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Series „Administratio Locorum" is concerned with the social, economic, geographic, legal, environmental and planning aspects of land administration. The aim of the journal is to provide an interdisciplinary platform for the exchange of ideas and information among scientists representing various disciplines, whose ideas and discoveries tribute to effective land administration. Thus, journal publishes both reviews and empirical studies presenting the results of surveys and laboratory works. Topics covered by our Authors include, i.e.: land administration, technical and social infrastructure, spatial economics, social-economic geography, land management, real estate management, rural areas, environmental protection, protection of historical buildings, spatial planning, local and regional development, sustainable development, urban studies, real estate market, transport systems, legal regulations for the land administration, and spatial management.
The primary aim of the journal and its mission are to spread information and guidance relevant both for authorities responsible for the effective land administration (local, regional and central), scientists and teachers.

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ul. Jana Heweliusza 14, 10-718 Olsztyn, Poland
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# THE REGIONAL SPATIAL DIVERSITY OF HOUSING PRICES AND MARKET ACTIVITY – EVIDENCE FROM POLAND

Radosław Cellmer[1]✉, Aneta Cichulska[2]✉, Mirosław Bełej[3]✉

[1] ORCID: 0000-0002-1096-8352
[2] ORCID: 0000-0001-6627-5259
[3] ORCID: 0000-0001-8650-6990
[1,2,3] University of Warmia and Mazury in Olsztyn
Prawochenskiego street 15, 10-720 Olsztyn, **Poland**

## ABSTRACT

The aim of this study is to identify the factors that significantly determine the regional spatial differentiation of housing prices as well as housing market activity in Poland. The present research makes the assumption that average housing prices and market activity (number of transactions) are regionally shaped by economic, social, infrastructural and environmental conditions which can be described as a set of diagnostic features ascribed to a given area, constituting a statistical unit. Furthermore, it is assumed that individual effects may appear, being tied to the idiosyncrasies and significance of the given area. The time horizon of the research is 2008–2018. Based on data sourced from the Central Statistical Office a panel data was prepared for each of 380 Polish districts (poviats). Next, parameters were estimated for a single-factor panel model, as well as a two-factor model in which the constant term is different for different time periods and different units. This resulted in a model encompassing both average price determinants, and individual effects which reflect certain regularities of their spatial distribution. Moreover, the research will result in a set of cartograms made with Geographic Information System tools, depicting the random effects resulting from estimates of panel models using the Nerlove and Swamy-Arora transformations.

**Keywords:** spatial diversity, spatial autocorrelation, panel data modelling, geomodelling, housing market, geographical information system

## INTRODUCTION

Residential construction has been a booming business in Poland (2008–2018), reflected in the number of new residential units, building permits issued and building works started. The trading frequency on the real estate market is also increasing, specifically including residential housing. The increase in supply and market size in the real estate segment is caused by an increasing demand for housing units, as well as for built-up land and land intended for housing. That demand, in turn, is the result of the significant development of the national economy, including a dynamic growth in Gross Domestic Product (GDP), indicating the growing wealth of the population. A growth trend in average monthly earnings has held for a number of years, although accompanied by rising prices of goods and services

✉rcellmer@uwm.edu.pl, ✉aneta.cichulska@uwm.edu.pl, ✉miroslaw.belej@uwm.edu.pl

(food prices increased by 4.6%, home upkeep costs – by 1.6%, transport – by 3.8%). Deflation or low inflation enabled constant interest rates (the central bank's (NBP) reference rate has stood at a record low 1.5% for the last 3 years), thereby increasing the stability of the money market, and indirectly capital market and accessibility of mortgage loans (a nearly 10% growth in new housing loans in 2014–2017 and a nearly 8% growth in new housing loans value), and ultimately – the financial accessibility of real estate purchases by the public. Economic development coupled with continued improvements on the labour market (lowest unemployment rate in many years: 4.5% according to Labour Force Survey, 6.6% according to Central Statistical Office), are borne out in the enduring growth trend of the housing market.

The aim of the research is to identify a set of factors that significantly determine the regional spatial differentiation of housing prices as well as housing market activity in Poland. The poviat was adopted as the statistical unit, in accordance with the statistical nomenclature of territorial units adopted in Poland, developed on the basis of the European Nomenclature of Territorial Units for Statistics (NUTS). Poland has a three-stage administrative division, with 2477 municipalities, 380 poviats and 16 voivodeships. The choice of a poviat as the average level of division of the country is a compromise between too much detail (municipalities) and too much generality (voivodeships). For the purposes of this research we have assumed that the spatial differentiation of residential property prices is determined by regional levels of economic, social, infrastructural and environmental factors. Therefore, the effect of the research will only indicate significant regional determinants of the price heterogeneity of apartments at the level of 380 poviats. The research will use time series of regional economic, social, infrastructural and environmental data and average prices of apartments and market activity (number of transactions) from 2008–2018. The research covers a relatively calm period after the 2008 crisis and before the current "coronacrisis". The use of panel data in research allows for more extended modelling than in case of classical cross-sectional data, because they contain more variability and less collinearity between variables. Moreover, the research will result in a set of cartograms of, so called, random effects by district resulting from estimated models for housing prices with the use of Nerlove's and Swamy-Arora transformations. The research used a statistical analysis software (Statistica, R, Gretl) and Geographic Information System tools (QGIS, ArcGIS Pro).

The article consists of an introduction, three chapters and a conclusion. A review of the literature on spatial modelling of the factors determining price volatility in residential markets has been conducted in the first chapter. The second chapter presents the data description and brief description of methodology. The third chapter presents detailed results together with a discussion of the results obtained. The article closes with conclusions.

## LITERATURE REVIEW

The real estate sector is one of the principal foundations of the national economy, not only stimulating economic growth in a keyway, but also creating an environment favourable for dynamic development. The fundamental nature of this sector consists in its role as a repository of fixed assets, as it creates spatial conditions for the development of various other sectors of the economy and presents a very important way to allocate capital. The market economy creates a system in which most sectors are correlated to others, whereby a given sector is susceptible to changes outside of itself and may influence the conditions in other sectors. This complexity of links and processes is also present in the housing market, necessitating constant scrutiny of events arising in it, in order to predict future market conditions [Adams & Füss, 2010]. According to Urbanavičienė et al. [2009] the growth or decline of the housing sector considerably affects the general growth or decline of a country's economy. One of the fundamental tasks of the state and local authorities is fostering conditions conducive for satisfying the residential needs of the society. Housing market requires its efficiency in allocating

✉rcellmer@uwm.edu.pl, ✉aneta.cichulska@uwm.edu.pl, ✉miroslaw.belej@uwm.edu.pl

the existing resources and the possibilities of creating new supply adequate in terms of quality and quantity to the notified demand constitute the outcome of quite a numerous group of economic and non-economic factors. Economic changes on the macro, meso and local levels influence the situation in the residential market to different degrees. Doubtless, a vital role in shaping the real estate market is played by the financial sector [Beltratti & Morana, 2010], including WIBOR (Warsaw Interbank Offered Rate) interest rates, accessibility of mortgage loans, formal and legal factors, including the legislation in force and general principles shaping the market, as well as economic trends, such as GDP dynamics. A relatively large number of research studies on macroeconomic determinants of real estate prices can be observed [Wang et al., 2017, Panagiotidis & Printzis, 2016, Belke & Keil, 2018]. Over the years, the relationship between macroeconomic indicators and the dynamics of real estate prices has been studied. One of the earliest is an analysis of real estate prices in the USA based on cross-sectional data from 1977 to 1991 [Hendershott & Abraham, 1992]. The findings establishing a close relationship between prices and interest rates were confirmed in research by Himmelberg et al. [2005] and those presented by Iacoviello and Minetti [2003], the latter of which focused on the influence of financial liberalisation on the relationship between monetary policy and real estate prices in Finland, Sweden and Great Britain. In turn, Brunnermeier and Julliard [2008] found that the level of real estate prices is shaped by inflation, with its probable influence on future economic recession. Adams and Füss [2010] turned special attention to the dependence of housing demand on interest rates, specifically mortgage interest rates and the costs of real estate developers. Demand models presented by Attanasio et al. [2012], and Eichholtz and Lindenthal [2014] prove that the age structure and educational structure of a population are also of significant importance. Research with a similar focus was undertaken, among others, by Nguyen and Wang [2010] – focusing on the GDP indicator and the prices of goods and services, Meidani et al. [2011] – the GDP indicator, prices of goods and services, currency exchange rates, Lastrapes [2002] – monetary shocks, or Tsatsaronis and Zhu [2004] – GDP, inflation, interest rates, and Englund and Ioannides [1996] – GDP and interest rates.

The housing market is incontrovertibly local, and hence is primarily shaped by local conditions [Hendershott & Abraham, 1992] which include, among others, indicators characterising the labour market (unemployment rate, average wage, etc.), factors relating to market size influencing price volatility – the number of inhabitants and households, age structure, marriage rate, etc. Nevertheless, it is the factors characterising the labour market, with their ability to shape demand and reflect the aggregate societal wealth, which are pointed to as the main determining factors of the housing market and its price levels [Adams & Füss, 2010]. An example of the utility of these factors is the research conducted by Żelazowski [2011], which relied on regional indicators such as: unemployment rate, average wage, population, extant and newly built housing. On the macroeconomic side, the research tracked GDP per capita.

The sheer number of hypotheticals determining factors in residential real estate prices burdens an individual assessment of their impact with a high likelihood of estimation error. Current research makes increasing use of analytical methods, including models based on panel data. Such data encompasses a set of independent variables along with dependent variables from more than one period. In other words, they are produced by aggregating time series of indicators for particular units of analysis. Therefore, they exhibit characteristics of cross-sectional data from a single period, as well as of time series pertaining to a single variable over different periods. Panel models also reflect the defining impact of the time factor on the dependent variable using lagged dependent variables [Liu et al., 2018]. There has been little research done in Poland using panel models to identify determining factors in housing prices, especially spatial aspects (more about panel models in 3.1).

As it can be observed from the review of literature, the research presented in the article is consistent with the current trend of research on the housing market, which takes into consideration social and economic factors.

✉rcellmer@uwm.edu.pl, ✉aneta.cichulska@uwm.edu.pl, ✉miroslaw.belej@uwm.edu.pl

## DATA DESCRIPTION AND METHODOLOGY

### Data description

The analysis conducted was based on data concerning the housing property market in Poland. A district (poviat) was adopted as a statistical unit, in line with the nomenclature of statistical territorial units adopted for statistical purposes in Poland, prepared on the basis of the European Nomenclature of Territorial Units for Statistics (NUTS). The analysis of factors determining differences in average residential real estate prices was performed using transactional and statistical data for 380 districts in Poland from 2008 to 2018, which were made available by the Central Statistical Office (GUS) and its Local Data Bank (BDL) via the website [https://bdl.stat.gov.pl/BDL, date: 10.10.2020].

The initial intent was to analyse the most recent 11 years by quarter or half-year periods. Ultimately, due an incomplete of such data, we decided to analyse over time periods of one year, which was also due to a greater availability of other statistical data. The table below presents variables which were analysed as a select set of indicators of environmental, demographic and economic conditions. The use of most of these variables is borne out in the literature, while in other cases the deciding motivation was an intention to find new and under-researched correlations. A summary of information on the adopted variables is presented in Table 1. The dynamics of average housing prices (PRC) and the average

**Table 1.** Description of variables

| Symbol | Description | Unit |
|---|---|---|
| PRC | Average housing price* | PLN/m$^2$ |
| NB | Number of transactions | number/1000 population |
| POP | Population density | persons/km$^2$ |
| BRTH | Birthrate | persons/1000 population |
| MOB | Share of mobile working age population in total population | % |
| MIGR | Migration rate | persons/1000 population |
| SAL | Average salary | PLN/month |
| EMP | Registered unemployment rate | % |
| BSN | Entities entered into register of business entities (REGON) | number/1000 population |
| POL | Emission of dust pollution PM10 | t/km$^2$ |
| AV | Average usable floor area of a dwelling unit per person | m$^2$ |
| DWL | Completed new dwellings | units/1000 population |

* 1 PLN ≈ 0.22 EUR
*Source*: own research.

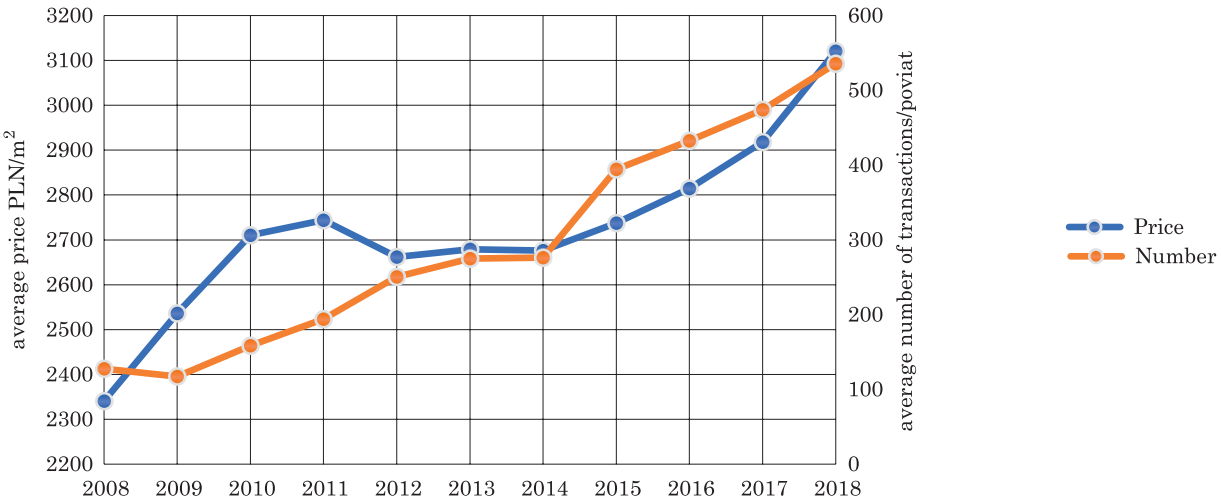


**Fig. 1.** Average price of 1 square metre of apartments and average number of sales in 2008–2018
*Source*: own research.

