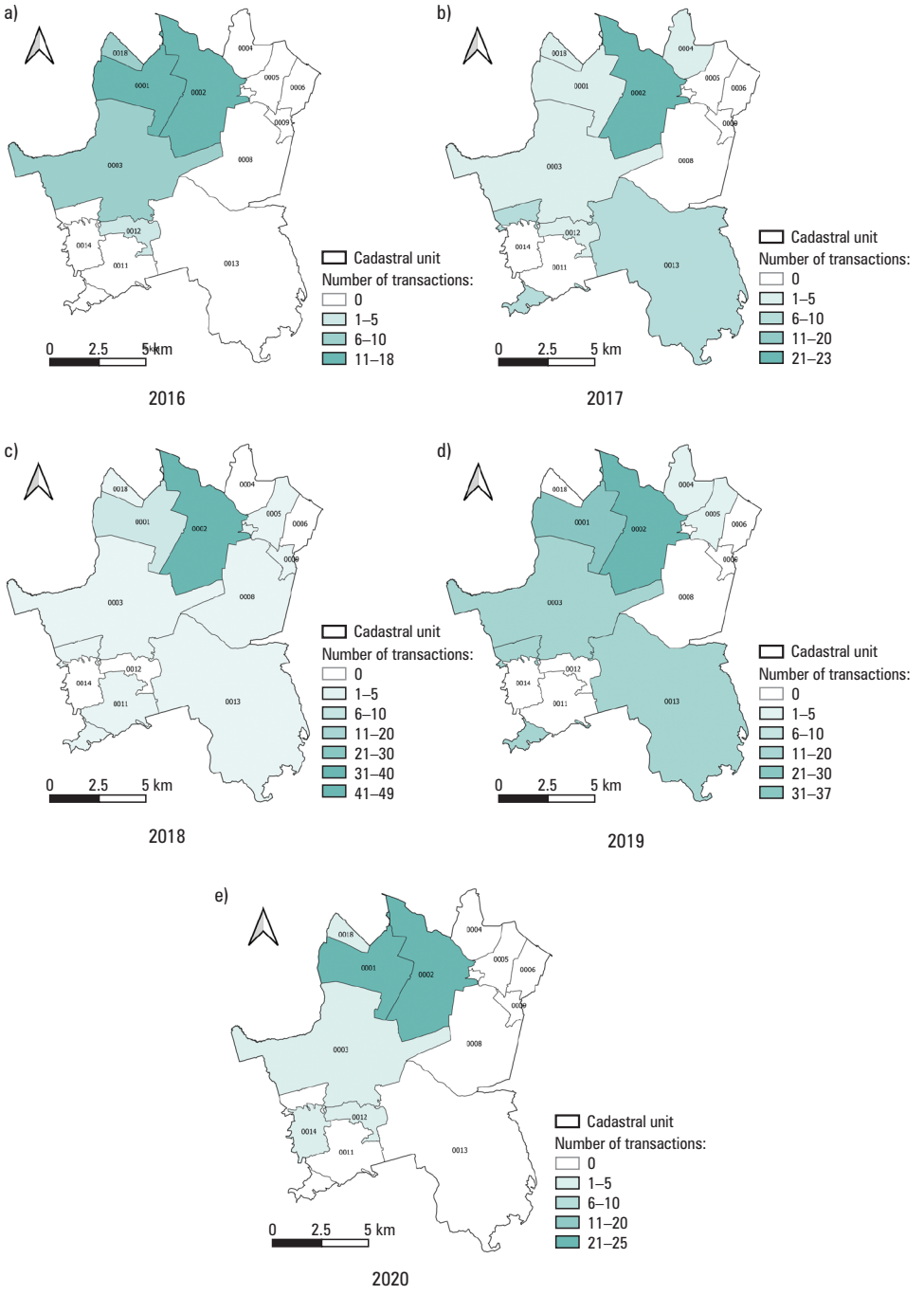

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Fig. 5. Distribution of the number of transactions on the primary market in individual years

