

Article

Conversion of Agricultural Land for Urbanization Purposes: A Case Study of the Suburbs of the Capital of Warmia and Mazury, Poland

Katarzyna Kocur-Bera *  and Adrian Pszenny

Institute of Geodesy and Civil Engineering, Faculty of Geoengineering, University of Warmia and Mazury in Olsztyn, 10-720 Olsztyn, Poland; adrianpszenny94@gmail.com

* Correspondence: katarzyna.kocur@uwm.edu.pl

Received: 4 June 2020; Accepted: 15 July 2020; Published: 20 July 2020



Abstract: Population growth, economic globalization and the launch of market economy instruments have become the main triggers for processes related to the anthropogenization of space. According to Organisation for Economic Co-operation and Development (OECD) statistics, the developed area indication tripled in the last 25 years. Humans keep appropriating more natural and semi-natural areas, which entails specific social, economic and environmental consequences. Provisions in some countries' laws and some economic factors encourage investors to engage in urbanization. The authors of this study noticed a research gap in the analysis of suburban areas in this topic. Our research aimed to analyze the conversion of plots of land used for agricultural purposes into urbanized land in the city's suburban zone, in areas of high landscape and natural value. We focused on the analysis of geodetic and legal divisions of plots of land and analyzed the conditions of plots of land "ex ante" and "ex post" and the changes in their values. To achieve the research objective, we used Corine Land Cover (CLC) data for various time intervals, orthophotomaps (using the Web Map Service browsing service compliant with Open Geospatial Consortium standards), cadastral data, administrative decisions, data from the real estate market, spatial analyses and statistical modeling (linear, non-linear and stepwise regression). In general, the CLC data resolution enables analysis at regional or national levels. We used them innovatively at the local level because CLC data allowed us to notice the development of the area over time. Detailed research confirmed that, in the studied area, the conversion of agricultural land into developed areas results from economic factors. The division procedure increases the plot value by about 10%. However, the effects of uncontrolled urbanization, which we are currently dealing with, generate long term social and economic losses, difficulties in the labour market and may become a barrier to development.

Keywords: land-use conversion; real estate division; plot division; suburbanization

1. Introduction

The turn of the 21st century was a period of accelerated antropogenization of space, mostly related to the emergence of scattered suburban development [1]. This phenomenon is associated with the globalization of the economy, launching market economy instruments [2–4] and speculative pressure on real estate markets [5]. These ongoing changes may pose a threat to areas with special natural values [6–9], resulting in a decrease in the surface of semi-natural areas. According to Organisation for Economic Co-operation and Development (OECD) statistics, the average developed area factor has tripled over the last 25 years (see Figure 1 for 40 countries in the world).

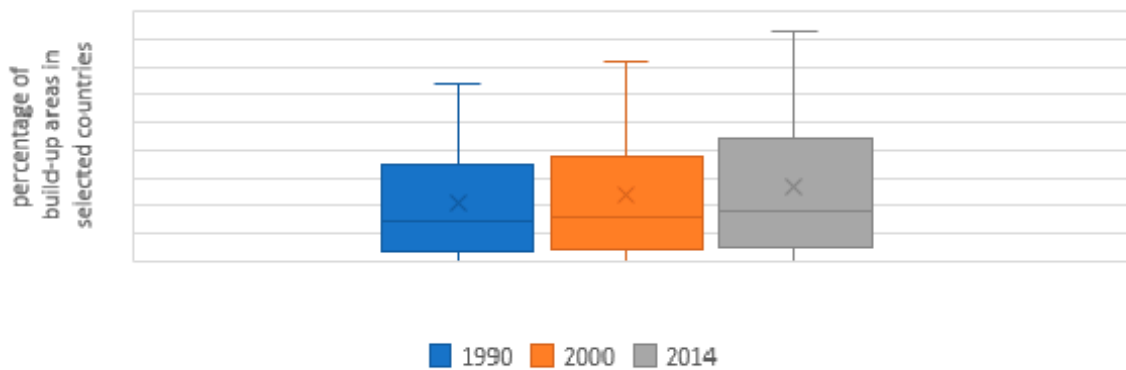


Figure 1. Average percentage increase in developed surface area between 1990 and 2014 in the 40 most developed countries of the world. Source: own study [10].

According to Prus [11], changes in land use in Poland in the last two decades affected 2.4% of the country's surface area. At such a change rate, in 100 years, approximately 1/5 of Poland's surface area may change its land cover type into non-agricultural land. Other post-socialist countries, such as Slovakia [12] or Belarus [13], are facing a similar problem.

Urbanization processes cause increased spatial changes [14] most often in the immediate vicinity and in the sphere of influence of an urban center. If transport infrastructure and public transport are sufficiently developed, rural areas adjacent to urban centers actively participate in the socio-economic life of the nearby city. As a result of the close cooperation of these areas, natural development processes occur, which consist of reducing the dissonances between them and making villages more similar to towns and cities. This requires a targeted organization of space to harmoniously meet social, economic, functional, environmental, cultural, compositional and aesthetic needs. The less it is controlled, e.g., with spatial planning, the more damage it causes in the area. This is related to issuing development decisions for almost every site, which leads to its dispersion and overwhelming urban chaos [15–17]. Scattered development generates further consequences, such as chaos in transport [18], the overloading of poorly developed transport routes leading to city centers, chaos in technical infrastructure [19,20], the poor provision of utilities, high costs of living and household upkeep [21], an increase in air pollution due to the excessive number of cars most often only transporting the driver, deterioration in the health of residents (stress related to commuting, the development of traffic-related diseases) and the development of monofunctional areas. Recent years have also seen another problem related to the suburbanization of so-called “shrinking cities” (cities that have experienced a notable population loss), as a result of which, authorities face problems with the development of depopulated urban spaces [22]. According to a report issued by the University of California, Berkeley, 130 cities have disappeared from the world map since 2010 [23]. These obstacles do not deter potential investors from purchasing agricultural land for conversion, as they see it as a business opportunity. There are also some positive aspects of suburbanization [24], as it allows for the realization of the “dream of living in a suburban area” [25], makes it possible to purchase land at lower prices than in city centers [26] and avoid conurbation zones [27]. Moreover, citizens can live a more secure life due to lower crime levels [28] and optimize real estate tax. The latter argument only applies to economies where real estate tax is based on property value (market, rent, capital). This is the case for most European countries, such as Belgium, the Netherlands, France, Sweden, Norway, etc. However, there is a group of countries where taxation is still based on the area and use method, e.g., in Bulgaria, the Czech Republic, Slovakia and Poland [29–32], due to which, property tax is similar in suburban and urban areas.

Thus, economic factors have a particular impact on the increase in demand for plots located in suburban zones and result in the development of this housing function. As a consequence, there are legal and administrative procedures implemented to transform agricultural land into land suitable for development. The division of the plot is one of these procedures. The division procedure affects the formation of the internal spatial layout of the land and, at the same time, determines the conditions

of the development and the aesthetic and landscape values of the countryside. In some markets, the division of a plot may also generate financial benefits for the owner. This usually occurs for three reasons. Firstly, smaller plots require less capital to be invested. Secondly, the prices of plots of sizes allowing for development are more attractive in relation to the prices of plots without such an option (e.g., too large a surface area). Thirdly, the location has a very significant impact, as the value of individual plots decreases with increasing distance from the city center and deteriorating transport options [33]. The closer the divided plots are to the city limits, the more attractive and valuable they become in the eyes of investors. Good location and the planning of the boundaries of the plots to be divided may also contribute to the reduction of spatial expansion [34–36] into agricultural areas, and thus to the reduction in interference with the natural environment and the improvement of the quality of life of the society living in such areas. However, some authors point out that it is difficult to plan development areas, taking into account the protection of the environmental values of rural areas and allowing for the surface expansion of the suburban city zones [33]. Urban sprawl will always result in land consumption [37]. However, it can be limited [38] through the use of available tools for the optimal division of plots.

This research aims to analyze the conversion of agricultural land use into developed land. For this purpose, we used Corine Land Cover data, orthophotomaps and cadastral data as tools for the economic assessment of plots. In general, the CLC data resolution enables analysis at regional or national levels. We used them innovatively at the local level, with the support of other sources of information. CLC data allowed us to notice the development of the area over time. The analysis of only an orthophotomap and cadastral data is very difficult and time-consuming. Meanwhile, CLC data allow us to quickly identify the area where rapid changes are taking place. This orientation of the use of CLC data makes them interdisciplinary. The world consists of microlocations. By analyzing phenomena and processes occurring in one microlocation, we can find similar relationships in other microlocations. This manuscript focuses on analyses of one real estate market (Stawiguda commune), because changes occur more rapidly in this location than in others. This change could only be confirmed by analyzing CLC data.

The selected microlocation was analysed using modeling of the impact of individual attributes (area of the “ex ante” plot: X_{area} , access to the plot: $X_{access\ to\ the\ plot}$, provision of utilities: $X_{utilities}$, number of border points/plot shape: X_{shape} , number of “ex post” plots: X_{number}) on the value of the plot before division (“ex ante”) and after division (“ex post”). We proposed a non-linear model to determine the increase in the parcel value resulting exclusively from the administrative and legal procedure of division, based on the difference between the parcel attributes in “ex post” and “ex ante” conditions. We studied suburban areas of the neighboring city.

This article is divided into several sections. After the introduction, in Section 1 presents the characteristics of the plot division procedures based on current laws. Section 2 presents the research area and the information sources used to select the locations for the study (Corine Land Cover data and orthophotomaps meeting the standards of the Open Geospatial Consortium). Section 3 describes the research process step-by-step together with the methods used. In Section 4, the research results are presented together with a discussion. The last section (Section 5) summarizes the analyses.