✉rcellmer@uwm.edu.pl, ✉aneta.cichulska@uwm.edu.pl, ✉miroslaw.belej@uwm.edu.pl

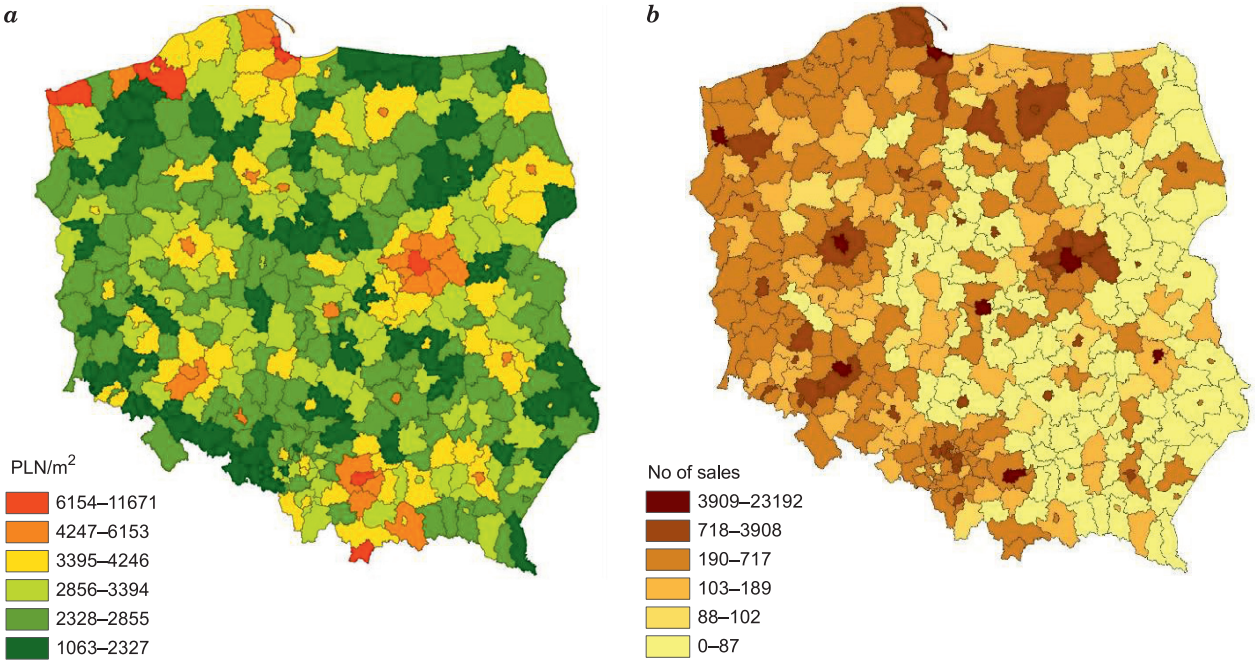


**Fig. 2.** Average housing price per m$^2$ (a) and the number of apartment sales (b) in 2018, by district
*Source*: own research.

number of transactions (NB) in Poland in the years 2008–2018 has been shown in Figure 1.

Since 2008, the average price per m$^2$ of apartment has been steadily rising (in 2017, the average selling price per m$^2$ was 10.4% higher from that of 2014), along with the average number of apartment sales in Polish districts in the recent years. As an example, Fig. 2 presents the spatial distribution of the PRC variable (average price per m$^2$ of apartment) and spatial distribution of the NB variable (number of transactions) on example on data from 2018.

Values concerning the average price of 1m$^2$ of an apartment and the number of apartment sales in 2018 divided by district in natural clusters highlight differences between metropolitan areas and typical areas with low investment.

## METHODOLOGY

Data encompassing cross-sectional and time dimensions, which are used in creating panel models contain both cross-sectional information (a description of a population in a single period), and time-series information (a description of a unit in many periods) [Mátyás & Sevestre, 2013]. Panel models relate their dependent variables not only to independent variables, but also to unmeasurable, constant factors individual for each unit, known as effects. Panel models are uniquely able to discern differences between periods for the same object, as well as between different objects in the same period. The model is formulated as below [Baltagi, 2008]:

$$y_{it} = \beta_0 + \sum_{k=1}^{k} \beta_{kit} x_{kit} + \alpha_i + \upsilon_t + \varepsilon_{it} \qquad (1)$$

where:

$y_{it}$ – dependent variable
$x_{kit}$ – independent (explanatory) variable
$\beta_0$ – constant term
$\beta_{kit}$ – structural parameter
$\alpha_i$ – individual effects (part of variation of variable $y$ characteristic for $i$-th object)
$\upsilon_t$ – period effects (part of variation of variable $y$ characteristic for period $t$)
$\varepsilon_{it}$ – random disturbance component
$i = 1, \ldots, N$ – sequence of objects

✉rcellmer@uwm.edu.pl, ✉aneta.cichulska@uwm.edu.pl, ✉miroslaw.belej@uwm.edu.pl

$t$ = 1, …, T – sequence of time periods
$k$ – independent variable number.

Panel data analysis is performed by the classical least squares estimation method, the fixed effects model, or the random effects model [Mátyás & Sevestre, 2013]. Estimation of panel data model with the ordinary least squares method (OLS) is employed if all objects are uniform and empirical data departs from hypothetical values of a dependent variable only as a result of the random component [Baltagi, 2008]. Such an estimation is permissible if there is no individual effect and the panel is a cross-sectional data set. A model based on OLS is formulated as follows [Wooldridge, 2002]:

$$y_{it} = x_{it}\beta + v_{it} \tag{2}$$

where:
$y_{it}$ – dependent variable
$x_{it}$ – independent variable (altogether, independent variables column vector)
$\beta$ – vector of N structural parameters
$v_{it}$ – aggregate random error, composed of the purely random component $\varepsilon_{it}$ and individual effect $u_i$ pertaining to the specific $i$-th unit of the panel.

Another method of panel data analysis is the panel model with fixed effects (FE – Fixed Effects Model), which eliminates fixed individual and period effects by averaging them over time (t index) [Wooldridge, 2002]. Its formulation is as follows:

$$y_{it} = \alpha_i + \sum_{k=1}^{k} \beta_{kit} x_{kit} + \varepsilon_{it} \tag{3}$$

where parameter $\alpha_i$ is taken as an individual characteristic of each unit, the estimation of which encompasses the impact of all characteristics not reflected in the observable variables vector. In the random effects panel model (RE), each unit is ascribed a random variable responsible for the individual effect in the given period. Ultimately, individual effects are not treated in the form of parameters, and the model assumes the following form:

$$y_{it} = \beta_0 + \sum_{k=1}^{k} \beta_{kit} x_{kit} + \upsilon_{it} \tag{4}$$

The model assumes that independent variables and random components, and their individual effects, are independent for all individuals. Consequently, assuming that constants are fixed results in the random component reflecting the discrepancies between objects and periods (one-way model). In the reverse situation, where the factor is variable relative to different periods and objects, the resulting model is two-factor (two-way model).

Estimation of the panel data model can make use the classical least squares method if the condition of estimator consistency for total error and pure random error is satisfied, and a correlation between an individual effect $u_i$ and explanatory variable $x_{it}$ does not exist [Baltagi, 2008]. The model with random effects assumes that the random component contains both individual and periodical effects. The Breusch-Pagan test shall be used to investigate whether the variance of random components for all observations is constant, based on statistics from a sample of the following form (Lagrange multiplier test):

$$LM = \frac{nt}{2(t-1)}\left[\frac{\sum_{i=1}^{n}(\sum_{t=1}^{t}\varepsilon_{it})^2}{\sum_{i=1}^{n}\sum_{t=1}^{t}\varepsilon_{it}^2} - 1\right]^2 \tag{5}$$

where $n$ is the number of observations, $t$ denotes the number of time units, while $\varepsilon_{it}$ are the residuals of the total regression model. With the truth of the null hypothesis, the above statistics has a chi-square distribution with one degree of freedom.

Including group and time effects in the panel models makes it necessary to use specific estimation methods. The use of the classical method of least squares encounters difficulties resulting from the fact that the assumptions of Gauss-Markov concerning the properties of a random component are not usually satisfied. Since random components in the RE model are correlated, in this situation, a generalized least squares estimator of structural parameters of the following form is used to estimate model parameters:

✉rcellmer@uwm.edu.pl, ✉aneta.cichulska@uwm.edu.pl, ✉miroslaw.belej@uwm.edu.pl

$$\hat{\beta}_{RE} = (X^T \Omega^{-1} X)^{-1} X^T \Omega^{-1} y \quad (6)$$

where $X$ is the matrix of explanatory variables, $y$ is a vector of response variables, while Ω denotes a reversible variance-covariance matrix of the total random error [Baltagi, 2008].

The decision to choose the appropriate model form (FE or RE) is made on the basis of Hausman's test, which consists in comparing the values of estimated parameters obtained with the use of both estimators. The null hypothesis $H_0$ then states that both estimators (FE and RE) are not biased, but in such a situation RE is more efficient, with the alternative hypothesis $H_1$ under which the FE estimator is not biased and the RE estimator is biased, or an error in the model specification occurred. The test statistic is defined by the following formula:

$$H = (\hat{\beta}_{RE} - \hat{\beta}_{FE})[var(\hat{\beta}_{RE}) - var(\hat{\beta}_{FE})]^{-1}(\hat{\beta}_{RE} - \hat{\beta}_{FE}) \quad (7)$$

and has a chi-square distribution with the number of degrees of freedom equal to the number of parameters estimated in both models.

Generalised least squares estimation (GLS) requires estimating the variance within each cross-sectional unit ($\sigma_\varepsilon^2$) and variance between units ($\sigma_v^2$), referred to simply as "within" and "between". There are several methods of estimating those values, whose detailed descriptions can be found in Baltagi [2008], Swamy and Arora [1972], and Nerlove [1971]. The Swamy and Arora method of estimation concerns the transformation of the model based on the following formula:

$$\bar{y}_i - y = \beta_1(\bar{x}_{1i} - \bar{x}_1) + \cdots + \beta_k(\bar{x}_{ki} - \bar{x}_k) + \bar{v}_i - \bar{v} \quad (8)$$

In a similar way, variables for individual periods of time are transformed. Alternative estimators are proposed by Nerlove [1971] with the use of following transformation:

$$y_{it}^* = \beta_1 x_{1it}^* + \cdots + \beta_k x_{kit}^* + v_{it}^* \quad (9)$$

where

$$z_{it}^* = z_{it} - \theta_1 \bar{z}_i - \theta_2 \bar{z}_t + \theta_3 \bar{z}_{it}$$

and

$$z_{it} \in \{y_{it}, x_{1it}, \ldots, x_{kit}, x_{kit}\}$$

and

$$\theta_1 = 1 - \frac{\sigma_\varepsilon}{\sqrt{T\sigma_\mu^2 + \sigma_\varepsilon^2}}, \quad \theta_2 = 1 - \frac{\sigma_\varepsilon}{\sqrt{N\sigma_\lambda^2 + \sigma_\varepsilon^2}},$$

$$\theta_3 = \theta_1 + \theta_2 + \frac{\sigma_\varepsilon}{\sqrt{T\sigma_\mu^2 + N\sigma_\lambda^2 + \sigma_\varepsilon^2}} - 1 \quad (10)$$

where $\mu_i$ is the individual-specific error component and $\lambda_t$ is period-specific error component.

Panel models are widely used for econometric analysis or for economic analysis, but also for studies of road safety, dependencies of demographic phenomena on economic factors, or environmental pollution and economic growth. The importance of panel models is also highlighted by Griliches and Intriligator [2007] and Hsiao [2003].

## RESULTS AND DISCUSSION

Panel modelling was preceded by an analysis of correlations between the adopted variables. High correlation between explanatory variables is an unfavourable phenomenon, although in the case of a relatively large number of variables it is difficult to avoid this phenomenon. The correlation matrix is presented in Table 2.

The variables most strongly correlated with the average price (PRC) are BSN and DWL. For the number of transactions, the variables most closely correlated with it are POP, SAL and BSN. A clear correlation also applies to the explained variables themselves. Some inconvenience may be the relatively high correlation between MIGR and DWL as well as between BSN and DWL variables. These variables are not directly related to each other in terms of content and at the same time they can bring important information to the model. Therefore, it was decided to include them in further analyzes. However, it should not significantly reduce the quality of the estimated models. The results of OLS modelling for the explained variables PRC and NB are presented in Table 3. It should be noted that this model was used only for preliminary dependency assessment.