on the primary market was recorded again within plat 2 (37 transactions). In the neighbouring districts, a relatively large number of transactions was also recorded: plat 1 – 23 transactions; plat 3 – 16 transactions. In plat 13 located in the south-eastern part of the city, 13 transactions were recorded. For seven plats, no transaction was recorded in the analysed period. In the remaining plats, only single transactions were concluded. In 2020 (Fig. 5e) most transactions were concluded within plats 1 and 2. In plats 3, 12, 14, 18, only a few transactions were recorded. In the remaining plats, no transactions were recorded on the primary market. In the case of the primary market, the highest activity was recorded in plats 1 and 2, as in the case of secondary trade.

Distribution of unit transaction prices recorded on the secondary market

Figure 6 shows the distribution of average unit prices in individual plats in 2016–2020 on the secondary market. In 2016 (Fig. 6a) the highest price was recorded in plat 12 located in the south-western part of Katowice and it amounted to PLN 5,810/m^2. The lowest price was obtained in plat 9 located in the north-eastern part of the city (PLN 2,288/m^2). Average unit prices in other areas range from PLN 2,319/m^2 to PLN 4,934/m^2. It should be noted that the plats in which the most transactions were carried out are characterised by lower prices, and namely from PLN 3,000–4,000/m^2. A similar situation took place in 2017 (Fig. 6b). The highest price was also recorded in plat 12 and additionally in plat 14. These boundaries are adjacent to each other. On the other hand, as far as prices are concerned, they remain at a similar level as in the previous year. Significant differences in the change in the price level can be clearly seen only in 2018 and 2019 (Fig. 6c and 6d). In this period, the prices of real estate located in the areas with the highest number of transactions increase on average by 25%, which causes them to fall into a higher price range of between PLN 4,001–5,000/m^2. On the other hand, the extreme values remain at similar levels as in previous years. An interesting change can be noticed in 2020 (Fig. 6e). The highest price here has doubled to nearly PLN 10,000/m^2. The lowest price was recorded in plat 5 and amounted to PLN 3,541/m^2, so there was an increase of about 50%. However, in the plats where the largest number of transactions was recorded, there was again an increase in prices to the amounts in the range of PLN 6,001–7,000/m^2. Therefore, it should be noted that in 2016–2019, a slight, systematic increase in prices was observed, while in 2020, a steep increase was observed.

Distribution of average unit transaction prices recorded on the primary market

Figure 7 shows the average unit transaction prices recorded in the studied area in 2016–2020, on the primary market. The distribution of data is related to the ongoing investments, therefore in 2016–2017, the eastern and southern plats are excluded from the analysis due to the lack of data. The first two years show a comparable distribution of unit prices (Fig. 7a and 7b). The highest prices were recorded in plat 1: nearly PLN 5,800/m^2, and the lowest in plat 18 located in the north-western part of the city and it is PLN 3,244/m^2. The average unit prices relate to plat 3, as in the case of the