Background and Related Research

Anthropological pressure on agricultural land forces the expansion of the boundaries of urbanized areas, which results in more and more land being allocated for development. An urban center has a strong impact on rural areas in terms of land use. These areas are most often converted [39] into housing estates and traffic areas. This process results in the necessity to divide the land plots into smaller plots [40] and to change the land use from agricultural to building areas. The concept of “plot division” has not been defined in Polish law. Many authors dealing with this issue specify that the purpose of plot division is to create at least two new ones, within the boundaries of the existing plot, which may then become independent objects of sale (or other forms of ownership transfer) on

the real estate market [41,42]. The art and craft of plot division requires technical skills, imagination and creativity, as well as compliance with legal rules and engineering practice. A land division design must meet modern requirements. When the land is divided into plots, streets, schools and parks, utility provision facilities are created shortly after and the pattern of the original division is unlikely to change. Thus, the division of land has far-reaching consequences. Many of the problems currently faced by communities living in rural areas, such as narrow roads, lack of space for sidewalks, traffic congestion, street noise and parks and schools being in the wrong place, can be directly attributed to how plots were originally divided [43,44]. Low profitability in agricultural areas is also attributed to an incorrect division of plots and their excessive dispersion [45,46].

Generally, a description of four procedures resulting in parcel division can be found in the literature and in legal regulations: (1) surveying division, (2) legal (civil) division, (3) mortgage-accounting division and (4) so-called “useable” division.

The surveying division (1) consists of the actual separation of a larger number of registered plots from the originally registered plot under the control of the current owner/perpetual usufructuary (in Poland, the right of perpetual usufruct is granted for 40–90 years, it is granted for consideration and is transferable within the limits of possible real estate use, thus almost to the ownership right). In the future, this type of division will enable the trading of individual plots of land to different entities. Without the cadastral separation of a part of the real estate, it cannot be separated and entered in a separate land and mortgage register [47].

Legal (civil) division (2) consists of legal actions resulting in the creation of new real estate. It is a consequence of a previous surveying division. The essence of the legal division lies in changing the subject, i.e., as a result of a sale, the acquisition of a part of real estate by way of prescription or the acquisition of a part of real estate by virtue of law, exchange, donation, etc. A legal division in the context of Article 96(3) [48] can be made without surveying division usually preceding it. This applies to a situation when plots within one piece of real estate already have a separate designation in the cadastre and thus this type of division does not require any administrative decision.

A mortgage-accounting division (3) is only the process of separating a part of the real estate (if it consists of several plots of land with a separate number in the real estate cadastre) from the existing land and mortgage register. For such a plot, a new land and mortgage register is created or it is attached to another, already existing one [49].

The useable division (4) only serves the purpose of determining the manner of use. It does not result in any changes to the subject matter plot. This type of plot division involves a physical determination of the scope of use of the shared property by co-owners or perpetual usufructuaries, e.g., by building a fence dividing the property/lot into parts. This type of division may actually become the reason for the surveying division as part of the update of cadastral data [49]. Figure 2 presents a breakdown of real estate division types; the mortgage-accounting division has not been distinguished as it is part of the legal (civil) and surveying division, which is shown by arrows pointing in a specific direction in the diagram.

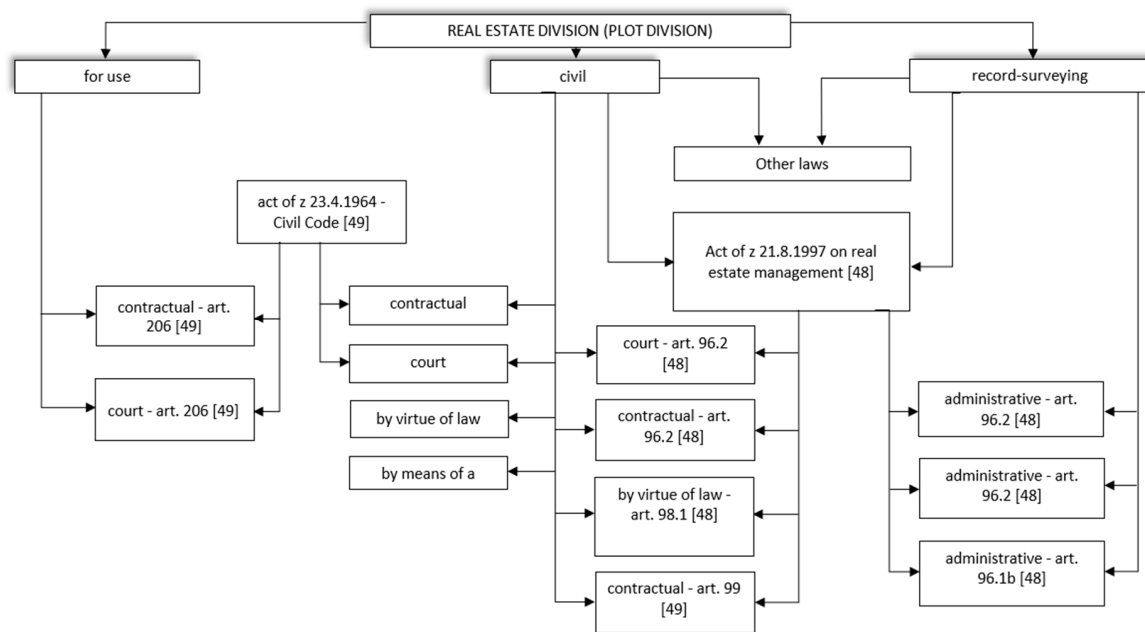


Figure 2. Types of possible real estate divisions. Source: own studies [48–50].

In this research, we focused on surveying divisions and their economic consequences, as they are the greatest incentive for changing the intended use of land from agricultural to urbanized. The (surveying) plot divisions may be carried out in accordance with three procedures. The type (A) procedure is followed when the division results from the zoning plan (the legislation provides a few exceptions to this rule) [48]. The type (B) procedure, the so-called simplified procedure, is launched when no updated zoning plan is available for the analyzed area [51]. However, the type (C) procedure provides for plot divisions being carried out based on a court decision.

In type (A) divisions, the method of division is strictly conditioned by the provisions of the local zoning plan, in particular, the surface area, shape or direction of the boundaries. If the procedure of type (B) is followed, only the surface area range of the new plot being created (not less than 0.3000 ha) is legally imposed, with the remaining parcel attributes being freely defined. The division according to the procedure of type (B) often disturbs the architectural, urban planning and landscape forms of development found in the area [52] and has a negative impact on the quality of farming space [46]. Counteracting such unfavorable phenomena is very difficult with the current legal conditions and growing demand for land located in suburban areas.

The division of type (C) is carried out autonomously, i.e., the competent executive body of the municipality does not need to issue a decision approving the division. If the division depends on the findings included in the local zoning plan, and if there is no such plan, the court may consult the commune head (mayor) without observing the form of a decision. Surveying divisions of type (A) or (B) are based on the court's ruling. This is also the case for making entries in the land and mortgage register and updating data in the real estate cadastre.

2. Research Area

The research covered an area (Stawiguda commune) directly adjacent to the city of Olsztyn, Warmia and Mazury Region, Poland (see Figure 3). The Warsaw–Olsztyn–Bezledy route runs through the commune. It is one of the most important routes in this region, which affects the economic and social development of the commune. Part of the Olsztyn city bypass crosses the commune. The surface area of the commune is 225.52 km². The structure of land use [53] is as follows: agricultural land: 4960 ha; forest, wooded and bushy land: 12,670 ha; developed and urbanized land: 1024 ha; land covered by water: 3172 ha. A population of 9860 lives in 29 villages of the studied commune [53]. The annual income of the

commune exceeds PLN 81.2 million with the income from housing and land management accounting for 2.5% of this amount. The Olsztyn City Functional Area largely influences the socio-economic situation of the commune, together with demographic and labor market changes. The commune fulfils the objectives of the Olsztyn agglomeration and the so-called Warmia–Mazury tigers (areas requiring strategic intervention due to their development potential). All of the localities located within the studied commune were included in our research: Bartąg, Bartązek, Dorotowo, Gaławki, Gryżliny, Kręsk, Majdy, Miodówko, Pluski, Ruś, Rybaki, Stawiguda, Tomaszkowo, Wymój, Zezuj, Owczarnia, Zazdrość, Grada, Zielonowo, Klekotowo, Łański Piec, Ustrych, Muchorowo, Jełguń, Sójka, Ćwikelnia, Kieruj, Zarośle, Stawiguda settlement.

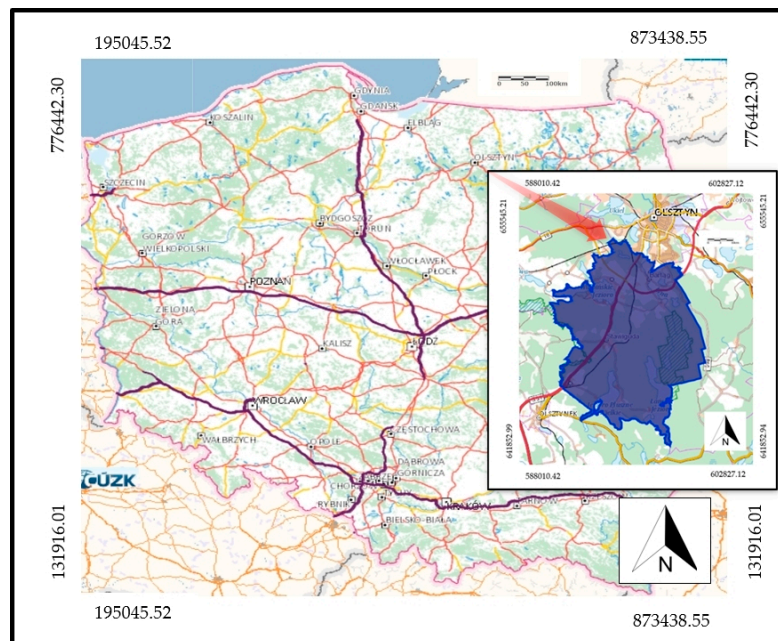


Figure 3. Research area. Source: own study [54].