✉rcellmer@uwm.edu.pl, ✉aneta.cichulska@uwm.edu.pl, ✉miroslaw.belej@uwm.edu.pl

**Table 2.** The correlation matrix

| | POP | BRTH | MOB | MIGR | SAL | EMP | BSN | POL | AV | DWL | PRC | NB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| POP | 1 | -0.073 | 0.010 | -0.101 | 0.269 | -0.288 | 0.355 | 0.458 | -0.100 | 0.133 | 0.381 | 0.475 |
| BRTH | -0.073 | 1 | 0.351 | 0.372 | -0.171 | -0.050 | 0.236 | -0.060 | -0.212 | 0.407 | 0.152 | -0.020 |
| MOB | 0.010 | 0.351 | 1 | 0.092 | -0.374 | 0.344 | 0.132 | 0.137 | -0.384 | 0.059 | -0.145 | -0.192 |
| MIGR | -0.101 | 0.372 | 0.092 | 1 | 0.052 | -0.273 | 0.361 | -0.140 | 0.467 | 0.677 | 0.318 | 0.085 |
| SAL | 0.269 | -0.171 | -0.374 | 0.052 | 1 | -0.467 | 0.214 | 0.141 | 0.374 | 0.211 | 0.420 | 0.497 |
| EMP | -0.288 | -0.050 | 0.344 | -0.273 | -0.467 | 1 | -0.173 | -0.120 | -0.456 | -0.314 | -0.400 | -0.265 |
| BSN | 0.355 | 0.236 | 0.132 | 0.361 | 0.214 | -0.173 | 1 | 0.121 | 0.221 | 0.530 | 0.602 | 0.491 |
| POL | 0.458 | -0.060 | 0.137 | -0.140 | 0.141 | -0.120 | 0.121 | 1 | -0.153 | -0.029 | 0.084 | 0.117 |
| AV | -0.100 | -0.212 | -0.384 | 0.467 | 0.374 | -0.456 | 0.221 | -0.153 | 1 | 0.398 | 0.370 | 0.133 |
| DWL | 0.133 | 0.407 | 0.059 | 0.677 | 0.211 | -0.314 | 0.530 | -0.029 | 0.398 | 1 | 0.559 | 0.374 |
| PRC | 0.381 | 0.152 | -0.145 | 0.318 | 0.420 | -0.400 | 0.602 | 0.084 | 0.370 | 0.559 | 1 | 0.489 |
| NB | 0.475 | -0.020 | -0.192 | 0.085 | 0.497 | -0.265 | 0.491 | 0.117 | 0.133 | 0.374 | 0.489 | 1 |

*Source*: own research.

**Table 3.** Results of OLS modelling

| | Dependent variable: PRC | | | Dependent variable: NB | | |
|---|---|---|---|---|---|---|
| Variable | coef. | std. error | p-value | coef. | std. error | p-value |
| intercept | 2686.400 | 508.718 | <0.001 | 11.096 | 1.193 | <0.001 |
| POP | 0.294 | 0.020 | <0.001 | 0.001 | <0.001 | <0.001 |
| BRTH | 36.832 | 5.580 | <0.001 | -8.083 | 0.013 | <0.001 |
| MOB | -54.882 | 7.205 | <0.001 | -0.202 | 0.017 | <0.001 |
| MIGR | -2.546 | 0.430 | <0.001 | -0.005 | 0.001 | <0.001 |
| SAL | 222.585 | 19.721 | <0.001 | 1.143 | 0.046 | <0.001 |
| EMP | -8.732 | 2.202 | <0.001 | 0.015 | 0.005 | 0.003 |
| BSN | 135.296 | 5.234 | <0.001 | 0.268 | 0.012 | <0.001 |
| POL | -20.231 | 6.145 | 0.001 | -0.113 | 0.014 | <0.001 |
| AV | 48.796 | 5.516 | <0.001 | -0.143 | 0.012 | <0.001 |
| DWL | 123.257 | 7.325 | <0.001 | 0.295 | 0.017 | <0.001 |
| | $R^2$ = 0.567, F (10, 4169) = 547.185 p-value<0.001 | | | $R^2$ = 0.527, F (10, 4169) = 464.950 p-value<0.001 | | |

*Source*: own research.

The overall results of the OLS estimation can only be considered as a preliminary analysis. However, it shows which variables can actually be treated as predictors of prices and number of transactions. In this case, all variables turned out to be statistically significant at a significance level (p-value) of less than 0.001. On the one hand, this may indicate that all explanatory variables significantly affect prices and the number of transactions, while on the other, a large number of degrees of freedom should be taken into account, which certainly affects the p-value assessment. Therefore, a certain distance should be approached to assess the quality of classic regression models built on the basis of cross-sectional data, especially when we use the ordinary least squares method for estimation. The results of OLS modeling may, however, constitute an important premise to conclude that the set of variables characterizing socio-demographic, eco-

✉rcellmer@uwm.edu.pl, ✉aneta.cichulska@uwm.edu.pl, ✉miroslaw.belej@uwm.edu.pl

nomic and environmental conditions has been selected in an appropriate way.

An appropriate panel model and a relevant method of estimation were selected on the basis of the Breusch-Pagan test and the Hausman test. The results of tests carried out for models with explanatory variables PRC and NB are presented in Table 4.

**Table 4.** Results of the Breusch-Pagan test and the Hausman test

| Test | dependent variable: PRC | dependent variable: NB |
|---|---|---|
| LM | 9325.100<br>p<0.001 | 3395.750<br>p<0.001 |
| H | 183.518<br>p<0.001 | 718.102<br>p<0.001 |

*Source*: own research.

A low p-value in the Breusch-Pagan test (LM) counts against the null hypothesis that pooled OLS model is adequate, in favour of the random effects alternative. Although the Hausman test indicates the FE model as consistent, the RE model was used because it provides the opportunity to analyze the spatial variation of random effects. Therefore, it was decided to estimate the model taking into account random effects. Both Swamy-Arora and Nerlove estimators were used in the construction of the panel models [Swamy & Arora, 1972, Nerlove, 1971]. Table 5 shows the parameters of the RE models (one way) for dependent variable PRC, i.e. average prices.

Comparison of information criteria indicates that a slightly better model is the one obtained as a result of the Swamy-Arora transformation. This is also indicated by the standard error of the residuals. In both models similar values of coefficients were obtained, with the biggest differences concerning the constant of the model. All variables turned out to be statistically significant. The variables MOB, MIGR, EMO and POL are average price destimulants, while the others have a positive impact on prices.

The signification of individual variables and their hierarchy can be determined either by a model using standardised values of the variables or simply by dividing the coefficient by the variable span. It turned out that by far the most important variable is the SAL variable, meaning the average salary, which may translate directly into demand resulting from the purchasing power. The least significant is the population density in the adopted statistical units.

**Table 5.** Model estimation results (GLS) for dependent variable PRC using Nerlove's and Swamy-Arora transformations

| | Nerlove transformation dependent variable: PRC | | | Swamy-Arora transformation dependent variable: PRC | | |
|---|---|---|---|---|---|---|
| Variable | coef. | std. error | p-value | coef. | std. error | p-value |
| intercept | 1431.230 | 549.749 | 0.009 | 1645.77 | 535.439 | 0.002 |
| POP | 0.255 | 0.021 | <0.001 | 0.267 | 0.021 | <0.001 |
| BRTH | 18.948 | 5.656 | <0.001 | 24.671 | 5.647 | <0.001 |
| MOB | -38.018 | 7.939 | <0.001 | -39.649 | 7.656 | <0.001 |
| MIGR | -2.929 | 0.416 | <0.001 | -2.816 | 0.421 | <0.001 |
| SAL | 336.082 | 22.338 | <0.001 | 289.983 | 21.281 | <0.001 |
| EMP | -21.510 | 2.344 | <0.001 | -17.634 | 2.304 | <0.001 |
| BSN | 145.850 | 5.522 | <0.001 | 143.360 | 5.434 | <0.001 |
| POL | -23.586 | 5.663 | <0.001 | -22.718 | 5.804 | <0.001 |
| AV | 46.277 | 5.616 | <0.001 | 46.174 | 5.593 | <0.001 |
| DWL | 114.463 | 7.151 | <0.001 | 117.559 | 7.210 | <0.001 |
| | LogLik: -33111.92<br>Std. error of residuals: 667.655<br>AIC: 66245.85<br>Schwarz: 66315.57 | | | LogLik: -33070<br>Std. error of residuals: 661.040<br>AIC: 66162.60<br>Schwarz: 66232.32 | | |

*Source*: own research.

✉rcellmer@uwm.edu.pl, ✉aneta.cichulska@uwm.edu.pl, ✉miroslaw.belej@uwm.edu.pl

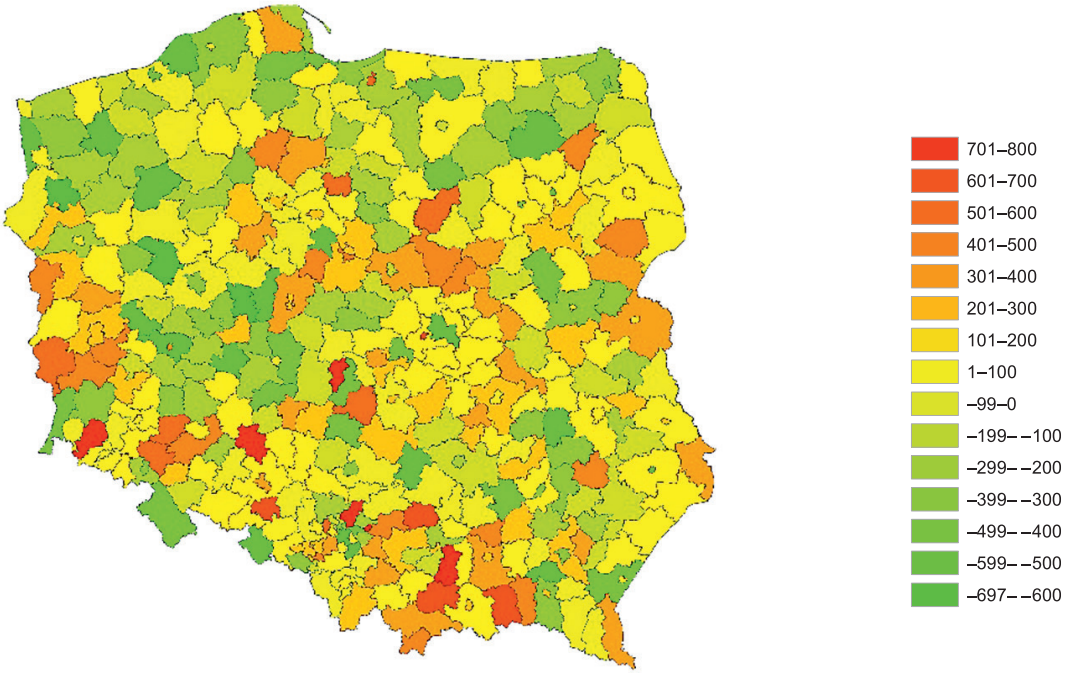


**Fig. 3.** Random effects by district resulting from estimated models for dependent variable PRC with the use of Nerlove's transformations
*Source*: own research.

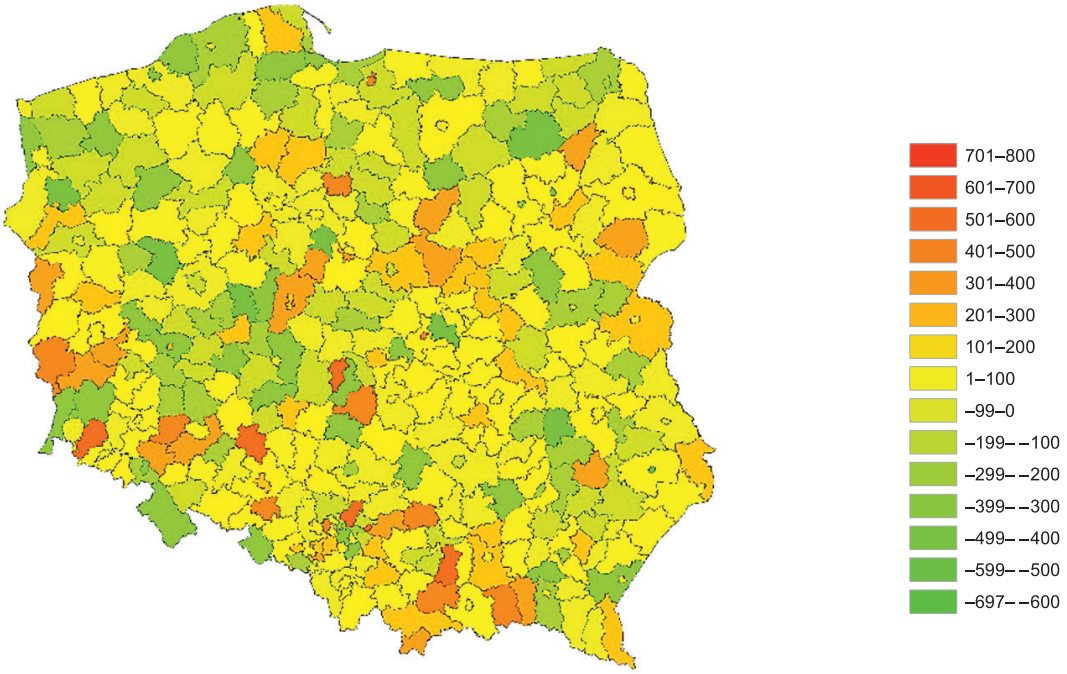


**Fig. 4.** Random effects by district resulting from estimated models for dependent variable PRC with the use of Swamy-Arora transformations.
*Source*: own research.

✉rcellmer@uwm.edu.pl, ✉aneta.cichulska@uwm.edu.pl, ✉miroslaw.belej@uwm.edu.pl

Figures 3 and 4 present the distribution of random effects in individual districts for both models.

The distribution of random effects in both models looks similar. In the Nerlove transformation model, these effects are slightly greater in terms of absolute value. The highest positive values are found mainly in the southern and south-western part of Poland. This may indicate a large market potential, resulting from the relatively high industrialization of these regions, as well as their location near the main communication routes. While in the case of positive random effects it is difficult to observe spatial autocorrelation, in the case of negative effects they are concentrated in the northern and central-western part of Poland.