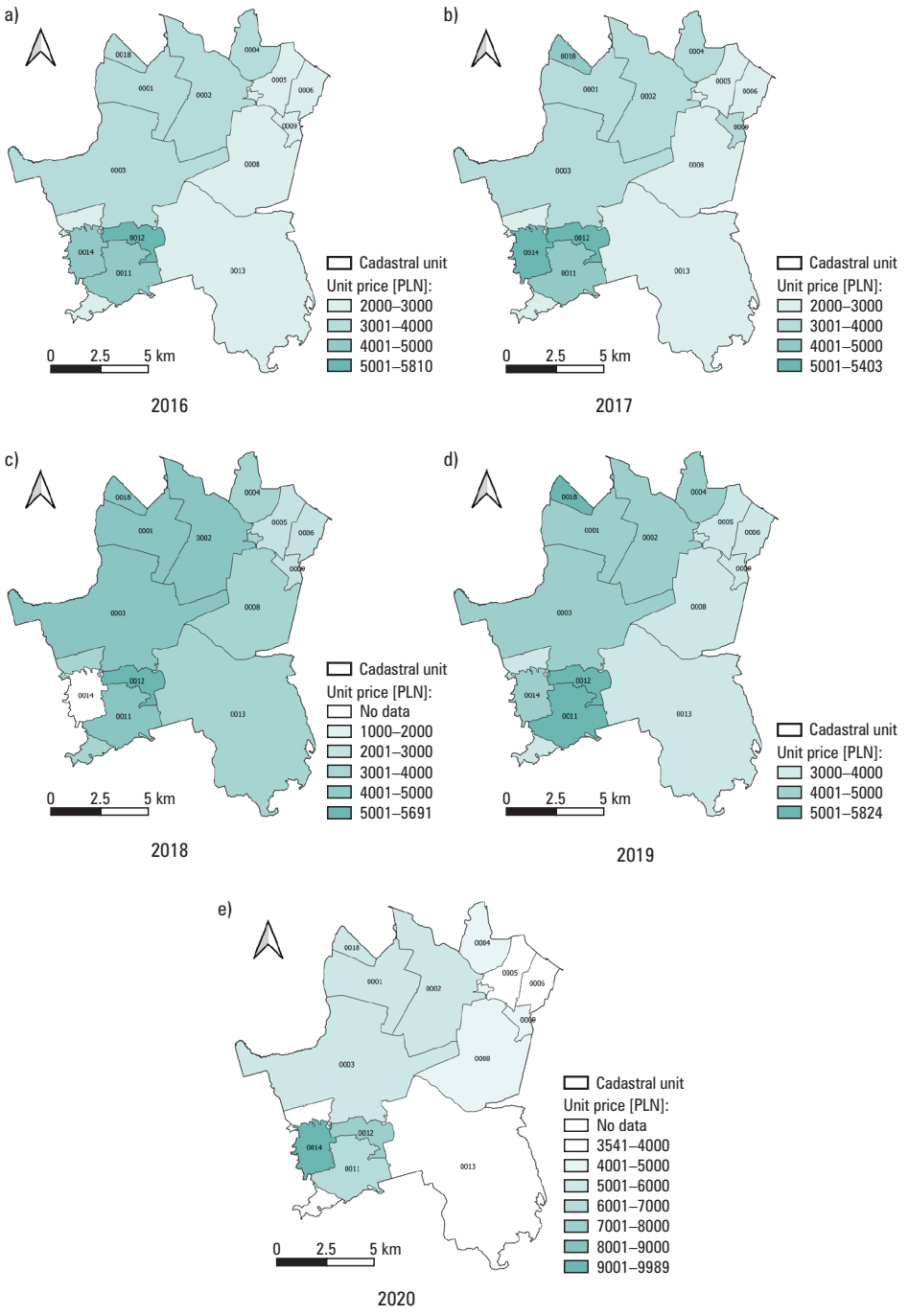

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Fig. 6. Distribution of average unit transaction prices recorded on the secondary market