3. Materials and Methods

3.1. Materials

The data for research were obtained from various sources. In the initial phase, we compared data from Corine Land Cover (CLC) from 2006, 2012 and 2018 to identify areas where land divisions occurred. The inventory was initiated in 1985 by the European Environment Agency (EEA). The main data sources for CLC include satellite images from Landsat 7, IRS and the SPOT 4 satellite, as well as aerial photographs and topographic maps. The CLC consists of a land cover inventory organized hierarchically into three levels. The first level includes five main categories of land cover forms, namely: anthropogenic land, agricultural land, forest and semi-natural land, wetlands and water. The second level distinguishes 15 forms of land cover, which can be presented on maps at a scale of 1:500,000 to 1:1,000,000. The third level includes 44 forms. The CLC uses a minimum mapping unit (MMU) of 25 hectares for areal phenomena and a minimum width of 100 m for linear phenomena. Time series are completed with change layers that use five-hectare MMUs to highlight changes in land cover. Different MMUs mean that the change layer has a higher resolution than the basic layer. Most countries produce CLC through the visual interpretation of high-resolution satellite images and in situ data, satellite image processing, GIS integration and generalisation [55,56]. The analysis of CLC data allowed for obtaining information on locations where there has been a change in use from natural or semi-natural use (according to the CLC nomenclature, 2.1.1.: arable land out of the range of irrigation equipment; 3.1.1.: meadows, pastures; 2.4.2.: complex cultivation patterns; 2.4.3.:

predominantly agricultural land with a high proportion of natural vegetation; 3.1.3.: mixed forests) to anthropogenic developed areas (1.1.2.: housing estates). The data were used to determine the general location of changes in use, which translates into selecting villages or parts of villages where such changes occurred (due to the size of the minimum mapping area). Figure 4 shows the CLC data from (a) 2006, (b) 2012 and (c) 2018 on the left and the corresponding archive orthophotomap (a'), (b') and (c') [54–56] to the right. The area for analysis was searched by comparing the state of the area in CLC over time intervals. Figure 4a–c show an example in Tomaszkowo in 2006, where the area was marked “arable land” (2.1.1., yellow color), and in 2018 “housing estate” (1.1.2., red color) and “construction sites” (1.3.3., purple color). There was a significant development of the residential function, which consequently gives an indication that divisions of plots of land have been made in this location.

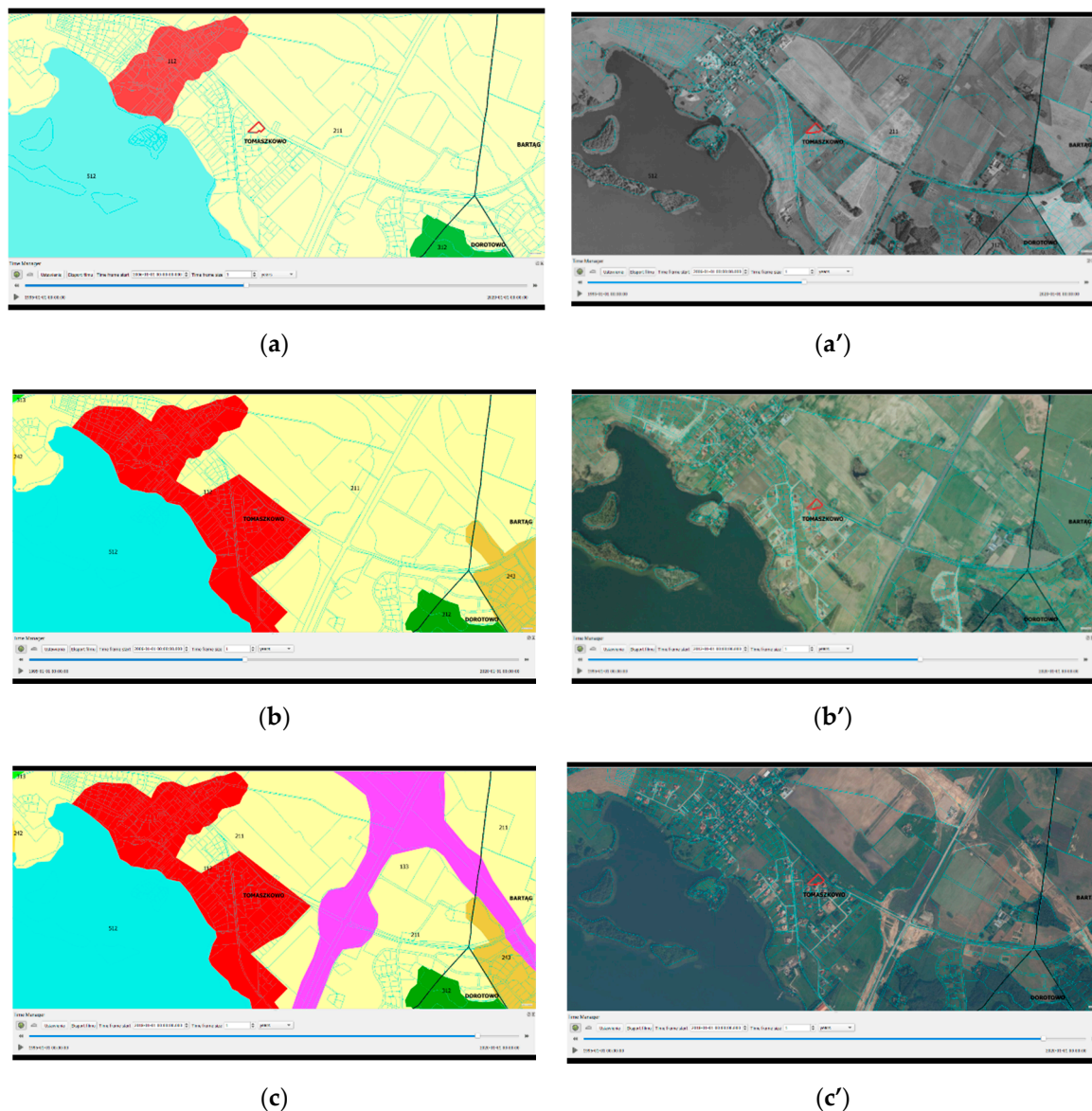


Figure 4. Comparison of information on land cover according to Corine Land Cover (CLC) data from the (a) year (2006); (b) 2012; (c) 2018 and orthophotos (www.geoportal.gov.pl) from the year (a') 2006; (b') 2012; (c') 2018. Source: [54–56].

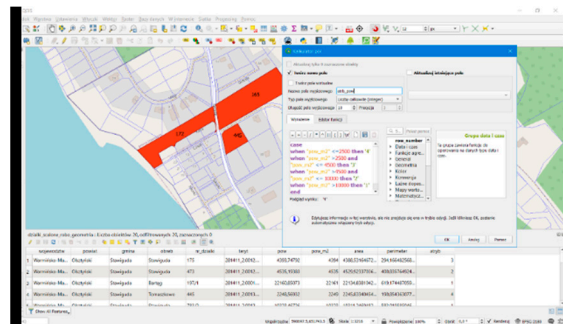
The following research step included collecting data on the division decisions issued by the relevant administrative bodies in the Stawiguda commune. Information was collected on issued

decisions approving land divisions (division according to procedure A, description in the Background section) and preliminary drafts of plot division (division according to procedure B, description in the Background section). The information about the conducted proceedings (administrative decisions), access to archive orthophotos and the use of QGIS software (Time Manager tool) all enabled further detailed analysis of plots in “ex ante” and “ex post” conditions. To eliminate from the base real estate what was divided for such purposes as, e.g., the regulation of land parcel boundaries, the allotment of a road, railway line, airport, flood protection structures, etc., we examined the condition of each plot. This type of administrative division proceeding is subject to expropriation procedures for public purposes and was not subject to our analysis.

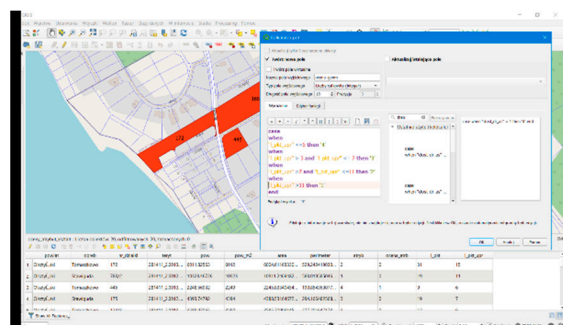
Data on transaction prices on the local market for real estate that were similar to examined pieces in the “ex ante” condition (large plots) and “ex post” condition (small plots) were then collected. Each transaction was analyzed and described with GIS tools and data from Geoportal [54] and MSIPMO (acronym MSIPMO—Miejski System Informacji Przestrzennej Miasta Olsztyn) [57] (internet portal providing public access to updated reference spatial databases of Olsztyn and to data of public registers related to the city’s spatial management). The Geoportal enables combining spatial datasets provided by different administration units into a coherent entity, available in electronic form via Geoportal, a service based on an interactive engine for map searching with tools for finding and analyzing spatial data [54]. The scope of the Geoportal project encompasses activities in the area of implementing and maintaining the Infrastructure for Spatial Information in the European Community (INSPIRE) services and their national and sector broker. The Municipal Spatial Information System of the City of Olsztyn (MSIPMO, Miejski System Informacji Przestrzennej Miasta Olsztyn) is an online information system. The system allows for implementing new public services through an electronic spatial information database. It also provides public access to updated reference spatial databases of Olsztyn and to data of public registers related to the city’s spatial management. MSIPMO’s task is to manage, collect, process and share “spatial information” for all authorized system users [57].