The modelling results for the dependent variable NB, i.e. the number of transactions, are presented in Table 6.

The comparative analysis of the presented models shows that the model in which the Swammy-Arora transformation was used is much better than the model in which the Nerlove transformation was used. This is indicated by both the value of the logarithm of the credibility function and the information criteria (AIC, Schwarz). This is indicated by both the value of the logarithm of the likehood function and the information criteria (AIC, Schwarz). Similar conclusions can be drawn from the standard error of the residuals. Among the significant differences one can also indicate the sign of the coefficient with the variable AV (average usable floor area of a dwelling unit per person). This variable is a stimulant in the Nerlove transformation model and a destimulant in the second one. Both models indicate that share of mobile working age population in total population and emission of dust pollution are factors that negatively affect the number of transactions. The other variables are stimulants. However, it does not have to mean cause-effect relationships (eg. unemployment rate).

All variables turned out to be statistically significant. The comparison of the results obtained with the range of values of the variables indicates that, similarly as in the case of average prices, the biggest influence on the market activity has the average monthly salary (variable SAL). Figures 5 and 6 present the distribution of random effects concerning the number of transactions in particular districts for both models.

**Table 6.** Model estimation results (GLS) for dependent variable NB using Nerlove's and Swamy-Arora transformations

| | Nerlove transformation dependent variable: NB | | | Swamy-Arora transformation dependent variable: NB | | |
|---|---|---|---|---|---|---|
| Variable | coef. | std. error | p-value | coef. | std. error | p-value |
| intercept | 27.830 | 1.402 | <0.001 | 26.679 | 1.325 | <0.001 |
| POP | 0.001 | <0.001 | <0.001 | 0.001 | <0.001 | <0.001 |
| BRTH | 0.095 | 0.020 | <0.001 | 0.055 | 0.017 | 0.001 |
| MOB | -0.533 | 0.019 | <0.001 | -0.469 | 0.018 | <0.001 |
| MIGR | 0.011 | 0.002 | <0.001 | 0.005 | 0.001 | <0.001 |
| SAL | 0.476 | 0.087 | <0.001 | 1.042 | 0.064 | <0.001 |
| EMP | 0.047 | 0.006 | <0.001 | 0.050 | 0.006 | <0.001 |
| BSN | 0.046 | 0.014 | <0.001 | 0.109 | 0.014 | <0.001 |
| POL | -0.131 | 0.021 | <0.001 | -0.115 | 0.019 | <0.001 |
| AV | 0.167 | 0.026 | <0.001 | -0.042 | 0.019 | 0.026 |
| DWL | 0.182 | 0.016 | <0.001 | 0.201 | 0.016 | <0.001 |
| | LogLik: -8726.190<br>Std. error of residuals: 1.954<br>AIC: 17474.38<br>Schwarz: 17544.10 | | | LogLik: -8059.987<br>Std. error of residuals: 1.666<br>AIC: 16141.97<br>Schwarz: 16211.69 | | |

*Source*: own research.

✉rcellmer@uwm.edu.pl, ✉aneta.cichulska@uwm.edu.pl, ✉miroslaw.belej@uwm.edu.pl

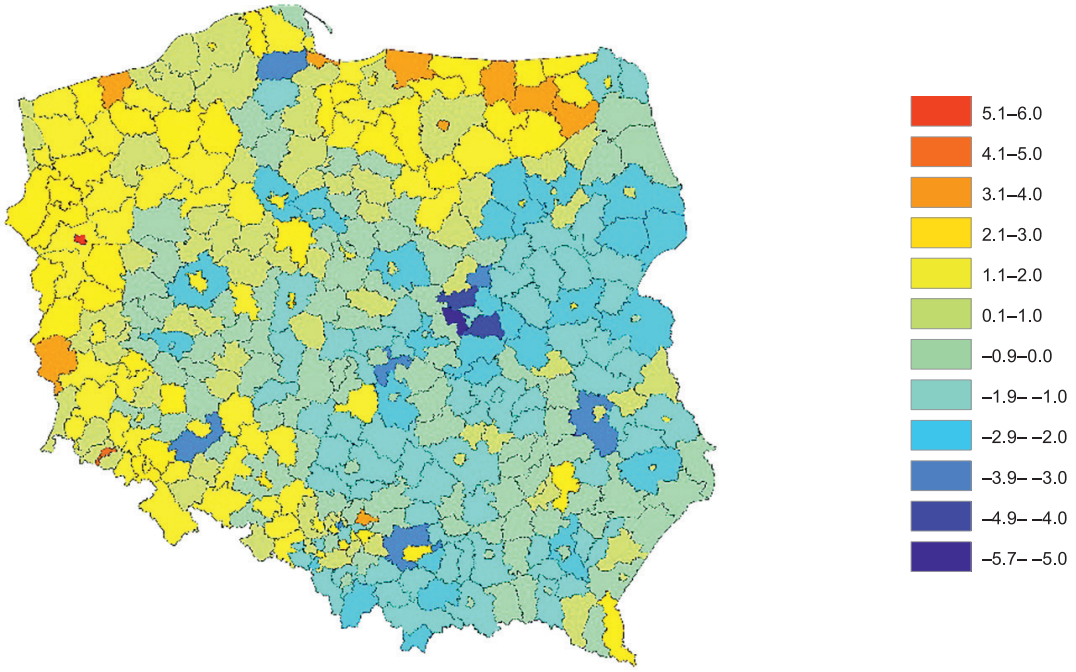


**Fig. 5.** Random effects by district resulting from estimated models for dependent variable NB with the use of Nerlove's transformations
*Source*: own research.

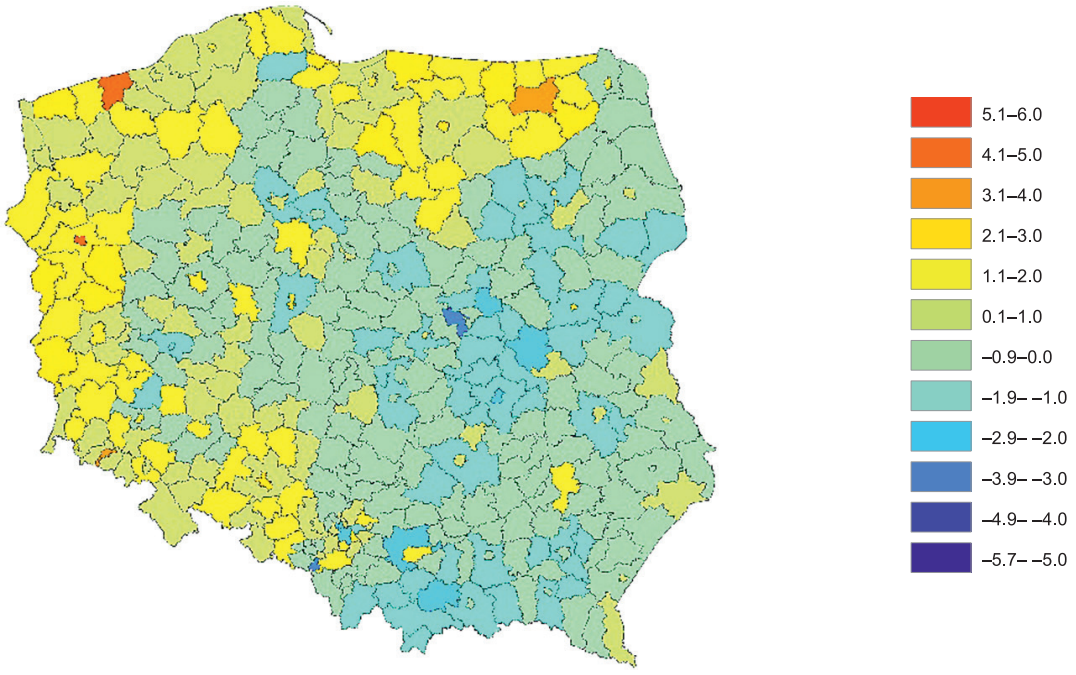


Fig. 6. Random effects by district resulting from estimated models for dependent variable NB with the use of Swamy-Arora transformations.
*Source*: own research.

✉rcellmer@uwm.edu.pl, ✉aneta.cichulska@uwm.edu.pl, ✉miroslaw.belej@uwm.edu.pl

The spatial distribution of random effects in both transformations is similar. Negative random effects are concentrated mainly in the eastern and south-eastern part of Poland. This means that there may be additional factors, not included in the model, influencing market activity in these areas. The spatial distribution of random effects also indicates a fairly clear spatial autocorrelation and the presence of clusters dominated by positive (yellow in Figures 5 and 6) and negative values (blue in Figures 5 and 6).

## CONCLUSIONS

The panel model employed in the analysis of cross-sectional time series data encompassing 380 spatial units (districts), in the context of 2 dependent variables and 10 independent variables, in a 11-year time series showed the utility of this kind of model for analysing the relationship between real estate prices and economic, social and spatial conditions. The process identified the set of variables which significantly impact both the housing unit price and the number of real estate transactions. Judging by the quality of the models produced, the present study indicates that all adopted variables turned out to be statistically significant with a significance level of less than 0.01. This means that the adopted set of variables characterizing socio-demographic, economic and environmental conditions to a large extent explains both price formation processes and the activity of the housing market. The variable that has the strongest impact on average prices and the number of transactions is the average monthly salary. It is also worth noting the significant impact of air quality expressed by the variable characterizing the emission of pollutants. Spatial distribution of random effects determined on the basis of average price models indicates medium spatial dependence. In models using the number of transactions as a variable explained by the spatial distribution of random effects points to clear clusters with low and high values.

The occurrence of spatial autocorrelation also indicates the possibility of continuing the research with the use of panel models taking into account spatial dependencies (spatial panel models). Although the presented models largely explain the studied phenomena, it should be noted that the dependent variables may also be affected by other factors not included in the model.

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✉rcellmer@uwm.edu.pl, ✉aneta.cichulska@uwm.edu.pl, ✉miroslaw.belej@uwm.edu.pl

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✉rcellmer@uwm.edu.pl, ✉aneta.cichulska@uwm.edu.pl, ✉miroslaw.belej@uwm.edu.pl

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# CO-PRODUCTION OF URBAN KNOWLEDGE: CONTEXT APPROACH FOR EFFECTIVE AND EFFICIENT GOVERNANCE OF CITIES

George M. Onyango[1]✉, Mirek Dymitrow[2]✉, Michael Oloko[3]✉, Stephen G. Agong[4]✉

[1] ORCID: 0000-0002-9349-899X
[2] ORCID: 0000-0002-6936-342X
[1] Maseno University
P.O. Box 333, Maseno, **Kenya**
[2] Lund University
Sölvegatan 10, SE-223 62 Lund, **Sweden**
University of Gothenburg
Viktoriagatan 13, SE-411 25 Gothenburg, **Sweden**
[3,4] Jaramogi Oginga Odinga University of Science and Technology
Bondo (Main) Campus, P.O. Box 210-40601, Bondo, **Kenya**

## ABSTRACT

Effective and efficient governance is driven by policies that prevail in urban contexts. Policies are usually the result of knowledge co-production, but the efficacy of the process of translating knowledge into policy is still not well defined in the Kenyan context. One example of this is the city of Kisumu, which has been the focus of knowledge co-production by researchers from Kisumu and Gothenburg, and when there is active involvement of academics, policymakers, and the private sector. The creation of networks and platforms has been instrumental in knowledge production and has allowed for multi-level co-production facilitating the governance of the city at different spatial and administrative levels. Understanding of the different contexts that have been key in the knowledge production, in turn, is important for the process of determining how these have been the drivers of urban knowledge for governance in Kisumu.

**Keywords:** co-production, urban knowledge, triple helix model, Kisumu, Kenya

## INTRODUCTION

Constant societal transformations put pressure on effective urban governance. Factors such as depopulation, resource depletion, pandemics, economic stagnation, wars, deteriorating service provision or autonomy erosion all exert a negative impact on urban settlements, both spatially and temporally [Krzysztofik et al., 2015]. As a result of this, urban governance is going through a metamorphosis with a greater inclusion of citizenry. This paradigm manifests through systems and networks about knowledge coproduction with a focus on how this can enhance governance. Experiences of players from two cities – Gothenburg, Sweden in the Global North, and Kisumu, Kenya in the Global South – provide an opportunity for interrogating this paradigm. Over the last decade researchers from the academia,

✉ georgemarkonyango@yahoo.com, ✉mirek.dymitrow@keg.lu.se, ✉moloko@jooust.ke, ✉sgagong@jooust.ac.ke

private practice and policy makers have been engaging in research activities in Kisumu. Experiences in coproduction of urban knowledge has been developed and created a unique demonstration of the effects and benefits that accrue to the city. The process and experiences are discussed through three concepts: knowledge production, coproduction, and urban governance. Kisumu City provides the context for the presentation. How these concepts interplay is assessed to allow for appreciation of knowledge and governance in cities in the Global South.