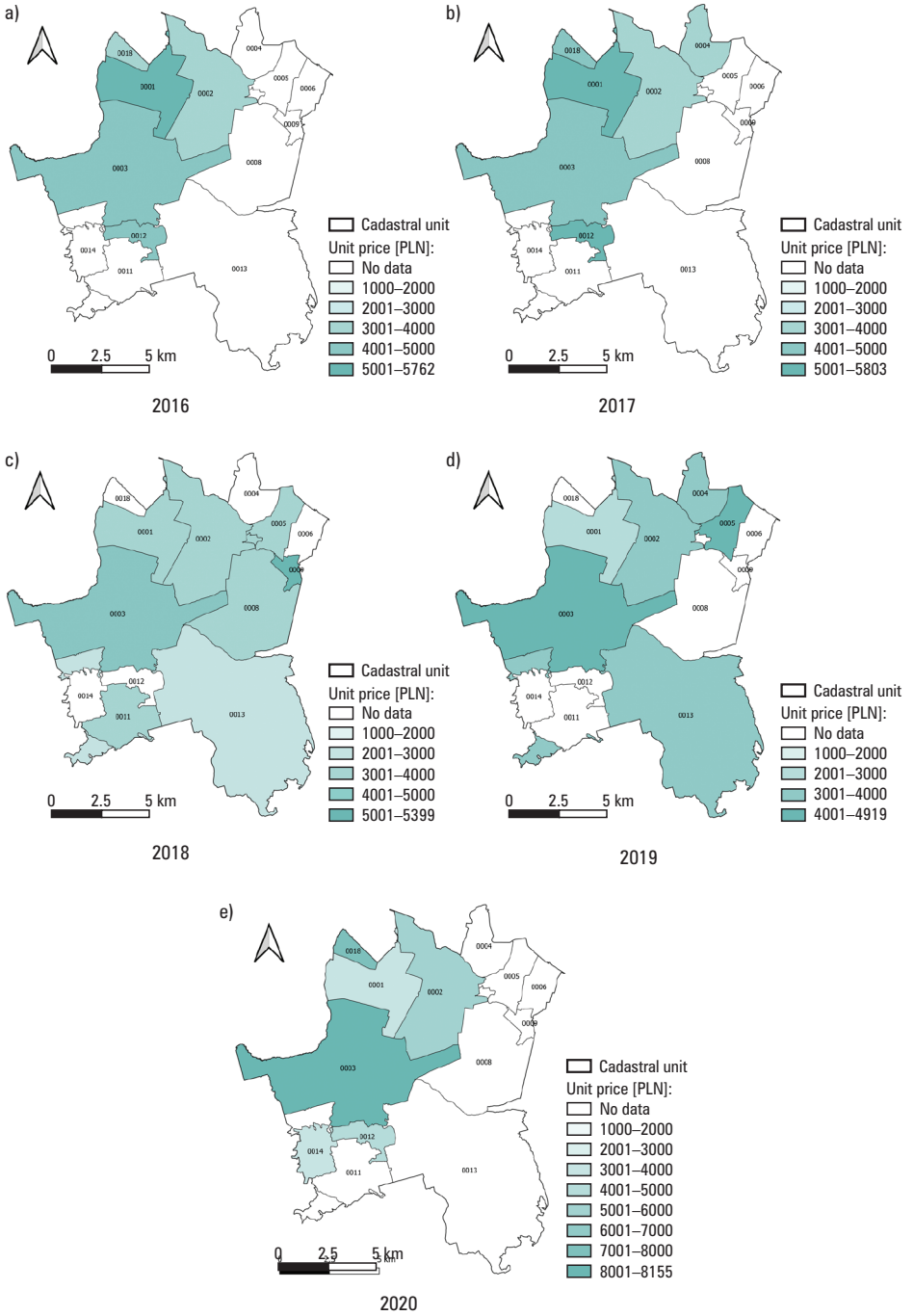

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Fig. 7. Distribution of average unit transaction prices recorded on the primary market

secondary market, and fall within the range of PLN 4,000–5,000/m^2. In the next two years, the number of new investments increased, while the prices remained at an even level (Fig. 7c, 7d). From the presented results, it can be concluded that new investments located in the eastern districts are less attractive, which translates into the level of prices. In 2020, only real estate transactions located in the plats in the eastern part of the city were recorded. The highest prices were recorded in plat 3, in the amount of over PLN 8,000/m^2, which is an increase of about 40% compared to previous years. A similar level of growth was also recorded in other areas of this part of the city of Katowice, which resulted in an increase in average prices to as much as PLN 7,000/m^2.