Both databases are based on the implementation of the Web Map Service (WMS) to create and share spatial data in raster format using QGIS. The data result from the implementation of the INSPIRE directive [58,59] in Poland and is made available according to Open Geospatial Consortium (OGC) standards.

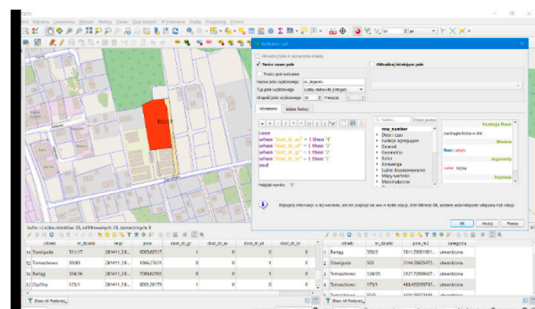
Transactions, of both those corresponding to the “ex ante” and “ex post” conditions, were selected for the research and located using the ULDK tool (Usługa Lokalizacji Działek Katastralnych—Cadastral Location Service). We obtained the description of the technical condition of the “ex ante” plots using the aggregate function, thanks to which the parcel boundaries were restored to their original condition (to the state before division). With the field calculator tool and the \$area function, we updated the attribute table with the “ex post” plot surface area. Using the SQL query language, we developed an algorithm that attributed ratings for particular attributes of sold properties, such as plot surface area (X_{area}), access to the plot ($X_{\text{access to the plot}}$), provision of utilities ($X_{\text{utilities}}$), number of boundary points/plot shape (X_{shape}) and number of “ex post” plots (X_{number}). Figure 5 presents an example of the process of obtaining information about the X_{area} (Figure 5a), X_{access} (Figure 5b) and X_{shape} (Figure 5c) attributes. The database, created in this way, was used for further analysis.



(a)



(b)



(c)

Figure 5. SQL query attributing ratings to real estate according to the adopted rating scale for the (a) X_{area} (plot area), (b) X_{access} (access to the plot) and (c) X_{shape} (number of border points/shape of plots), attributes. Source: own study.

3.2. Research Methodology

We divided the methodological procedure into several stages:

Stage 1: First, we collected the necessary data from CLC [55,56], MSIMPO [57] and Geoportal [54] and we used it to determine the research area. We compared CLC data [55,56] and cadastral layers [54,57] for two time periods, i.e., 2000 and 2018. For this purpose, we searched for areas where the land use changed from natural or semi-natural (2.1.1; 2.3.1; 2.4.2; 2.4.3; 3.1.3) to urbanized (112: housing estates).

Stage 2: Next, we obtained data on plot divisions and a database of plot sales prices, which were used for further analyses.

Stage 3: We described the facilities using GIS tools and the data available in the OGC standard. We created a database of sold properties and described it using GIS (QGIS) tools, the SQL query language and available databases, meeting OGC standards [54–56].

Stage 4: We calculated the change trend, taking into account the time and surface attributes (Formulas (1) and (2)). Regression enabled the modeling of relationships between two or more variables [60,61] according to Equation (1):

$$Y = a_0 + a_1X_1 + \varepsilon \quad (1)$$

where:

Y —dependent variable (value of the plot)

a_0, a_1 —fixed parameters of the model

X_1 —independent variable (time)

ε —random component of the model.

The value change factor, taking into account the passage of time [60], was calculated according to Equation (2):

$$r = \frac{a_1}{a_0} * 100\% \quad (2)$$

where:

r —time trend

a_0, a_1 —fixed parameters of the regression model.

Stage 5: We updated the plot value for “ex ante” and “ex post” conditions at a given moment in time. The progression index (PI), taking into account the flow of time for the surface area range of the examined plots, was determined by Equation (3):

$$\Delta w = w_{ex\ post} - w_{ex\ ante} \quad (3)$$

where:

Δw —increase in the value of the “ex post” plot

$w_{ex\ post}$ —value of the “ex post” plot

$w_{ex\ ante}$ —value of the “ex ante” plot.

Stage 6: We determined the stepwise regression models [62] for the selection of the attributes and determined their weight for the “ex ante” and “ex post” conditions according to Equation (4):

$$Y_{ex\ ante/ex\ post} = a_0 + a_1X_1 + \dots + a_iX_i \quad (4)$$

where:

$Y_{ex\ ante/ex\ post}$ —dependent variable (value of the plot)

X_1 —independent variable

a_0 —free term

a_1, a_i —model parameters, coefficients determined with the least square method.

The calculation of weights for the “ex ante” and “ex post” conditions using standardized regression coefficients [63,64] was done according to Equation (5):

$$\beta = \frac{a_i s_x}{s_y} \quad (5)$$

where:

β —standardized regression coefficient

a_i —parameter of the regression function

s_x —standard deviation of the independent variable

s_y —standard deviation of the dependent variable.

Stage 7: We created a non-linear model and simulation of the “ex post” plot value based on the “ex ante” value and found the difference in the attributes in the “ex ante” and “ex post” conditions (the attributes are presented in Table 1) according to Equation (6):

$$w_{ex\ post} = w_{ex\ ante}(1 + a_1v_1 + a_2v_2 + a_3v_3 + a_4v_4 + a_5v_5) \quad (6)$$

where:

- $w_{ex\ post}$ —value of the plot after division
- $w_{ex\ ante}$ —value of the plot before division
- a_i —parameter of the regression function
- v_i —i-th independent variable (difference in the explanatory variable in the “ex ante” and “ex post” conditions).

Table 1. Basic statistics of the data of the model together with the attribute descriptions.

Attribute	Description	Aver.	Min.	Max.
X_{area}	Surface area of the “ex ante” plot [m ²] [1—above 10,000 m ² ; 2—4500 m ² to 9 999 m ² ; 3—2500 m ² to 4499 m ² ; 4—up to 2499 m ²]	1.9948	0.0237	31.6709
X_{access}	Access to the plot [1—no access (ground easement); 2—direct access to a public road, unpaved (ground) road; 3—direct access to a public road, paved road (deconstruct, other types of paving, but not tarmac); 4—direct access to a public road, paved road, tarmac in good condition]	2.00	1.00	4.00
$X_{utilities}$	Provision of utilities [1—no utilities provided; 2—electricity, water supply within reach; 3—electricity, water supply, sewerage system; 4—all utilities, electricity, water supply, sewerage, gas, etc.]	2.00	1.00	4.00
X_{shape}	Number of border points/plot shape [1—irregular arrangement of the plot boundaries, more than 11 border points; 2—irregular or significantly elongated shape, max. 11 border points; 3—regular arrangement of the borders, max. 7 border points; 4—regular arrangement of the borders, max. 5 border points]	10.13	4.00	22.00
X_{number}	Number of “ex post” plots [1–2 plots “ex post”; 2–3 to 4 plots “ex post”; 3–5 to 10 plots “ex post”; 4—above 10 plots “ex post”]	5.24	2.00	45.00

QGIS 3.12.0 “București” and Statistica v.13.1 were used for data analysis.

The final stage of the research included the formulation of a non-linear model, based on the plot value in the “ex ante” condition and the difference in condition attributes for the “ex ante” and “ex post” plots. The model allowed us to forecast plot value after division (in the “ex post” condition).

STAGE 8: We verified the estimated values based on market observations.

4. Result and Discussion

Analyses of CLC data supported by orthophotomap and cadastral data for twopoints in time (2000 and 2018) showed that the largest changes in the conversion of agricultural land to developed land occurred in the municipality of Stawiguda. There are 29 villages in this location, which is a suburban area of the city of Olsztyn (Warmia and Mazury). Most areas were located in the villages of Stawiguda, Tomaszkowo and Bartag.

The results of this analysis provide an answer to the question of where to perform a deeper analysis and look for decisions on approving plot divisions (see Figure 3).

In the Stawiguda commune, 74 decisions approving the division of plots were issued in the 2015–2018 period (see Table 2). Their number peaked in 2016 (36) and fell in 2018 (4). Seventy-five percent of the plot divisions were made to re-sell them, 10% were to regulate the plot boundaries between neighbors and 13% were to divide co-ownership, while the remaining 2% included divisions to achieve public goals (e.g., road construction). The total area of all the divided plots was 145,6173 ha. The minimum surface area of a plot before the surveying division (“ex ante”) was 0.0237 ha and the largest was 31.6709 ha (with a mean of 1.9948 ha). The division of 75 “ex ante” plots gave 393 “ex post” plots. The smallest plot after the division procedure (“ex post”) had an area of 0.0007 ha and the largest 9.8056 ha (with a mean of 0.3744 ha). Most often, plots were divided into two to three new plots with an area of 500–1000 m². The surface area of 189 “ex post” plots was less than 0.5000 ha, 146 plots had an area of 0.5000–1.0000 ha, 42 plots 1.0000–2.0000 ha, nine plots 2.0000–4.0000 ha and seven plots were larger than 4.0000 ha.

Table 2. Description of analyzed data.

Characteristic	Description
Number of analyzed decisions	74
Period	2015–2018
Number of analyzed “ex ante” plots	75
Number of analyzed “ex post” plots	393
Maximum area of “ex ante” plots	31.6709 ha
Minimum area of “ex ante” plots	0.0237 ha
Minimum area of “ex post” plots	0.0007 ha
Maximum area of “ex post” plots	9.8056 ha

A downward trend in the unit price was observed, along with an increase in the plot area (see Figure 6A). Similar relationships were observed for other real estate markets [61]. Therefore, the examined group of facilities was divided into two area ranges, the first one up to 5000 m² (see Figure 6B), the second exceeding 5000 m² (see Figure 6c).