## 1. BACKGROUND

### 1.1. Knowledge production

Lately, social scientists have been attending to the relations and experiences "shaped by a focus not only on the world order, but on how the world is evolving through an engagement with our interventions in, and responses to, the world" [Greenhough, 2010, p. 42]. Mindful that "social practices exact citational force because of the spaces in which they are embedded" [Thrift, 2000, p. 677], calls for new forms of humanism have awoken, one "that avoids the rationalist and self-righteous claims of the old ones but maintains elements of the experiential dimension of social life" [Simonsen, 2013, p. 10]. With that mindset, we are entering a new dimension of knowledge-making, where comprehension of lived experience, notions of agency, politics, and participation for *knowledge production* become increasingly relevant on how we understand the world from a range of theoretical, methodological and empirical considerations [Dymitrow, 2017]. Knowledge production, as outlined by STS-scholars, is mainly a matter of *praxis*, with the implication that although philosophically contradicting knowledge claims cannot be achieved, in praxis it is possible [cf. Collins & Evans, 2008]. Consequently, there is greater emphasis on the process of coproduction. Moreover, knowledge about sustainable urban governance is not just theories about indications and contraindications, but also a specific language that needs mastering to take sustainability work forward. In other words, what knowledge receives recognition depends on the proficiency of its articulation in official documents and, accordingly, its subsequent impact claims [Brauer et al., 2019].

### 1.2. Coproduction

While knowledge production may denote any form of new knowledge emerging through social and cultural interaction, the concept is commonly associated with the related activities clustered in a higher education institution, a research centre or any enterprise professionally creating new knowledge (Latour's "centres of calculation"). The main characteristic of a centre of calculation though is its ability to legitimize knowledge, not because it is better but simply because it has passed through its institutional rites. The obvious crux is that formalization is not necessarily the same as quality, although formalization very often is interpreted as an indicator of quality.

To counterbalance hierarchical ways of producing knowledge, *co-production* refers to an arrangement where citizens produce, at least in part, the services they use themselves. Co-producing citizens do not rely on financial or other inputs from public agencies to develop a new or improve an existing service [Schlappa & Ramsden, 2000]; this is more so in policy frameworks. Policy networks facilitate the coordination of public and private interests and resources and enhance efficiency in the implementation of public policy [Katsamunska, 2016].

When cities are viewed as knowledge societies, it is about capabilities to identify, produce, process, transform, disseminate, and use information to build and apply knowledge for human development. Such capabilities require an empowering social vision that encompasses plurality, inclusion, solidarity, and participation [Arsovski et al., 2018]. In order to plan and manage a city, a novel way is through knowledge engineering which require the design and implementation of a knowledge infrastructure [Laurini, 2017]. Yigitcanlar et al. [2008] state that 'knowledge-based urban development' (KBUD) has become an important mechanism for the development of knowledge cities. KBUD is extensively seen as a potentially

✉ georgemarkonyango@yahoo.com, ✉mirek.dymitrow@keg.lu.se, ✉moloko@jooust.ke, ✉sgagong@jooust.ac.ke

beneficial set of instruments, which may improve the welfare and competitiveness of cities.

Knowledge coproduction in cities is thus geared towards positioning cities as knowledge societies where the knowledge based urban development is achieved through a process of involvement of key players in the production of the said knowledge [Yigitcanlar et al., 2008]. It is against this backdrop that this paper examines the concept of urban governance.

### 1.3. Urban governance

Virtudes [2016] posits that governance is the exchange of information and control in a process where the local government and population are both the transmitter and the receiver of information. In Kenya, this process in the devolved structure is anchored in the institutions set up by the County Government Act. In the Weberian model, public administration implied governance by law, simply because society was governed through the imposition of law and other forms of regulation. Other institutions of the state were also included in a hierarchical system of command and control. Sub-national government has some degree of autonomy, but the state never surrendered its legal authority over these institutions [Katsamunska, 2016]. The "Global Village" and non-standardization of services has critics considering the model inappropriate.

Governance builds on a consensual image of the community and the positive involvement of its members in collective matters. It is believed that the state or local government is too big and too bureaucratic to deal with these issues and hence the multiplicity of players involved to enhance governance [Hendriks, 2013].

### 1.4. Research Objective

The objective of this study is to assess coproduction of knowledge for urban governance within the context of Kisumu. The City of Kisumu is used as a case study which allows for demonstration of effective and efficient governance using coproduction approaches.

A number of studies have been done on coproduction of urban knowledge. However, this paper addresses ways in which this knowledge coproduction can be used in supporting effective and efficient governance. Kisumu is a typical medium city in Sub-Saharan Africa and provides a practical case study for assessing these concepts within an urban environment.

## 2. METHOD

This study utilizes *framework analysis* as its principal method. Framework analysis is a tool for analyzing textual material to create an audit trail between the original material and the final conclusions [Dymitrow & Brauer, 2017]. It is used to organize and manage research by means of summarization, resulting in a robust yet flexible matrix output which allows for analyzing data both by case and theme. By borrowing principles from different epistemological traditions, framework analysis works independently of theoretical approach as long as sufficient preliminary thinking about the studied material has been done. The method is most effective for analysis of primary data, such as in systematic reviews of published texts, where it can be used to test a theory or to develop it [cf. Ritchie & Lewis, 2003, Smith & Firth, 2011, Srivastava & Thomson, 2009, Ward et al., 2013]. In order to present a comprehensive picture, the analyzed data material includes scientific publications, Acts of Parliaments and policy documents.

Moreover, experiences from the researchers, policy makers and practitioners were collected through *interviews* with key informants and consolidated to generate the general thematic areas. Data obtained during these processes was processed using the method of *content analysis* by putting issues based on differences and similarities. Documentation was reviewed to triangulate these findings and shared in roundtable meetings to create consensus. Examples are drawn from activities of researchers from Kisumu and Gothenburg in the last decade, which – though limited in scope – provide an opportunity to present a perspective on urban knowledge coproduction.

✉ georgemarkonyango@yahoo.com, ✉mirek.dymitrow@keg.lu.se, ✉moloko@jooust.ke, ✉sgagong@jooust.ac.ke

The first section presents the case study city: Kisumu. It enables the reader to contextualize the discussions in the subsequent sections. The second section of the discussion addresses knowledge mapping. We look at the broad categories of knowledge that has been coproduced in Kisumu as a result of the interventions of the Kisumu Local Interaction Platform. The section gives an insight onto the extent that knowledge can be coproduced at various levels. The next section looks at the context of coproduction where we identify central actors and examine knowledge-power relations in the platform and how these impact on the direction and scope of urban knowledge that is coproduced. Finally, we address governance issues exploring institutional cultures and systems that would facilitate knowledge coproduction based on the context of Kisumu within the confines of the Kisumu Local Interaction Platform.

## 3. FINDINGS AND DISCUSSIONS

### 3.1. Case Study Town: Kisumu City

Kisumu is used to show case the concepts of this study. Kisumu is the third largest urban centre in Kenya, located on the shore of Lake Victoria. The City, with a population of over 500,000, is the hub of innovation in the greater Western Kenya. A number of research and development interventions have been undertaken in Kisumu with a lot of knowledge being generated and experimentations on governance being piloted here.

Urban knowledge co-production has been piloted in Kisumu allowing for demonstration of how urban governance can draw from coproduction. The city has been a focus of knowledge co-production by researchers from local and external universities with active involvement of academicians, policy makers and the private sector, especially civil society organizations. The knowledge so produced has been key in governance of the city at different spatial and administrative levels.

Understanding of the different contexts that have been key in the knowledge production are important in the process of determining how these have been drivers of governance in Kisumu. Effective and efficient governance is driven by the policies that prevails in the city. The policies have been the result of knowledge co-production but the efficacy of the process of translating knowledge into policy is still not well defined.

The governance of Kisumu City has undergone transformation from the system of local government in the old dispensation to the new system after the promulgation of the new Constitution 2010. The old system had a Municipal Council made up of members elected by the citizenry. The Council then formed committees to run the various functions of the City Government. The Town Clerk who was the Chief Executive of the Council was a member of the Kisumu Local Interaction Platform with the Director of City Planning and Chairman of the Town Planning Committee also being members [Onyango & Obera, 2014]. In the new dispensation the City is governed by a board comprising of not more than 11 members; comprising, 6 members appointed by the County Executive Committee and 5 members nominated by the Institution of Surveyors of Kenya (ISK), Kenya Institute of Planners (KIP), Architectural Association of Kenya (AAK), Law Society of Kenya (LSK), an association of urban areas and cities, Institute of Certified Public Accountants of Kenya (ICPAK) and the business community [Urban Areas and Cities Act, 2011].

These changes in governance structures have had a direct impact on knowledge co-production in both form and content. The networks and platforms formed, and interactions created, have been shaped by the ways and means of communication in the different structures.

Mistra Urban Futures (MUF) centre, a sustainability research and practice centre, headquartered in Gothenburg, Sweden has established Local Interaction Platforms (LIPs) which operate as Urban Living Lab (ULL). Urban Living Labs (ULL) is an emergent concept based on an approach based on the 'quadruple helix', namely collaboration among public authorities, firms, research organisations and people [Wirth et al., 2018].

✉ georgemarkonyango@yahoo.com, ✉mirek.dymitrow@keg.lu.se, ✉moloko@jooust.ke, ✉sgagong@jooust.ac.ke

LIPs were established in Gothenburg (Sweden), Greater Manchester (UK), Kisumu (Kenya) and Cape Town (South Africa) The network of LIPs are the primary organisational mechanism for delivering the vision and mission of MUF. The LIPs provide a bridge between different stakeholders and recombine diverse forms of expertise to address urban challenges [Perry et al., 2018]. In Kisumu, the LIP has been engaged in surveys, events and service experiments carried out by students, academicians, practitioners, and private sector actors and often there is partnership with other LIPS in Gothenburg and Cape Town. LIPs provide a meeting arena where local, regional, and state representatives can interact with academic researchers, outside their home-organisation restrictions.

Membership of Kisumu Local Interaction Platform (KLIP) is based on experiences from former networks in the city. The membership of KLIP included academia from Maseno University and Jaramogi Oginga Odinga University of Science and Technology, policy makers who are Directors from the County Government involved in planning and the environment and the City Manager. Private sector members include the civil society.

Nesti [2017] notes that there are three key problems that ULL addresses namely:

a. the first problem concerns maintaining motivation to collaborate high among volunteers;
b. the second problem concerns the governance of co-production; and
c. the last problem relates to the sustainability of ULLs.

While the concept of living labs is not clearly defined, there is a consensus that citizen and user involvement is central and that innovation takes place as a result of bringing together complementary urban knowledge, skills and resources in real-life experimentation [Lund, 2018]. KLIP should therefore be understood in this context.

## 3.2. Urban Knowledge Mapping

The concept of co-production in urban development is by no means clear and well defined. It has multiple roots: partly in the social innovation literature; partly in the private sector innovation literature; and partly in the 'communicative turn' in planning theory [Lund, 2018]. Richardson et al. [2018] state that coproduction implies multiple forms of expertise and knowledge, bringing new or additional perspectives as befits complex wicked policy issues. Perry [2018] argues that co-production of urban knowledge is a response to procedural and epistemic deficiencies. This includes, on the one hand, recognition that existing forms of urban governance and elite decision-making processes are insufficient to address contemporary multiple-problem challenges and, on the other, that implementable solutions in practice cannot develop without drawing on distributed forms of expertise beyond the usual technocratic fix. Kisumu City has had various types of decision-making governance systems, i.e. the elected Municipal Council and appointed Municipal Commission and eventually the City Board. Each system has made efforts at creating urban knowledge to respond to the city growth and development. Inclusion strategies have had various levels of success, but what is outstanding about Kisumu is the constant attempt at enjoining the citizenry in participation for planning and implementation.

Sometimes we have parallel production, when civil society organisations, end up "doing it alone" because of weak relations with public authorities. They work in parallel to public authorities while lip service is paid to "consultation" and "participation" and relationships are often solely focused on funding [Schlappa et al., 2000]. This arrangement must therefore not be confused with co-production. Evidence exists in Kisumu of co-production through such processes and have been documented. The City Development Strategy and the "Kisumu We Want" public consultations in Kisumu largely revealed an urban community ready to experience positive transformation in the socio-economic setting with optimal exploitation and astute management of their natural resources [UN Habitat, 2004].

Knowledge–action systems are the networks of actors, their visions and expectations of the future, and the practices and dynamics underlying the production of knowledge to advance specific

✉ georgemarkonyango@yahoo.com, ✉mirek.dymitrow@keg.lu.se, ✉moloko@jooust.ke, ✉sgagong@jooust.ac.ke

policies, decisions, and actions related to sustainability Muñoz-Erickson [2014]. The level of continuity of actors in Kisumu on coproduction has led to some level of consistency in the knowledge created. When we look at documentation of these knowledge there is a thread of "the Kisumu we want" which includes use of the Lake Victoria, upgrading of informal settlements, enhancing productivity in the informal sector, public transport and public space. This scenario has been well captured by Frantzeskaki [2016] who notes that there are two types of conditions that influence the way knowledge can be co-created: a) conditions that relate to the way knowledge co-production processes are set-up and b) conditions that relate to the expected value or benefit that the co-produced knowledge will bring across society, policy and practice. These two conditions have mainly influenced how co-produced knowledge is presented and leveraged to achieve acceptance in the decision making and implementation process. This commonality across African and European city-regions points to the wider relevance of the "platform" concept for urban decision-making in the context of increased uncertainty and complexity and the demand for transdisciplinary knowledge production [May & Perry, 2017]. The Kisumu Local Interaction Platform (KLIP) has consolidated its position and has been at the forefront of urban knowledge coproduction. These focus on various aspects of the city's knowledge system. As a process of knowledge mapping, we take a look at some of these knowledge coproduction outputs.