5. Summary

The aim of the study was to assess the activity of the local residential real estate market in the city of Katowice in 2016–2020. The research was carried out using GIS tools that provide the ability to combine geospatial data from different sources. The activity of the real estate market reflects the number of transactions and the level of prices. As it results from the analyses, in the first four years there was a systematic increase in the number of transactions in all plats of the city, both on the primary market and on the secondary market (Fig. 8). However, in 2020, they decreased significantly, which was due to the decrease in the number of new investments. A similar situation can be observed with regard to the level of transaction prices on the secondary market (Fig. 9a). In 2016–2019, there is a gradual increase, while in the last year of the analysis, 2020, there is a clear steep increase in prices. In the case of the primary market, fluctuation is noticeable (Fig. 9b). Prices in the period considered are both increasing and decreasing. In 2017, prices increased, and in the following years they were adjusted. On the other hand, 2020 brought a large jump in prices.

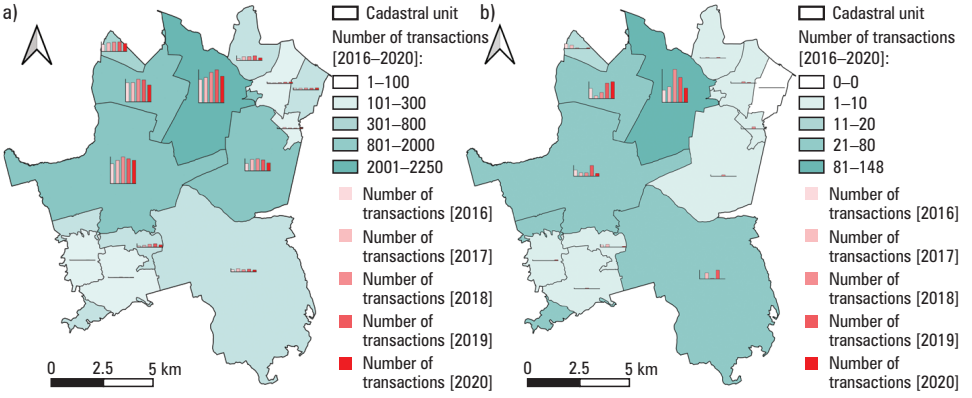

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Fig. 8. Distribution of the number of transactions in 2016–2020; a) on the secondary market, b) on the primary market

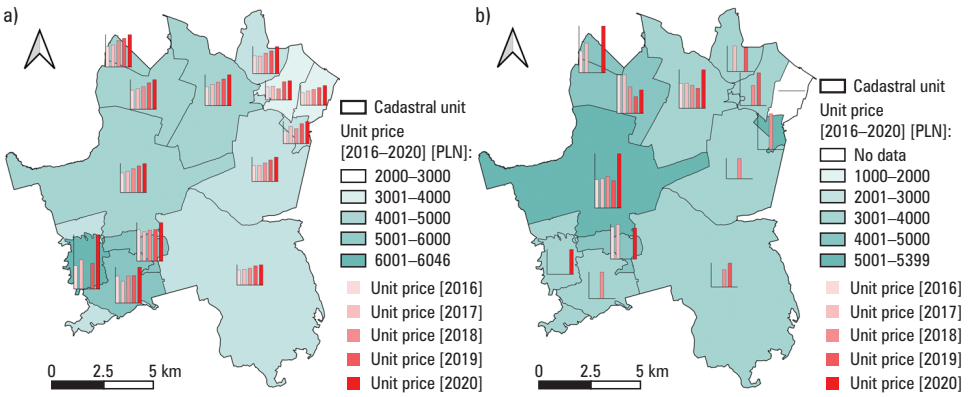

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Fig. 9. Distribution of the average unit prices in 2016–2020; a) on the secondary market, b) on the primary market