Plots with an area above 5000 m² are characterized by a slower price increase than plots with an area up to 5000 m². Smaller plots exhibited a price increase almost twice as high (0.77%) as plots with a larger surface area (0.39%). The value progression index for “ex ante” plots ranged between a maximum of 16.11% and a minimum of 3.0% (with a mean of 9.75%).

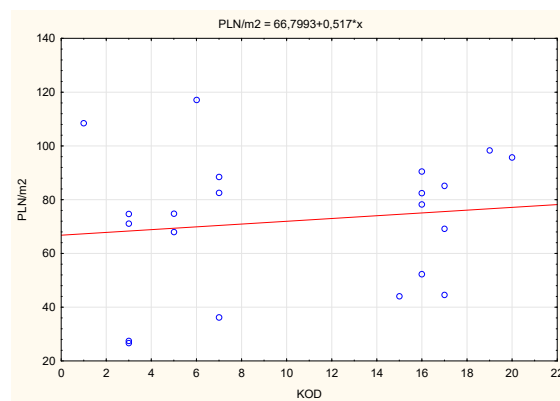
The weight of attributes determining the plot value was estimated based on two models for each of the analyzed conditions, i.e., “ex ante” (see Table 3) and “ex post” (see Table 4). Both models explained between 50% and 70% of the total variance in the dependent variable (see Tables 3 and 4). In the “ex ante” condition, there were two attributes with the greatest influence on the plot value: its area (X_{area}) with influence at the level of 63% and access to the plot (X_{access}) whose influence was estimated at the level of about 23%.

Generally, the buyers of plots intended for development are more willing to purchase smaller plots and are willing to pay more for those plots (as converted per unit of surface area) than for plots with a larger surface area. Similar tendencies are observed in real estate markets near other Polish cities [65]. The implementation of development projects requires large areas [66] and this depends on the scale of the project. The other important attribute (X_{access}) is related to access to a public road and the quality of the road surface. Polish law allows for the development and operation of new housing investments without the obligation to build and pave the road. This particularly applies to suburban areas. The cost of building a road is usually borne by the commune once it takes over/acquires land for the road. This does not mean that the situation is not beneficial for the commune. Once the investment is completed (construction of a house), the tax on the developed property is much higher than the tax on agricultural land as it results from the Polish model based on surface area and manner of land use [31,67,68]. This is one of the reasons why the authorities are interested in the citizens investing in the commune area and approve of such investments. The last three attributes, $X_{\text{utilities}}$,

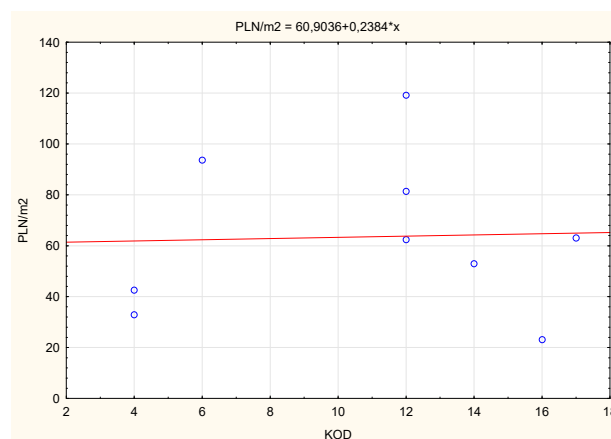
X_{shape} and X_{number} (provision of utilities, plot shape and the number of “ex post” plots), are statistically insignificant and have only a marginal influence on the plot value in the “ex ante” condition.



(a)



(b)



(c)

Figure 6. (a) Relationship between surface area and price in the examined real estate. (b) Relationship between plot area (up to 5000 m²) and time interval. (c) Relationship between plot area (above 5000 m²) and time interval. Source: own study. Legend: KOD—the time interval covering the number of months from real estate transactions to the time of the analysis.

Table 3. Modeling results for determining the weight of individual attributes for the “ex ante” plot condition.

Independent Variable	Coefficient b	Sdev.	t-Student	P	Beta	Weight [%]
Const.	44.6056	24.4938	1.8211	0.0900		
X_{area}	14.5846	4.1933	3.4781	0.0037	0.5620	63.21
X_{access}	9.9540	5.1916	1.9173	0.0758	0.2010	22.61
$X_{\text{utilities}}$	-3.8256	2.8933	-1.3222	0.2072	0.0672	7.56
X_{shape}	-4.2461	4.4158	-0.9616	0.3526	0.0382	4.30
X_{number}	-12.5049	18.7966	-0.6653	0.5166	0.0207	2.33
R	0.7017					
Adjusted R ²	0.4924					

Table 4. Modeling results for determining the weight of individual attributes for the “ex post” condition.

Independent Variable	Coefficient b	Sdev.	t-Student	P	Beta	Weight [%]
Const.	-1.3821	48.8204	-0.0283	0.9778		
X'_{area}	26.6204	10.0904	2.6382	0.0194	0.2623	28.15
X'_{access}	10.3894	4.7656	2.1800	0.0468	0.2347	25.19
$X'_{\text{utilities}}$	-5.1383	3.7042	-1.3871	0.1871	0.0786	8.44
X'_{shape}	3.1433	5.3739	0.5849	0.5679	0.0134	1.44
X'_{number}	-21.2665	7.8755	-2.7003	0.0172	0.3443	36.78
R	0.7148					
Adjusted R ²	0.5110					

For “ex post” plots (Table 4) the attributes influence the value differently than in the “ex ante” condition. A statistically important feature, with significant weight, is plot surface area (X'_{area}), with its influence estimated at 28%, and access to the plot (X'_{access}), with its influence estimated at 25%. At this stage of research, another feature was revealed, i.e., the number of plots created after division (X'_{number}). Our model showed that this feature is statistically significant, with its estimated impact weight at almost 37% (see Table 4). This relationship shows that the larger the number of plots after division, the lower their unit value. This trend is linked to the incentive for prospective buyers to invest in newly allotted areas. The most effective method is to reduce the unit price for a plot or group of plots in a given location.

The remaining attributes, $X'_{\text{utilities}}$ (provision of utilities) and X'_{shape} (plot shape), proved statistically insignificant and had an impact of 8.44% and 1.44%, respectively, on the prices of plots in the “ex post” condition.

The insignificant influence of the $X'_{\text{utilities}}$ and X'_{shape} attributes is understandable. Newly allotted “ex post” plots with extremely uncomfortable and irregular geometric boundaries are very rare. Designing the boundaries of new plots requires maintaining the required distance from neighboring buildings. Polish law allows for constructing a building on a plot if the distance between it and the plot boundary is at least 4 m for walls with windows or 3 m for a wall without windows [69,70]. Such requirements force the designer (surveyor) to plan optimal plot shapes in local conditions. A figure close to a quadrilateral mostly meets such requirements. In this situation, the shape of the plots (X'_{shape}) does not have a significant impact, as shown by the dependencies in the model. When it comes to utility provision ($X/X'_{\text{utilities}}$), it was similar for both “ex post” and “ex ante” conditions. A comparison of the weights of the plot characteristics for both “ex post” and “ex ante” conditions is presented in Figure 7.

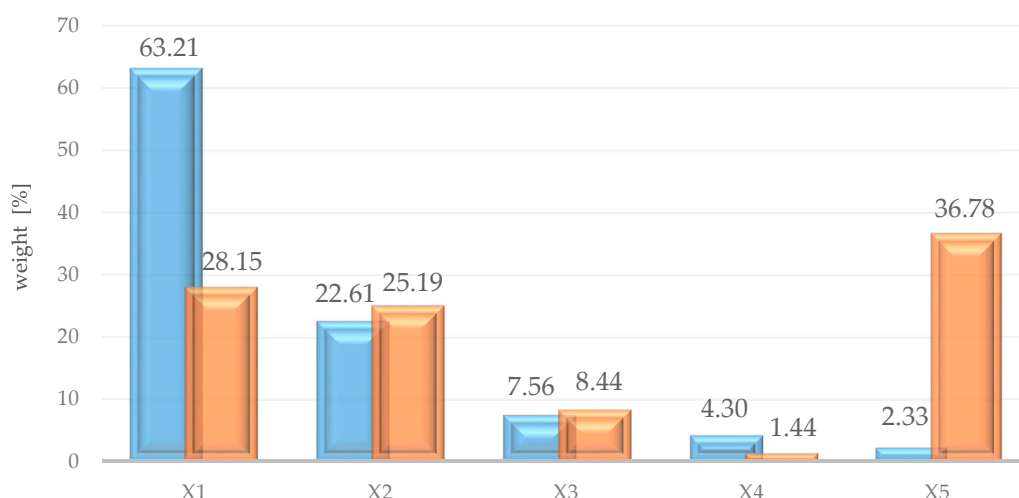


Figure 7. Comparison of the weights of attributes for plots in “ex ante” and “ex post” conditions.

The proposed model accounted for cases in which the division of the plot had a positive or zero impact on the plot value in the “ex post” condition. The negative impact was most often observed for divisions made for public purposes (e.g., road construction, etc.). The model is characterized by a high determination coefficient ($R^2 = 0.98$), which means that all predictors explain more than 98% of the variability of the dependent variable (increases in value resulting from the plot division). Estimates are presented in Table 5.

Table 5. Modeling results for the non-linear model.