### 3.2.1. Co-planning of policy

a. County Government adoption of policy framework for Market Waste Management: The involvement of the County Government in the Market Place research as researchers and stakeholders has seen a shift in policy formulation at the County Government level. In a number of activities, the County Executive Members in charge of Tourism, Environment and Trade have engaged with the KLIP team as key participants in workshops and conferences and in launching of activities. They have eventually adopted they key lessons from the research to inform policy and intervention strategies. The most prominent is the waste separation model which has now been implemented in the whole CBD with bins for waste separation. The next phase is scheduled for markets. Kibuye Market Management based in Kibuye Market has also been given a Temporary Occupation License which gives them authority to use space at the market for research demonstration and knowledge cogeneration. This is an activity that is supported by KLIP. The City of Kisumu has also since signed a Memorandum of Understanding with the School of Planning and Architecture, Maseno University to work together which will include translation of the research into practice.
b. Kisumu Action Team: Having developed the City Development Strategy (CDS) to guide the city's development, the stakeholders involved in the CDS process realized that the CDS and its participatory process were a departure from the normal top-down planning and development procedures used by the Municipal Council of Kisumu. To support the City in mobilizing resources for implementation and monitoring the stakeholders' forum was transformed into the Kisumu Action Team (KAT). KAT membership included:
   – the mayor;
   – two Municipal Council of Kisumu representatives;
   – three representatives from the Informal sector;
   – three representatives from the CSOs;
   – five representatives from the private sector;
   – a representative from the faith-based organizations;
   – four representatives from government departments; and
   – three representatives from academia.

KAT was actively engaged in development of policy and monitoring interventions led by the City Council for a couple of years up to the year 2010 when the new Constitution of Kenya [2010] ushered in a new governance system.

✉ georgemarkonyango@yahoo.com, ✉mirek.dymitrow@keg.lu.se, ✉moloko@jooust.ke, ✉sgagong@jooust.ac.ke

### 3.2.2. Co-prioritization of services – Participatory budgeting

Active participation of KLIP membership in the County planning and project prioritization culminates in the County Budgeting process. Integral participation of key Directors from City Management, Town Clerk and Mayor in meetings and workshops organized by KLIP engage in the discussion processes that eventually lead to prioritization of services which eventually get included in the County Budget.

The quality of participation will depend a great deal on how participation is organized, how citizens are asked to express their views, and how they are presented with information about resource limits and trade-offs [Kenya School of Government, 2015]. By operating as a platform KLIP provides an all-inclusive non-formal networking that allows for interaction between the policy makers and the citizenry. It thus becomes a platform to engage the public as the City management presents the budget for citizen participation.

### 3.2.3. Co-design of services

a. Market Waste Management: Waste separation project was initiated in Manyatta Peace Market. This project aimed at building capacity of neighbourhood associations working with local markets to manage solid waste. The project utilizes the principle of 3Rs (Reduce, Reuse, Recycle). Relatively small proportion of waste is therefore transported to dump site. This project supports urban agriculture, cottage industries as well as creating employment for the youth.

The waste separation project (see Fig. 1) has brought the Manyatta resident association to engage in solid waste management hence healthy environment and business opportunities. The prototypes that were developed, which include fertilizer production, attracted immense interest and the team has got the buy in of the County Government Environment Ministry. The project was then upscaled to Kibuye Market where it was adopted by the County Government. The project is Market Community Driven. It is run by Kibuye Market Waste Management CBO representing all traders from all sectors in the market. The City Market Master compliments the traders' efforts by proving local transport for the fertilizer production. The fertilizer has since got certification form Kenya Bureau of Standards and Kenya Agricultural Research Institute. In the trial in run in 2015 the CBO produced 150 bags of 50 kg each which were sold at USD 25 each. Integration of SWM in the market operations is a coproduction process that has created a great amount of learning.

Dunga Craft Market Places: Energized Crafted Marketplace is a comprehensive integrated program that aims at socio-economically empowering the communities living along the beaches of Lake Victoria. The program is a collaboration of, KLIP and Zingira CBO who took the lead role of implementing the whole process. The training program focused on the empowerment of women and youth, environment protection and conservation, gender and rights-based approach businesses that would create employment and defeat poverty. The training design involved the community from the beginning through social mapping and needs assessment to ensure that ownership of outcomes is credited to the community. This was achieved through a SWOT analysis. After which Twenty (20) participants were nominated to attend the entrepreneurship/ Craft development training.

The training approach and methodology majorly focused on three main elements to ensure success: *People*, *Process* and *Deliverables*. Trainers used participative methodology in which all participants were involved. The training was broadly concerned with development of professional, technical skills and ethical and moral behaviour by conveying the unique meaning, obligation, and virtue of business ethics, leadership and morality in society or the acquisition of values, dispositions, and skills appropriate to the society. A broad range of methods of teaching and training techniques that were participant-centred were used.

✉ georgemarkonyango@yahoo.com, ✉mirek.dymitrow@keg.lu.se, ✉moloko@jooust.ke, ✉sgagong@jooust.ac.ke


**Fig. 1.** Waste Separation in Kibuye Market
*Source*: authors' own photographs.

The training brought into focus the need for good partnership with leaders to improve the local infrastructure and enable easy access to markets. The participants requested that local leaders should be invited to attend training sessions so that they can be able to understand their role in societal development and in promoting the utilization of water hyacinth in L. Victoria.

## 3.3. Context of Urban Knowledge Coproduction

The new Constitution of Kenya [2010] introduced County Governments, with Kisumu City falling under the County Government of Kisumu. The position of mayor was abolished, and the management of the city was transferred to a City Management Board with a City Manager handling the day-to-day operations.

✉ georgemarkonyango@yahoo.com, ✉mirek.dymitrow@keg.lu.se, ✉moloko@jooust.ke, ✉sgagong@jooust.ac.ke

As a result of the changes, new power centres have emerged in the Governor's office and the County Assembly. The prime function of KAT lost its relevance in a system where the city has become just one of several players in a region competing for resources. Decision-making has shifted to a whole new team who do not seem to see a role for KAT in the new dispensation. With no anchor in the city establishment, KAT became history, and the players have repositioned themselves in new roles. The Kisumu Local Interaction Platform (KLIP) was established through the work with Mistra Urban Futures. The platform has grown in stature and strategy as it positions itself to take over the space left by KAT. The activities connected to these projects include collaboration between the researchers from Maseno University, Jaramogi Oginga Odinga University of Science and Technology (JOOUST), the University of Gothenburg, Chalmers, CSOs, the County Government of Kisumu and surrounding counties, community members, and a number of local institutions [Onyango & Obera, 2014].

In the later stages, KAT had the advantage of hindsight, and hence was able to address some of the challenges of engaging stakeholders in co-production in the dynamic city planning environment. The team included high-level professionals as well as representatives of the informal sector. We see that the last phase of KAT was probably the best of the phases in terms of the co-production of knowledge. Players from the informal sector were able to make presentations which were quite sound on their continued positioning in the city system. Experts were able to translate the ideas into concepts which were piloted and implemented. Examples include street kiosks which have since burgeoned. The same applied to the transport sector. This included reorganization of movement of the public transport within the CBD and location of termini. Due to the co-productive nature of the process it was easy to get acceptance and hence became implementable. Furthermore, KAT was engaged in assessment of the post-2007 election challenges in Kisumu and this allowed it to develop a reconstruction strategy. This Strategy was used to fund raise and the idea was bought by the French Development agency eventually forming the Kisumu Urban Project, a mega planning and infrastructure intervention [Onyango & Obera, 2014]. Having become moribund in the new constitutional dispensation in 2010, KAT members have since become members of the Kisumu Local Interaction Platform with a focus of coproduction of urban knowledge as its core mandate.

It is important not to forget issues of power and inclusion in co-creation processes, particularly as they relate to the identification and prioritisation of problems. When coming up with solutions to these collectively identified problems there is a sense of ownership by all co-producers. The MUF LIPs have developed differently in response to local contexts because of a realization that a one-size-fits-all model initially proposed for the LIPs was not tenable. There is the irrefutable logic of local contextualisation driven by co-production, co-financing, and partner-ship arrangements [Perry et al., 2018]. The influence that the academia has in Kisumu City has positioned them as the drivers of KLIP and enabled them influence to a great extent the coproduction of urban knowledge and how this is used in policy development in the city. This has seen KLIP influence the development of the Integrated Strategic Urban Development Plan, Kisumu Sustainable Solid Waste Management Plan, Sustainable Public Transport Policy amongst others.

Governments are more and more adopting Citizens' participation processes since they may help better understand needs and better reach communities' goals. With the emergence of ICTs, citizens' participation processes have taken new forms such as social media, blogs, and participative platforms [Marzouki et al., 2017]. A context-based citizen participation approach enables one to appreciate the dynamics of citizen participation comprehensively. That 'context' and 'politics' matter has become increasingly axiomatic within development theory and practice over the past decade. What is less clear are which specific context factors matter most and how thinking and action around social accountability interventions can be re-framed accordingly [Bukenya

✉ georgemarkonyango@yahoo.com, ✉mirek.dymitrow@keg.lu.se, ✉moloko@jooust.ke, ✉sgagong@jooust.ac.ke

et al., 2012]. Governments from the countries that are trying to achieve the breakthrough in public sector reform based on ICTs usually tend to use the same methods as the leading countries do. Yet these attempts are often unsuccessful due to the overlooked differences in institutional, cultural, and social contexts [Malinauskienė, 2013].

### 3.4. Governance Systems and Coproduction of Knowledge

Urban governance refers to how governments (local, regional, and national) and stakeholders decide how to plan, finance, and manage urban areas. It involves a continuous process of negotiation and contestation over the allocation of social and material resources and political power. It is, therefore, profoundly political, influenced by the creation and operation of political institutions, government capacity to make and implement decisions and the extent to which these decisions recognise and respond to the interests of the poor. It encompasses a host of economic and social forces, institutions, and relationships [Avis, 2016].

Hendriks [2013] argues that governance refers to the institutionalized working arrangements that shape productive and corrective capacities in dealing with urban steering issues involving multiple governmental and nongovernmental actors. Figure 2 above comprehensively covers the players in the governance system in Kisumu. The academia is considered as professional expertise and form a key component in local governance.

A more neoliberal strand of urban governance has influenced the practice and conceptualisation of participation. Throughout the 1990s to date new forms of public-private partnerships and networks have been promoted to (among other things) tackle social exclusion. KLIP as a platform provides a network that fosters inclusion. It is argued that partnerships and networks were more inclusive than purely public initiatives because they created new spaces for participation [Lund, 2018]. KLIP provides an opportunity for different levels of players to engage in issues of governance in Kisumu. Participation and governance have become inextricably linked. The Kenya Constitution [2010] makes it mandatory for the public to be included in the process of governance at all levels. This is based on experiences from the governance system in the country before 2010, where the role of the citizenry was generally limited to electing leaders. The Urban Areas and Cities Act [2011] provides for the appointment of a City Board and a City Manager who are recruited administratively. However, it states that residents may:

a) deliberate and make proposals to the relevant bodies or institutions on:
   i) the provision of services;
   ii) proposed issues for inclusion in county policies and county legislation;
   iii) proposed national policies and national legislation;
   iv) the proposed annual budget estimates of the county and of the national government;
   v) the proposed development plans of the county and of the national government; and
   vi) any other matter of concern to the citizens;
b) plan strategies for engaging the various levels and units of government on matters of concern to citizens;
c) monitor the activities of elected and appointed officials of the urban areas and cities, including members of the board of an urban area or city; and
d) receive representations, including feedback on issues raised by the county citizens, from elected and appointed officials [UA&C Act, 2011, sec. 22].

This Act effectively provides for citizen contribution in the governance process in terms of contributing to initiatives but also having input in feedback from the city administration. The Act has seen a greater involvement of Neighborhood Associations in city governance mostly in the form of knowledge generation.

Saparniene & Valukonyte [2012] argue that in Good Governance social and economic priorities would be widely supported by general agreement (consensus) in the society and that the voices of the poorest and the most vulnerable society's members

✉ georgemarkonyango@yahoo.com, ✉mirek.dymitrow@keg.lu.se, ✉moloko@jooust.ke, ✉sgagong@jooust.ac.ke