6. Conclusions

The analyses carried out in this paper made it possible to get to know and assess the residential real estate market in the city of Katowice. In the assumed time period (2016–2020), it can be concluded that the Katowice real estate market developed evenly, except for 2020, when there was a significant decrease in the number of transactions. In the case of the number of concluded transactions, plats 1, 2 and 3 dominate on the secondary market, and plat 2 on the primary market. In addition, in both cases, 2019 was the year with the most activity. On the other hand, the highest transaction prices on the secondary market were recorded in plat 14, in 2020. The last year of the analysis is the period in which there was a large jump in prices, with a decrease in the number of transactions. The analysis of trends on the market showed that the highest unit prices are achieved in the south-western part of Katowice, about 9 kilometres from the adopted city centre. The applied GIS tools made it possible to visualize the results, thanks to which it was possible to perform comparative analyses. The analysis of the frequency of transactions in the city area and the analysis of the relationship between the distance from the city centre and the unit price, using Voronoi diagrams, were carried out. The use of these tools allows for the creation of products that clearly convey information on the situation on the real estate market. In addition, they provide an opportunity to assess the phenomena occurring on the market, which may result in an increase in the popularity of reports regarding the situation on the markets and an increase in public awareness of the dynamics of the market and its local character.

Clear changes in the situation on the real estate market in the last year of the analysis suggest the need to continue the research in the following years. Probably the change in the socioeconomic situation as a result of the pandemic will affect the activity of the real estate market. This effect has been partially demonstrated in this paper on the basis of research results in relation to 2020.

References

Adamska-Kmieć D., Kowalczyk C. 2017. GIS Analysis and Statistical Methods of Tree Location – A Case Study of Jakubowo Park. Science, Nature, Technologies, 11(2) 185–195. http://dx.doi.org/10.17306/J.NPT.00180

Bielecka E. 2006. Systemy informacji geograficznej. Teoria i zastosowania. Wydawnictwo PJWSTK, Warszawa.

Bryx M. 2009. Podstawy zarządzania nieruchomościami. Wydawnictwo Poltext, Warszawa.

Bryx M. 2008.Wprowadzenie do zarządzania nieruchomością. Wydawnictwo Poltext, Warszawa.

Czaja J. 2001. Metody szacowania wartości rynkowej i katastralnej nieruchomości, KOMP-SYSTEM, Kraków.

Dydenko J. 2020. Szacowanie nieruchomości. Wolters Kluwer, wyd. 4.

Dydenko J., Telega T. 2018. Wycena nieruchomości. Wolters Kluwer, wyd. 2.

Gołąbeska E. 2007. Rynek nieruchomości i jego podmioty. WSFiZ, Białystok.

Iwańczak B. 2016. Qgis. Tworzenie i analiza map. Gliwice, Helion.

Kucharska-Stasiak E. 2004. Nieruchomość a rynek. Wydawnictwo Naukowe PWN, Warszawa.

Mitchell A. 2005. The ESRI Guide to GIS Analysis. T. 2. Spatial Measurement and Statistics. Redlands. ESRI Press.

Siejka M. 2017. Local Investments Site Selection and the Behavior of the Real Estate Market – Case Study in Poland. Environmental Engineering 10th International Conference Vilnius Gediminas Technical University Lithuania, 27–28 April 2017. https://doi.org/10.3846/enviro.2017.238.

Siejka M., Relidzyński K. 2019. Extension of the Road Network as the Determinant of Development of the Regions on the Example of Cracow (Poland). IOP Conf. Ser.: Mater. Sci. Eng. 603 022057. https://doi.org/10.1088/1757-899X/603/2/022057

Siejka M. 2020. The Use of AHP to Prioritize Five Waste Processing Plants Locations in Krakow. ISPRS Int. J. Geo-Inf., 9, 110. https://doi.org/10.3390/ijgi9020110

Uchwała Nr XLVI/449/97 Rady Miejskiej Katowic z dnia 29 września 1997 r. w sprawie nazw i granic obszarów działania jednostek pomocniczych samorządu na terenie miasta Katowice.

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