Non-Linear Model						
Independent Variable	Coefficient	Sdev.	t-Student	P	Upper Confidence Interval	Lower Confidence Interval
X _{area}	−0.0576	0.0234	−2.4553	0.0437	−0.1128	−0.0021
X _{access}	−0.0538	0.0123	−4.3487	0.0033	−0.0831	−0.0245
X _{utilities}	−0.0146	0.0082	−1.7698	0.1200	−0.0341	0.0049
X _{shape}	0.0461	0.0193	2.3911	0.0480	0.0005	0.0916
X _{number}	0.1111	0.0282	3.9337	0.0056	0.0443	0.1779
R	0.9861					
Alpha	0.050					

The non-linear model based on the increase in the plot value resulting from the division of the plot was compared to the observed values. The determined differences range from −10.82% to +18.42% (see Figure 8). This model was well reproduced by market trends.

The analysis of the results of the study indicates that owners of large plots of land located in suburban zones are willing to divide them to convert land used for agriculture into land for development. This process is effective from an economic point of view. The division procedure increases the plot value by about 10% (see Figure 8), with the remaining attributes being the same. Other authors [71,72] also observed such a phenomenon. They claim that agricultural land is being transformed into residential areas or production/service spaces. Owners of large plots are eager to divide them and they find buyers for them. The popularity of such locations results from, among other reasons, lower land costs, the possibility of buying larger plots of land than would be the case in city centers and easier access to natural areas.

The legal conditions that have been in force for more than a decade, concerning, among other things, the process of plot division, have become one of the reasons for the spatial management crisis in Poland, which has exacerbated the urban planning chaos. This phenomenon is extremely unfavorable from many points of view. Figure 9 presents a comparison of the suburban zone of Łódź in Poland (a), exhibiting urban planning chaos, and a city with a similar population, i.e., Cologne in Germany (b). Figure 9a presents the area around the city of Łódź (Poland), where the development

of the suburban area is dispersed. Picture (b) shows the area around the city of Cologne (Germany), where the suburbanization zone is developing in a targeted and focused way.

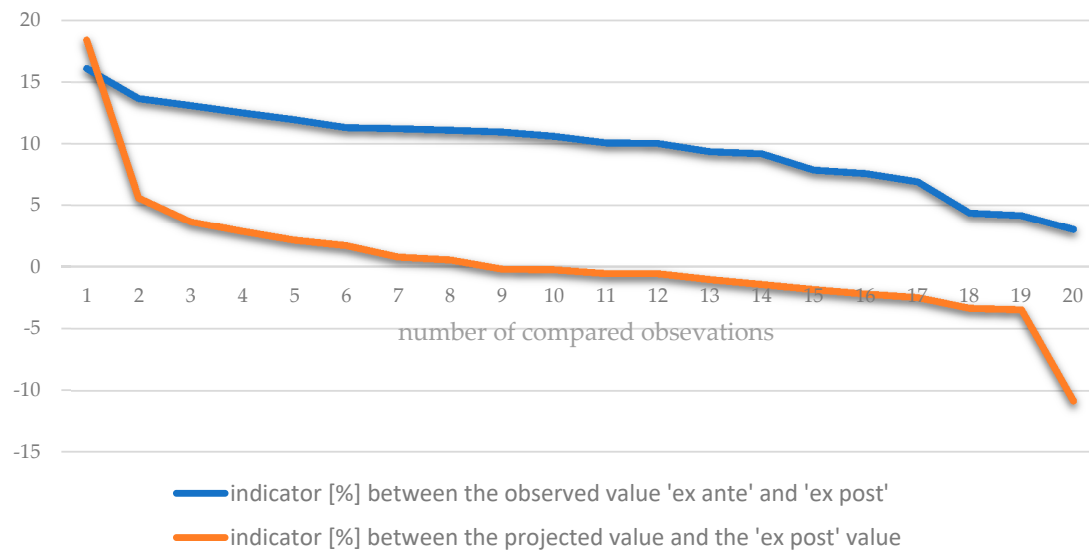


Figure 8. Ratios (%) between the value from the model and the observed “ex ante” value, as well as the forecast and observed values (%). Source: own study.

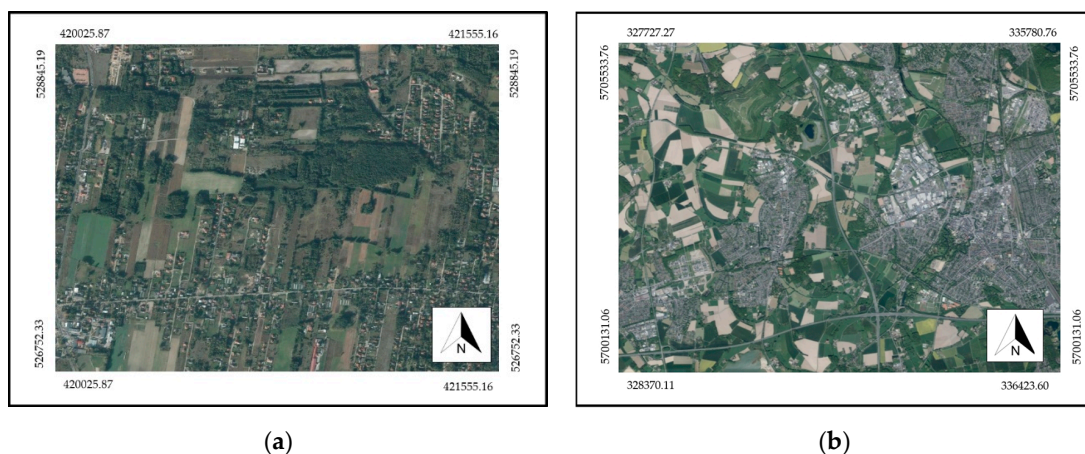


Figure 9. Suburbanization zones in (a) the city of Łódź (Poland) and (b) the city of Cologne (Germany). Source: own study [54].

Allowing for the erection of individual buildings or their small clusters at a considerable distance from the existing developments and technical infrastructure, which is the case in Poland, is perceived by many specialists as unfavorably affecting society, the environment and the economy. Urban planning chaos hinders budget planning in local government units (communes) and leads to a growing deficit in public finances, as the society, living in such dispersed locations, exerts pressure on local authorities to include road and utility provision investments in their budgets [73,74]. As a rule, such investments weigh heavily on the commune budget and, at the same time, only satisfy the needs of a small social group. It is not possible to meet even minimum traffic and service standards due to the high costs, which are many times higher than with well-planned and concentrated development. The lack of a land development program and the easy division of plots deteriorates the spatial order in a given commune with respect to space division into areas homogeneous in terms of use and the development of floodplains. The homogeneity of the existing forms of development and urban and architectural systems [16] is also disturbed. Chaos negatively affects the quality of life of the inhabitants,

causing social problems, such as growing pathologies, alienation, the disappearance of social bonds, frustration and conflicts. It also contributes to a decrease in physical activity [75] and an increase in the incidence of cardiovascular and overweight-related diseases [76]. An intensification of the negative effects of anthropopressure on the natural environment is observed in such areas. The development disturbs the functioning of open spaces, areas used for agriculture [77,78] and locations attractive in terms of landscape, aesthetics and nature, which leads to the destruction of ecological systems [79] and the defragmentation of natural systems, i.e., ecological corridors and green wedges. Chaos in development also weakens the competitiveness of Polish metropolises in comparison with others in Europe and worldwide [16].

Despite the destructive impact on society, the economy and the environment, the chaotic development of suburban zones continues, with the process of plot division and the conversion of agricultural land into development land greatly contributing to it. Not only is it legally sanctioned, but also, as confirmed by research, it is economically viable for the landowners. The created non-linear model based on plot value in the “ex ante” condition and the difference between property attributes in “ex ante” and “ex post” conditions showed that the plot value forecast for the “ex post” condition corresponds to observations made of the real estate market.

The research has its methodological limitations. First of all, the analyses were based on a relatively small database. However, this resulted from the assumptions made at the very beginning. The plots in the “ex ante” conditions were selected for the possibility of confronting it with the “ex post” condition. This means that in the analyzed real estate market, the analyzed location needed to include both large plots undergoing the division process and small plots that were already divided and sold. Such a coherence was very difficult to achieve, but the use and comparison of CLC data from different time intervals proved an invaluable source of information and largely accelerated the selection process.

In general, the CLC data resolution enables analysis at regional or national levels. We used them innovatively at the local level, with the support of orthophotomaps and cadastral data. The world consists of microlocations. By analyzing the phenomena and processes occurring in one microlocation, we can find similar relationships in other microlocations.

Many phenomena take place in different locations and have already been observed by humans before, but difficulties resulting from the impossibility of quickly locating the research area and observing the condition of space over several years or decades often made their analysis impossible. Nowadays, thanks to the growing number of available images of CLC data, it is possible to analyze the human–procedure–space relationship over time.

5. Conclusions

The process of conversion of agricultural land to developed land is inevitable as the population grows. Humans permanently put natural and semi-natural areas under pressure, adapting them to their needs. We focus solely on economic benefits without paying attention to a wide range of side effects. The results of this research show the following detailed conclusions:

- (a) the use of currently available CLC, geoportal and MSIPMO data for various time intervals and GIS tools allow for the analysis of agricultural land conversion in the direction of development use;
- (b) the analysis of statistical models confirms that the conversion of land from agricultural to development use is economically viable for property owners (about 10%);
- (c) current legal conditions in the studied area are conducive to the conversion process, which consequently creates urban chaos.

Uncontrolled urbanization generates growing social and economic losses, reduces the level and effectiveness of investments, hinders the functioning of the labour market and becomes an increasing barrier to development. We thus need to think about how to slow down or stop this process. Otherwise, we risk leaving the next generations with a difficult legacy because poorly planned living spaces are a permanent element and, for this reason, they are the most difficult to eradicate. For the authorities,

the most urgent task is mastering the chaotic urbanization processes. The actual needs and development possibilities of the communes and the interests of individual citizens should determine the size of the investment areas.