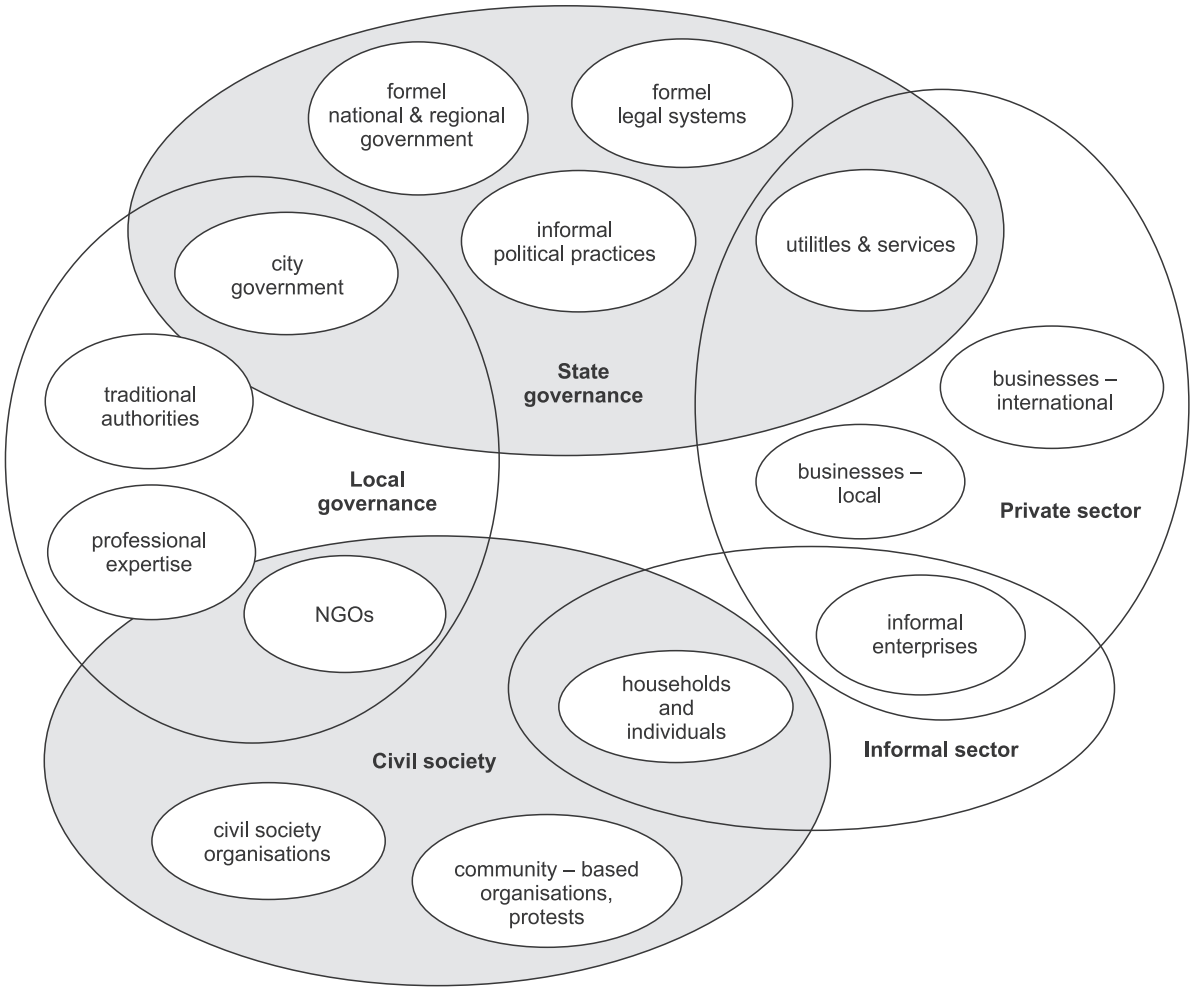


**Fig. 2.** Actors and Institutions of Urban Governance
*Source*: Avis, 2016.

would be heard when adopting the decisions regarding the distribution of funds for development. That level of participation has been the aspiration of cities as they set up co-production processes in the different contexts. Kisumu County is in the process of setting up Ward Committees to coordinate the participation of citizens in each Ward to ensure that prioritization is anchored in grassroot needs as envisioned in the Constitution. The budgeting process has however provided an opportunity for citizens to critique and input in the priority projects of the city through a legal requirement that the County budget be subjected to an open for a of public participation. This process is limiting since people may be intimidated by the setup of the vetting process in which assumptions are made about capacity to understand the documentations presented at such fora. The level of knowledge on budgeting may limit participation and hence limit effectiveness of the process.

Virtudes [2016] borrowing from the United Nations recognizes that good urban governance is guided by five goals namely:

a. effectiveness (including efficiency, subsidiarity and strategic vision);
b. equity (including sustainability, gender equality and intergenerational equity);
c. accountability (including transparency, rule of law and responsiveness);

✉ georgemarkonyango@yahoo.com, ✉mirek.dymitrow@keg.lu.se, ✉moloko@jooust.ke, ✉sgagong@jooust.ac.ke

d. participation (including conflict resolution, human security); and
e. environment safety.

Legislative provision to achieve the above in Kisumu is enshrined in the Constitution [2010], Urban Areas and Cities Act [2011] and County Governments Act [2012]. The City is in the process of operationalizing these goals. The City Board has been established. The Board is mandated to develop policy that will guide in preparation of legislation that should ensure good urban governance. The Board operates as a subsidiary of the County Executive and has the mandate of rolling out approved policy. It is guided by national values including gender equity as enshrined in the Constitution. Regular feedback to the public, including the Budget Day, provide an avenue for accountability and this is all part of the participation process. Environmental safety is a role that the community has an active role. The biggest challenge to all these "best laid plans" is the old school of thinking that still prevails in the public service in which the people should wait for the City Management to plan and implement at all times. Experiences from the activities undertaken by KLIP has however impacted positively on ensuring good governance. The players from the Civil Society have become empowered in positioning their knowledge through the triple helix to leverage on City initiatives. Having established that KLIP is a platform they can use positively, they have been able to mobilize membership to develop intervention strategies such as the Solid waste management in Markets, Eco-Tourism and Urban Agriculture. The fact that County and City officials are part of the KLIP network has enabled for interaction between the citizen and policy makers well before the formal processes begin. The coproduction of knowledge has thus become integrated in the process of policy development and implementation of intervention with a clear understanding of the role of the various players.

We are seeing shifts in urban governance as result of the legislative transformation in Kenya after the new Constitution was promulgated in year 2010. The shifts in urban governance are based on time and circumstance with horizontal and vertical arrangements in decision making and implementation of the results of urban knowledge. Hendriks [2013] provides a framework for understanding these shifts which are applicable to Kisumu based on the levels of coproduction of urban knowledge (see Fig. 3).

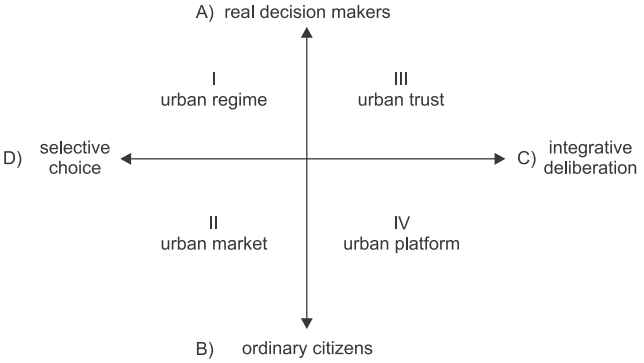


**Fig. 3.** Shifts in Urban Governance
*Source*: Hendriks, 2013.

A model of governance may be considered effective to the degree and way in which it shows an ability to truly do things, solve problems, and deliver value for money.

**Urban market:** In this level of urban governance communities form neighborhood associations, Market traders and Business groups. Communication is mainly through mobile phones with several WhatsApp groups set up to exchange information about the feelings and aspirations of members. In Kisumu these include the various Estate and Slum area neighborhood association which have been formed for purposes of enhancing social capital. Market traders and the Central Business District also have associations that address their aspirations. The informal sector also has associations that cover various sectors including street traders, "boda-boda" motorcycle transport amongst others.

**Urban regime:** The Kisumu Action Team [Onyango & Obera, 2014] was a typical example of this shift in urban governance. KAT was a select gathering of Kisumu City officials and top administrators from Maseno University and Jaramogi Oginga Odinga University of Science and Technology and Civil

✉ georgemarkonyango@yahoo.com, ✉mirek.dymitrow@keg.lu.se, ✉moloko@jooust.ke, ✉sgagong@jooust.ac.ke

Society Organizations. KAT was highly productive in its later phases, but the social and political legitimation tends to be problematic since the institution was not anchored in law. Its decisions had to be tabled in the City Council for ratification to legitimize them. Galuszka [2018] notes that in this scenario there may be struggles. They may range from soft, discursive struggles, which can be managed via consensus-oriented means, to violent confrontations in which different authorities try to achieve their goals. It is these struggles that saw the informal traders being marginalized as the shift in governance moved to urban trust.

**Urban trust:** KAT evolved into a multilevel and multisectoral network, connecting leading figures of various levels of government. It was more interactive but excluded the civil society in its popular form. The KAT was able to prepare documentation that led to AfD funding for Kisumu Infrastructure to the tune of KSh 8 billion. This funding has seen a transformation of the informal settlements in Kisumu in terms of construction of roads and markets and installation of street lighting. Other development are model primary schools.

**Urban Platform:** The establishment of KLIP was envisioned as a wide and open platform on which everyone can have a say. KLIP revolves around dialogue, not contest by institutionalizing a comprehensive rather than exclusive approach to alternatives and collective decisions. The fact that membership includes policy makers allows for policy to be developed informally and then translated into official documentation by the policy makers in their official capacity. The other players on the platform are actively engaged in knowledge coproduction which then gets translated into policy. This platform affords integrative deliberation.

## CONCLUSIONS

The interplay between the various forms of coproduction within the context of Kisumu has been demonstrated to be linked to the governance systems. Kisumu has seen multilevel co-production that has evolved over time as the various stakeholders and players within the city's complex system positioned themselves to influences policy and practice. The creation of networks and platforms provides opportunities for interactions for various players and has to a great extent made it feasible for the ordinary citizen to have an avenue to coproduce urban knowledge that has shaped the Kisumu they want. The prospects provided by KLIP have been exemplary in creating an opportunity for showcasing how academia, policy makers, and the private sector are able to work as co-researchers in knowledge production and have a space where ideas are considered equal without prejudice to its origin. This teamwork has endeared Kisumu to a number of international institutions including UN Habitat, who have consistently engaged with the players in this urban platform. This confirms that when the context is right co-production can become a viable way of urban knowledge production. The involvement of different players in knowledge co-production thus provides an opportunity for the City Management to leverage on this to enhance governance systems and have a greater impact from its interventions.

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✉ georgemarkonyango@yahoo.com, ✉mirek.dymitrow@keg.lu.se, ✉moloko@jooust.ke, ✉sgagong@jooust.ac.ke

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✉ georgemarkonyango@yahoo.com, ✉mirek.dymitrow@keg.lu.se, ✉moloko@jooust.ke, ✉sgagong@jooust.ac.ke

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✉ georgemarkonyango@yahoo.com, ✉mirek.dymitrow@keg.lu.se, ✉moloko@jooust.ke, ✉sgagong@jooust.ac.ke

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# THE METHOD OF DETERMINING RESEARCH UNITS FOR THE NEEDS OF VALORISATION OF RURAL LANDSCAPE AT THE LEVEL OF PLANT COVER ON THE EXAMPLE OF THE PUCHACZÓW COMMUNE

Sylwia Szefler✉

ORCID: 0000-0002-4887-0481
University of Life Sciences in Lublin
Głęboka street 28, 20-612 Lublin, **Poland**

## ABSTRACT

One of the methods of landscape valorization is assessment based on the analysis of vegetation. It makes it possible to recognize changes taking place in the natural environment. The first stages of valorization include the designation of relevant research units. The aim of the article is to present a model method of extracting research units for valorization of a rural landscape. The area for which the author presents the research model is the Puchaczów commune, located in the Lublin province. The method of determining units used in the research combines two types of research fields: natural and geometric. In order to designate research units in the commune, the author used the analysis of land cover and topography. The comparison of the results of the above-mentioned studies allowed to recognize 16 homogeneous types of landscapes. The next stage of research was the generalization the shape and surface of units of landscape types by lay on them a grid of squares. An important issue was the selection of the appropriate size of research fields. The article tested the possibility of using squares with sides equal to 500 m and 1 km. The results indicated that too high a degree of generalization of units would lead to a reduction in landscape types on the map, which would distort future valorisation results.

**Keywords:** landscape valorization, rural landscape, landscape research units, plant cover

## INTRODUCTION

The concept of sustainable development of rural areas assumes shaping them in such a way that their economic does not adversely affect the resources of the natural environment, landscape or cultural heritage of the village, while improving the quality of people's lives. This idea seeks to reconcile competitive factors: economics and ecology by adapting business activities and planning to existing natural and social conditions [Urban, 2003].

The implementation of the principles of sustainable rural development is influenced by legal acts, development strategies of international and national rank. Agenda 21 emphasizes the great importance of local authorities of municipalities in achieving the goals set out in this document – stop the degradation of the environment and its protection [Regionalne

✉syszef@wp.pl

Samorządowe Centrum, 1993]. Shaping a pro-ecological, regional spatial policy is connected with the obligation for municipalities to adopt a study of spatial development conditions and local spatial development plan. Another document that shows how to achieve lasting progress, built on harmonious relations between socjety, economics and the natural environment is the European Landscape Convention, wich is the first international treaty devoted exclusively to landscape issues. In Poland, legal acts referring to the idea of sustainable development include The Constitution (Article 5), the Act of 27 April 2001 – Environmental Protection Act, or the Strategy for the sustainable development of rural areas, agriculture and fisheries for 2012–2020 [Żmija, 2014]. All the above-mentioned documents set directions, the implementation of which will ensure sustainable and balanced development of the village. However, it should be remembered that such development will not occur without a planning act carried out and implemented, and this requires specific landscape research, including its valorisation and recognizing the problems with the functioning of rural areas in relation to natural resources.

In Poland, the methods associated with the valorisation of cultural landscape, which includes rural areas, have been most widely developed by the Krakow universytyof landscape architecture [Antolak, 2017]. Professor Janusz Bogdanowski [1976] proposed a method for assessing JARK-WAK landscape units and interiors, the designation of which is based on the division of land according to three criteria: form of terrain, land cover and historical origin. The JARK-WAK valorization method does not directly refer to plant communities, but it can be a guideline for developing a method for their detailed research. An example would be the research carried out by Targońska and Łukasik [2010] regarding the assessment of the landscape of the village Owińsk in the Greater Poland Voivodeship. In the research the authors used two different methods. The first consisted in a compositional analysis based on general inventory and valorisation of cultural and natural elements. The second stage of the study was based on the JARK-WAK method, which was expanded to include plant cover assessment. The studied area divided into homogeneous areas, designating units with cultural, natural-cultural and natural features. It should be added that at the level of phytocoenoses, anthropogenic processes trigger transformation of communities with a more organized structure into less organized ones. Synanthropization of flora is a directional process whose distinguishing feature is the replacement of native species by foreign plants [Plit, 1996]. Considering the above, valorisation based on plant cover can be used to assess the degree of naturalness of plant landscapes. The exaple may be assessment method developed by Olaczek and Sowa [1972]. They distinguished a number of replacement phytocoenoses for potential phytocoenoses, and assessed the degree of transformation on a six-point scale [Wysocki & Sikorski, 2014]. A similar research method, which assumes that the compatibility of real vegetation with the habitat potential is the most important, was developed by Plit [1996]. The method emphasizes qualitative changes in vegetation, and indirectly also changes in the environment [Plit, 1996].