Author Contributions: Conceptualization K.K.-B.; methodology K.K.-B. and A.P.; software K.K.-B. and A.P.; validation K.K.-B. and A.P.; formal analysis K.K.-B. and A.P.; investigation K.K.-B.; resources K.K.-B. and A.P.; data curation K.K.-B. and A.P.; writing—original draft preparation K.K.-B.; writing—review and editing K.K.-B.; visualization K.K.-B.; supervision K.K.-B.; project administration K.K.-B.; funding acquisition K.K.-B. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

References

- Jiang, G.; Ma, W.; Qu, Y.; Zhang, R.; Zhou, D. How does sprawl differ across urban built-up land types in China? A spatial-temporal analysis of the Beijing metropolitan area using granted land parcel data. *Cities* **2016**, *58*, 1–9. [CrossRef]
- Gibas, P.; Heffner, K. *Spoleczne i Ekonomiczne Koszty Bezladu Przestrzeni—Osadnictwo Obszarów Wiejskich*; Komitet Przestrzennego Zagospodarowania Kraju PAN: Warszawa, Poland, 2018; pp. 163–197.
- Mrakuszevska, I. Conflicts between legal policy and rural area management in Poland. *Acta Geogr. Slov.* **2018**, *58*, 59–67. [CrossRef]
- Śleszyński, P.; Markowski, T.; Kowalewski, A. *Synteza: Uwarunkowania, Skutki i Propozycje Naprawy Chaosu Przestrzennego*; KPZP: Warszawa, Poland, 2018.
- Markowski, T. *Ekonomiczny Wymiar Urbanizacji*; KPZK: Warszawa, Poland, 2014; pp. 19–29.
- Jankava, A.; Parsova, V.; Berzina, M.; Palabinska, A. Role of brownfields regeneration in sustainable use of natural resources. *Balt. Surv.* **2019**, *2*, 31–39. [CrossRef]
- Jensen, J.R. *Introductory Digital Image Processing: A Remote Sensing Perspective*, 3rd ed.; Prentice Hall: Upper Saddle River, NJ, USA, 2005.
- Kanianska, R.; Kizeková, M.; Nováček, J.; Zeman, M. Land-use and land-cover changes in rural areas during different political systems: A case study of Slovakia from 1782 to 2006. *Land Use Policy* **2014**, *36*, 554–566. [CrossRef]
- Cegielska, K.; Noszczyk, T.; Kukulska, A.; Szylar, M.; Hernik, J.; Dixon-Gough, R.; Jombach, S.; Valanszki, I.; Filepne Kovacs, K. Land use and land cover changes in post-socialist countries; some observations from Hungary and Poland. *Land Use Policy* **2018**, *78*, 1–18. [CrossRef]
- Organisation for Economic Co-operation and Development. Available online: <http://OECD.stat> (accessed on 4 April 2020).
- Prus, B. Koncepcja badania pokrycia terenu w Polsce i określenie prognozy jego zmian. *Zesz. Nauk.* **2019**, *422*, 205.
- Repaska, G.; Vilianova, K.; Solcova, L. Trends in development residential areas in suburban zone of the city of Nitra (Slovakia). *Eur. Countrys.* **2017**, *9*, 287–301. [CrossRef]
- Shcharbach, Y.S.; Potaev, G.A. Specific features in building and development of residential areas in suburbs of largest Bielarussian cities. *Sci. Tech.* **2017**, *16*, 275–281.
- Kowalczyk, A.M. Valuation and Valorisation of Urban Landscape in Olsztyn. *Studia Reg.* **2012**, *34*, 77–94.
- Grochowska, A. Konflikty przestrzenne w procesie planowania na przykładzie gmin powiatu trzebnickiego. *Studia Miejskie* **2015**, *20*, 179–187.
- Kowalewski, A.; Mordasewicz, J.; Osiatyński, J.; Regulski, J.; Stępień, J.; Śleszyński, P. *Raport o Ekonomicznych Stratach i Społecznych Kosztach Niekontrolowanej Urbanizacji w Polsce (Report on the Economic and Social Costs of Uncontrolled Urbanization in Poland)*; Foundation in Support of Local Democracy and Institute of Geography and Spatial Organization, Polish Academy of Sciences: Warsaw, Poland, 2013; Available online: http://www.frdl.org.pl/pliki/frdl/document/zalaczniki_artykuly/Raport%20Ekonomiczny%2029.10.2013%20calosc.pdf (accessed on 10 March 2020).
- Ziobrowski, Z. *Polityka Przestrzenna a Decyzje o Warunkach Zabudowy*; KPZK: Warszawa, Poland, 2010.

18. Borkowski, P.; Brunewicz, J.; Koźlak, A.; Pawłowska, B.; Ważna, A. Transport a organizacja przestrzeni w życiu społeczno-gospodarczym. In *Studia Nad Chaosem Przestrzennym, Cz.2, Koszty Chaosu Przestrzennego*; Kowalewski, A., Markowski, T., Śleszyński, P., Eds.; Komitet Przestrzennego Zagospodarowania Kraju PAN: Warszawa, Poland, 2018; pp. 81–113.
19. Śleszyński, P. *Wydatki Związane z Infrastrukturą Techniczną*; Komitet Przestrzennego Zagospodarowania Kraju: Warszawa, Poland, 2018; pp. 196–228.
20. Zathay, M. *Zanieczyszczenie Powietrza i Nieefektywność Energetyczna Struktur Osadniczych w Kontekście Bezładu Przestrzennego w Polsce*; KPZK: Warszawa, Poland, 2018; pp. 229–238.
21. Thompson, D. Suburban sprawl: Exposing hidden costs, identifying, innovations. In *Sustainable Prosperity*; University of Ottawa: Ottawa, ON, Canada, 2013.
22. Williams, T. Blighted Cities Prefer: Razing to Rebuilding. *New York Times*. Available online: <https://www.nytimes.com/2013/11/12/us/blighted-cities-prefer-razing-to-rebuilding.html> (accessed on 15 March 2020).
23. Anderson, M.W. Dissolving cities. *Yale Law J.* **2012**, *121*, 1364–1446.
24. Silva, C. The rural lands of urban sprawl: Institutional changes and suburban rurality in Santiago de Chile. *Asian Geogr.* **2019**, 1–28. Available online: <https://www.tandfonline.com/doi/abs/10.1080/10225706.2019.1701505> (accessed on 15 March 2020). [CrossRef]
25. Ekers, M.; Hamel, P.; Keil, R. Governing suburbia: Modalities and mechanisms of suburban governance. *Reg. Stud.* **2012**, *46*, 405–422. [CrossRef]
26. Mattingly, K.; Morrissey, J. Housing, and transport expenditure: Socio-spatial indicators of affordability in Auckland. *Cities* **2014**, *38*, 69–83. [CrossRef]
27. Kassa, F. Conurbation and Urban Sprawl in Africa: The case of the City of Addis Ababa. *Ghana J. Geogr.* **2013**, *5*, 73–89.
28. Zhang, R.; Pu, L.; Zhu, M. Impacts of transportation arteries on land use patterns in urban-rural fringe: A comparative gradient analysis of Qixia District, Nanjing City, China. *Chin. Geogr. Sci.* **2013**, *23*, 378–388. [CrossRef]
29. Firlej, C.; Firlej, K.A. *Porównanie Systemów Opodatkowania Nieruchomości w Unii Europejskiej (Comparison of Property Taxation Systems in the EU)*; Institute of World Economics: Krakow, Poland, 2014; Available online: <https://depot.ceon.pl/handle/123456789/7545?show=full> (accessed on 15 May 2020).
30. Marona, B. System opodatkowania nieruchomości w Polsce na tle rozwiązań w wybranych krajach europejskich. *Zeszyty Naukowe Akademii Ekonomicznej w Krakowie* **2006**, *703*, 115–128.
31. Kocur-Bera, K. Data compatibility between the Land and Building Cadaster (LBC) and the Land Parcel Identification System (LPIS) in the context of area-based payments: A case study in the Polish Region of Warmia and Mazury. *Land Use Policy* **2019**, *80*, 370–379. [CrossRef]
32. Kocur-Bera, K.; Dawidowicz, A. Land use versus land cover: Geo-analysis of national roads and synchronization algorithms. *Remote Sens.* **2019**, *11*, 3053. [CrossRef]
33. Silva, C. Auckland’s Urban Sprawl, Policy Ambiguities and the Peri-Urbanisation to Pukekohe. *Urban Sci.* **2019**, *3*, 1. [CrossRef]
34. Fulton, W.; Pendall, R.; Nguyen, M.; Henderson, A. *Who Sprawls Most?* Brookings Institution: Washington, DC, USA, 2001.
35. Jaret, C.; Ghadge, R.; Reid, L.W.; Adelman, R.M. The measurement of suburban sprawl: An evaluation. *City Community* **2009**, *8*, 65–84. [CrossRef]
36. Angel, S.; Parent, J.; Civco, D.L.; Blei, A.M. *Atlas of Urban Expansion*; Lincoln Institute of Land Policy: Cambridge, MA, USA, 2012.
37. Szold, T.S. Introduction and overviews: And then there was smart growth. In *Smart Growth: Form and Consequences*; Szold, T.S., Carbonell, A., Eds.; Lincoln Institute of Land Policy: Cambridge, MA, USA, 2002; pp. 2–15.
38. Abbott, C.; Margheim, J. Imagining Portland’s urban growth boundary: Planning regulation as a cultural icon. *J. Am. Plan. Assoc.* **2008**, *74*, 196–208. [CrossRef]
39. Schmid, A.A. *Converting Land from Rural to Urban Uses*; Resources for the Future, Inc.: Washington, DC, USA, 1968.
40. Liu, P. Smart Plot Division—A Plot-based Rehabilitation Strategy for Historic Urban Areas. *Urban Plan. Forum* **2018**, *5*, 16.
41. Jedrak, J. Legal and Economic Aspects of Real Estate Property. *Secur. Econ. Law* **2018**, *1*, 30–73.

42. Felcenloben, D. Wydzielenie działki budowlanej zabudowanej budynkiem mieszkalnym w trybie art. 95 ust. 7 ustawy o gospodarce nieruchomościami. *Przegląd Geodezyjny* **2019**, *91*, 15–18. [[CrossRef](#)]
43. LDCQ. Land division control guide. In *Planning Guide Number 1, Wisconsin*, 2nd ed.; Southeastern Wisconsin Regional Planning Commission: Waukesha, WI, USA, 2001; Available online: https://www.sewrpc.org/SEWRPCFiles/Publications/pg/pg-01_land_division_control_guide.pdf (accessed on 20 April 2020).
44. Booba, T.N.; Rao, Y.R.M. Zoning within Plot—An Approach to Land Sub-Division to Control Violation of Development Control Rules. *Int. J. Multidiscip. Curr. Res.* **2014**, *2*, 48–59. Available online: <http://ijmcr.com> (accessed on 20 March 2020).
45. Balawejder, M.; Noga, K. The influence of the highway route on the development of a patchwork of plots. *J. Water Land Dev.* **2016**, *30*, 3–11. [[CrossRef](#)]
46. Porzucek, W.; Rybicki, R.; Czernyszewicz, E. Wpływ podziałów i połączeń nieruchomości na jakość rolniczej przestrzeni produkcyjnej na przykładzie obiektu w gminie Wólka. In *Jakość i Zarządzanie w Agrobiznesie Wybrane Aspekty*; University of Life Science in Lublin: Lublin, Poland, 2018; pp. 108–124.
47. Malina, R.; Kowalczyk, M. *Geodezja Katastralna*; Wydawnictwo Gall: Katowice, Poland, 2011.
48. Act of 27 of August 1997 on Land Management (Journal of Laws 115, Item 147). Available online: <http://www.isap.gov.pl> (accessed on 13 March 2020).
49. Act of 23 of April 1964 on Civil Code (Journal of Laws 16, Item 93). Available online: <http://www.isap.gov.pl> (accessed on 16 April 2020).
50. Wolanin, M. *Podziały, Scalenia i Rozgraniczenia Nieruchomości, Wydanie 2*; Wydawnictwo, C.H. Beck: Warszawa, Poland, 2013.
51. Act of 17 of May 1989 on Geodetic and Cartographic Law (Journal of Laws 30, Item 163). Available online: <http://www.isap.gov.pl> (accessed on 12 April 2020).
52. Wszółkowska-Szewczyk, A. The current spatial structure of rural landscape and consequences of building single family houses. *Tech. Issues* **2017**, *2*, 48–58. [[CrossRef](#)]
53. Główny Urząd Statystyczny. Available online: <https://stat.gov.pl/> (accessed on 10 April 2020).
54. Geoportal. Available online: https://mapy.geoportal.gov.pl/imap/Imgp_2.html (accessed on 15 January 2020).
55. Corine Land Cover. Available online: <http://clc.gios.gov.pl/index.php/o-clc/definicje-klas> (accessed on 11 April 2020).
56. CLC. Available online: <http://land.copernicus.eu> (accessed on 17 June 2020).
57. Portal Mapowy Systemu Informacji Przestrzennej Miasta Olsztyna. Available online: <https://msipmo.olsztyn.eu/imap/> (accessed on 11 April 2020).
58. Dyrektywa 2007/2/WE Parlamentu Europejskiego i Rady z Dnia 14 Marca 2007 r. Ustanawiająca Infrastrukturę Informacji Przestrzennej We Wspólnocie Europejskiej (INSPIRE) (Dz.U. L 108 z 25.4.2007). Available online: <https://eur-lex.europa.eu/legal-content> (accessed on 20 April 2020).
59. Rozporządzenie Komisji (UE) nr 268/2010 z Dnia 29 Marca 2010 r. wykonujące Dyrektywę 2007/2/WE Parlamentu Europejskiego i Rady w Odniesieniu do Dostępu Instytucji i Organów Wspólnoty do Zbiorów i Usług Danych Przestrzennych Państw Członkowskich Zgodnie ze Zharmonizowanymi Warunkami (Dz.U. L 83 z 30.3.2010). Available online: <https://eur-lex.europa.eu/legal-content> (accessed on 20 April 2020).
60. Bitner, A. Construction of the multiple regression model in real estate valuation. *Acta Scientiarum Polonorum Administratio Locorum* **2007**, *4*, 59–66. Available online: <https://www.ceeol.com/search/article-detail?id=800732> (accessed on 20 March 2020).
61. Bitner, A. Zależność cena—pole powierzchni dla nieruchomości gruntowych niezabudowanych. *Acta Scientiarum Polonorum Administratio Locorum* **2008**, *7*, 41–53.
62. Wang, J.; Xu, Q. The Influence of Floating Population on Real Estate Prices: An Empirical Study of Beijing. In *Proceedings of the 2nd International Conference on Education, E-learning and Management Technology*. Available online: <http://www.dpi-proceedings.com/index.php/dtssehs/article/view/14418> (accessed on 20 March 2020).
63. Czaja, J.; Prewda, E. Analiza ilościowa różnych współczynników korelacji na przykładzie sześciowymiarowej zmiennej losowej. *Geodezja* **2000**, *6*, 147–154.
64. Ostasiewicz, W. *Badania Statystyczne*; Warszawa Wolters Kluwer Bussines, 2011; p. 268. Available online: <http://www.books.google.pl/books> (accessed on 20 April 2020).
65. Zydroń, A.; Walkowiak, R. Analysis of Factors Affecting Value of Undeveloped Plots Allocated for Building Development in Mosina Municipality. *Annu. Set Environ. Prof.* **2013**, *15*, 2911–2924.

66. Dzieciuchowicz, J.; Dmochowska-Dudek, K. The size and the shape of ground plots in Łódź. *Acta Universitatis Slodziensis Folia Geographica Socio-Oeconomica* **2014**, *16*, 149–167.
67. Kocur-Bera, K.; Stachelek, M. Geo-Analysis of Compatibility Determinants for Data in the Land and Property Register (LPR). *Geosciences* **2019**, *9*, 303. [CrossRef]
68. Kocur-Bera, K. Understanding information about agricultural land. An evaluation of the extent of data modification in the Land Parcel Identification System for the needs of area-based payments—A case study. *Land Use Policy* **2020**, *94*, 104527. [CrossRef]
69. Act of 7 July 1994 on Building Law (Journal of Laws, Item 1186). Available online: <http://www.isap.gov.pl> (accessed on 6 October 2019).
70. Regulation of the Minister of Infrastructure and Development on 12 April 2002 on the Technical Conditions to be Met by Buildings and Their Location (Journal of Laws, Item 1422). Available online: <http://www.isap.gov.pl> (accessed on 3 March 2019).
71. Leszek, D. *The Commune of Mielno as a Case Study of the Increase of Real Estate Value due to Divisions of Real Estate and Construction of the Infrastructure*; Motrol. Commission of Motorization and Energetics in Agriculture, Koszalin University of Technology: Koszalin, Poland, 2014; pp. 19–24.
72. Jiang, G.; Ma, W.; Wang, D.; Zhou, D.; Zhang, R.; Zhou, T. Identifying the internal structure evolution of urban built-up land sprawl (UBLS) from a composite structure perspective: A case study of the Beijing metropolitan area, China. *Land Use Policy* **2017**, *62*, 258–267. [CrossRef]
73. Brueckner, J.K. Urban Sprawl: Diagnosis and Remedies. *Int. Reg. Sci. Rev.* **2000**, *23*, 160–171. [CrossRef]
74. Cobbinah, P.B.; Aboagye, H.N. A Ghanaian twist to urban sprawl. *Land Use Policy* **2017**, *61*, 231–241. [CrossRef]
75. Frumkin, H. Urban Sprawl and Public Health. *Public Health Rep.* **2002**, *117*, 201–217. [CrossRef]
76. Cieślak, I.; Biłozor, A.; Szuniewicz, K. The Use of the CORINE Land Cover (CLC) Database for Analyzing Urban Sprawl. *Remote Sens.* **2020**, *12*, 282. [CrossRef]
77. Mosammam, H.M.; Nia, J.T.; Khani, H.; Teymouri, A.; Kazemi, M. Monitoring land use change and measuring urban sprawl based on its spatial forms: The case of Qom city. *Egypt. J. Remote Sens. Space Sci.* **2017**, *20*, 103–116. [CrossRef]
78. Cechcini, M.; Zambon, I.; Pontrandolfi, A.; Turco, R.; Colantoni, A.; Mavrakis, A.; Salvati, L. Urban sprawl and the ‘olive’ landscape: Sustainable land management for ‘crisis’ cities. *GeoJournal* **2019**, *84*, 237–255. [CrossRef]
79. Dupras, J.; Marull, J.; Parcerisas, L.; Coll, F.; Gonzalez, A.; Girard, M.; Tello, E. The impacts of urban sprawl on ecological connectivity in the Montreal Metropolitan Region. *Environ. Sci. Policy* **2016**, *58*, 61–73. [CrossRef]



© 2020 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).

© 2020. This work is licensed under <http://creativecommons.org/licenses/by/3.0/> (the “License”). Notwithstanding the ProQuest Terms and Conditions, you may use this content in accordance with the terms of the License.