Currently, valorization methods developed with the use of GIS are becoming more popular. Picuno et al. [2019] focused on identifying changes in the rural landscape and their impact on environmental aspects by comparing historical maps from different eras with aerial photographs. The scope of the research covered the region of Basilicata (southern Italy). This method allowed to study the direction of landscape changes along with the time analysis. The transformation of landscape under the influence of human activity over the centuries with the use of Geographic Information System, was also studied by De Jong and Stremke [2020]. The article presents a case study that aimed to map the evolution of energy landscapes in the region of the western part of the Netherlands. The research shows that all energy transformations are related to the transformation of landscapes.

It should be pointed out that landscape identification and valorisation requires the adoption of appropriate measures and units. The main purpose of the article is to present a model method

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of extracting research units for the valorization of rural landscape based on research on plant cover. The research territory is the area of the Puchaczów commune located in the Łęczna County in Lublin Voivodeship. It is a rural commune with a complex functional, spatial and environmental structure. A distinctive feature of the area is the presence of hard coal deposits. Natural conditions largely define the contemporary development of the commune, where, apart from the agricultural function of the area, the mining industry developed. In this situation, the selection of the appropriate methodology for assessing rural landscapes should be dictated by the possibility of conducting surveys on the scale of the entire commune, based on documents unified at the national level. The research model that the author tries to present should also be as simple as possible so that they can be used in the future for planning purposes.

## MATERIALS AND METHODS

Landscape-building components, both abiotic and biotic, are connected through close correlations. This landscape design allows the use of selected elements as indicators for the assessment of entire natural systems [Szyszko, 2013]. Plant cover, as one of the most labile landscape components, reflects natural and anthropogenic changes [Plit, 1996]. Based on the presence of plant species, communities can indirectly conclude about other features of the natural environment. The big advantage of plants as indicators is also the lack of mobility, which allows greater accuracy of research than in the case of fauna. Depending on the scale of the studied area, the vegetation cover can be an information indicator at the species and biocenotic level and landscape [Wysocki & Sikorski, 2014]. It is worth noting that the study of plant cover in times of huge climate changes, which have already become a fact, have additional value. The transformation of weather conditions is largely influenced by increased greenhouse gas emissions caused by anthropogenic processes. Plant cover is an element of the environment that is particularly sensitive to climate change, and the response of ecosystems to extreme weather is easily noticeable [Czerepko et al., 2010]. Atmospheric conditions determine the spatial distribution of flora. The transformation of environmental conditions caused by global warming can lead to significant changes in the species chorology model, and also affects the range of plant occurrence [Chauchard et al., 2010].

For the Puchaczów commune, the author planned a valorisation based on analyzes of the plant cover, consisting of comparing potential and real vegetation. The scope of research related to the assessment of plant cover transformation covers the area of the Puchaczów commune within its current administrative boundaries. This area has been selected due to its location in the Lubelskie Voivodeship and the complex functional and spatial structure and environmental conditions. Puchaczów is a rural commune located in the Łęczna County. The area of the commune is estimated at 91 $km^2$, and the number of inhabitants is about 4884 people. Geographically, the Puchaczów commune belongs to two physiographic units of the Łęczyńsko-Włodawskie Lake District and the Dorohuska Plain [Mącik et al., 2012]. A special feature of this commune is its situation within hard coal deposits and it is crucial for the development of region. The largest company in this territory is Lubelski Węgiel "Bogdanka" S.A. [Szot-Gabryś, 2008].

Due to the nature of the valorisation, the purpose of which is to assess the degree of naturalness of the vegetation cover, and indirectly also to assess landscape transformations, the current land cover and its topography have been chosen as the basis for determining research units for the Puchaczów commune. This information provided data on the structure of the landscape, which enabled the selection of homogeneous areas in terms of development and topography (landscape types). The source materials used during the research were orthophotomap, topographic map, digital terrain model – ISOK project – hypsometry [https://puchaczow.e-mapa.net/, date: 06.01.2018] and the Study of Conditions and Directions of Spatial Development of the Puchaczów Commune [Mącik et al., 2012].

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**Fig. 1.** Location of the Puchaczów commune in Poland and Europe
*Source*: Author's own work based on the map from: https://d-maps.com, date: 05.09.2020.

## RESULTS

The land cover analysis has identified five main forms of municipal development:
– forest areas (L);
– meadows and pastures (Ł);
– concentrated settlement rural areas (Z);
– agricultural areas with dispersed rural buildings (R);
– industrial areas (P).

The dominant form of land cover are agricultural areas (R), occurring throughout the commune as multifaceted patches. Meadows and pastures (Ł) with a flap-band system are next in terms of size. These areas accompany mainly the valleys of the Mogielnica and Świnka rivers. Compact settlement systems (Z) occupy about 14% of the total area of the studied commune. These areas have a band character and are located along the main communication routes. The largest part of the compact settlement system is located in the western part of the commune. Forest communities constitute about 12% of the commune's area. They include complexes found in Ciechanki, Ostrówek, Zawadów, Wesołówka, Puchaczów and Nadrybie. Forests located in the southern part of the commune, they form part of the Nadwieprzański Landscape Park and its buffer zone. There are 4 main industrial areas in the Puchaczów commune. The largest area is occupied by the Bogdanka Coal Mine, located in the central part of the commune. Percentage share of individual development forms in relation to the area of the entire commune is shown in the diagram (Fig. 3).


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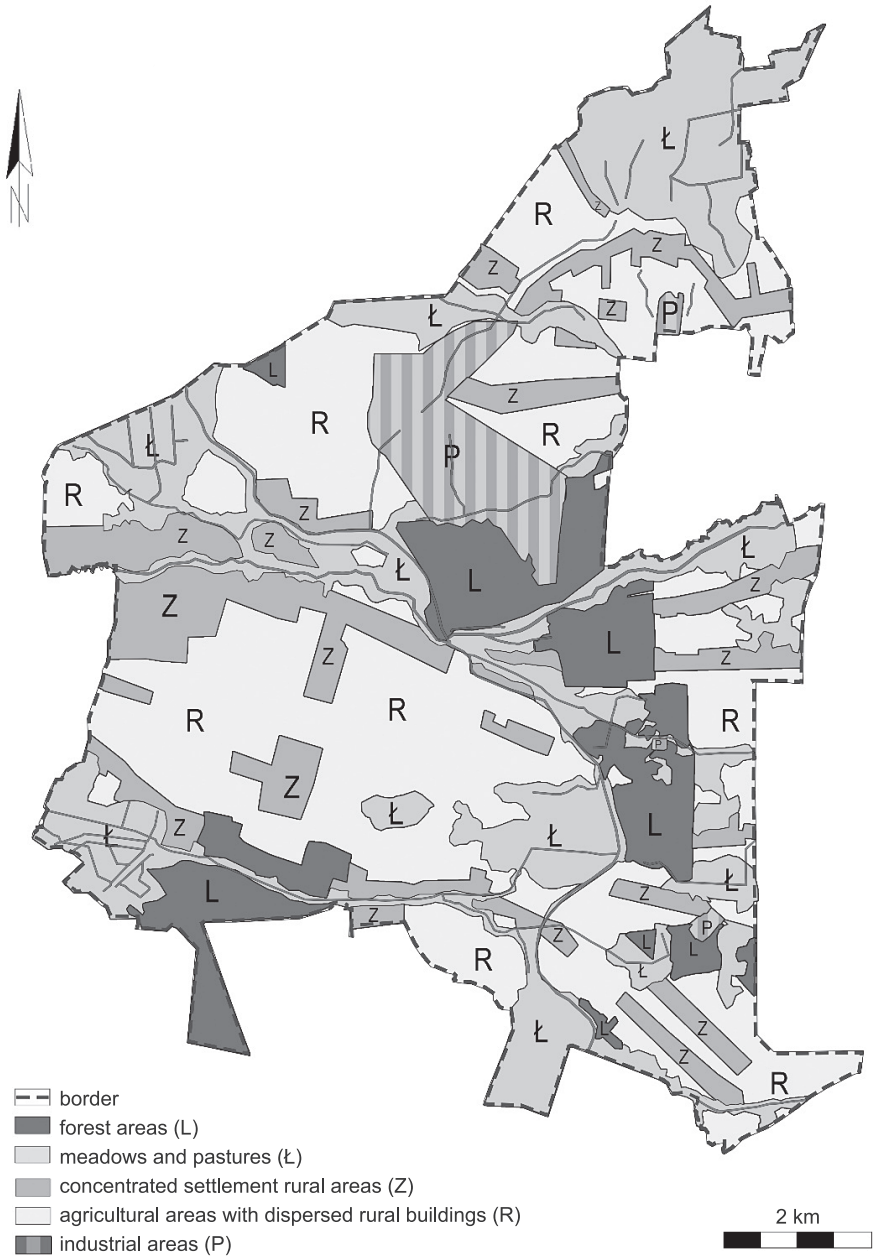


**Fig. 2.** Land cover in the Puchaczów commune
*Source*: Author's own work, 2018.

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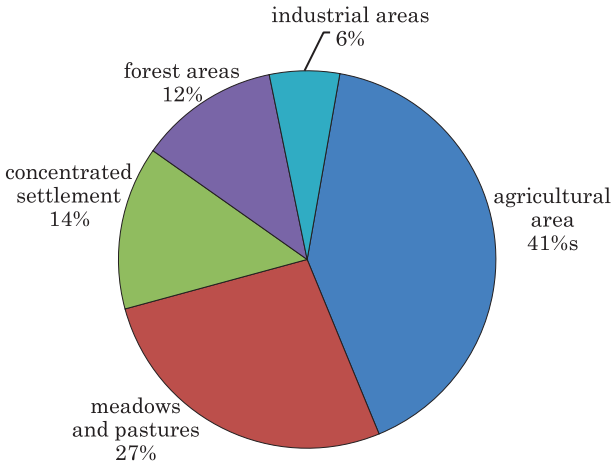


**Fig. 3.** The structure of land cover in the Puchaczów commune
*Source*: Author's own work, 2019.

During the analysis of the terrain, height and type of relief were taken into account. Four main landforms have been identified:
– Areas of the main watercourse valleys (D);
– Flat areas with few, small hills or depressions (P);
– Slightly wavy areas with small differences in height (L);
– Strongly wavy areas (W).

The landscape of Puchaczów commune is characterized by low altitude variation. In the hypsometric context, there are mainly types of slightly wavy or flat, flat forms with few elevations or depressions. Areas with a strongly wavy terrain are located mostly at the eastern border of the commune.

The imposition of information from maps presenting forms of land cover (Fig. 2) and landforms (Fig. 4) allowed to distinguish 16 homogeneous in the area of the Puchaczów commune in terms of use and shape of units, types of landscapes:
– Compact buildings on flat areas (ZP);
– Compact buildings on slightly wavy areas (ZL);
– Compact buildings in clearly undulated areas (ZW);
– Agricultural areas in flat areas (RP);
– Agricultural areas in slightly wavy areas (RL);
– Agricultural areas in strongly wavy areas (RW);
– Industrial areas in slightly wavy areas (PL);
– Industrial areas in strongly wavy (PW);
– Industrial areas in river valleys (PD);
– Forest areas in slightly wavy areas (LL);
– Forest areas in strongly wavy areas (LW);
– Forest areas in river valleys (LD);
– Meadows and pastures in flat areas (ŁP);
– Meadows and pastures in slightly wavy areas (ŁL);
– Meadows and pastures in strongly wavy areas (ŁW);
– Meadows and pastures in river valleys (ŁD).

**Table 1.** Comparison of different degrees of generalization of units

| The length of the side of the square | 500x500 [m] | 1x1 [km] |
|---|---|---|
| Surface units [km^2]: | | |
| Compact buildings on flat areas (ZP) | 8,5 | 5 |
| Compact buildings on slightly wavy areas (ZL) | 8 | 6 |
| Compact buildings in clearly undulated areas (ZW) | 1,75 | - |
| Agricultural areas in flat areas (RP) | 13 | 15 |
| Agricultural areas in slightly wavy areas (RL) | 18,75 | 23 |
| Agricultural areas in strongly wavy areas (RW) | 4,75 | 5 |
| Industrial areas in slightly wavy areas (PL) | 3,25 | 3 |
| Industrial areas in strongly wavy (PW) | 0,75 | - |
| Industrial areas in river valleys (PD) | 0,5 | - |
| Forest areas in slightly wavy areas (LL) | 6,25 | 9 |
| Forest areas in strongly wavy areas (LW) | 6,5 | 6 |
| Forest areas in river valleys (LD) | 0,25 | - |
| Meadows and pastures in flat areas (ŁP) | 4,75 | 7 |
| Meadows and pastures in slightly wavy areas (ŁL) | 4 | 6 |
| Meadows and pastures in strongly wavy areas (ŁW) | 1,5 | 2 |
| Meadows and pastures in river valleys (ŁD) | 21 | 22 |
| Sum of identified units | 16 | 12 |

*Source*: Author's own work, 2020.

The above analysis showed that the isolated units are strongly diversified in terms of size, and also have an irregular shape of the borders, which is often not sharply marked in the landscape, it has the character of a gradient. The next stage of research was the generalization the shape and surface of units of landscape types, which is very important from a methodical point of view.


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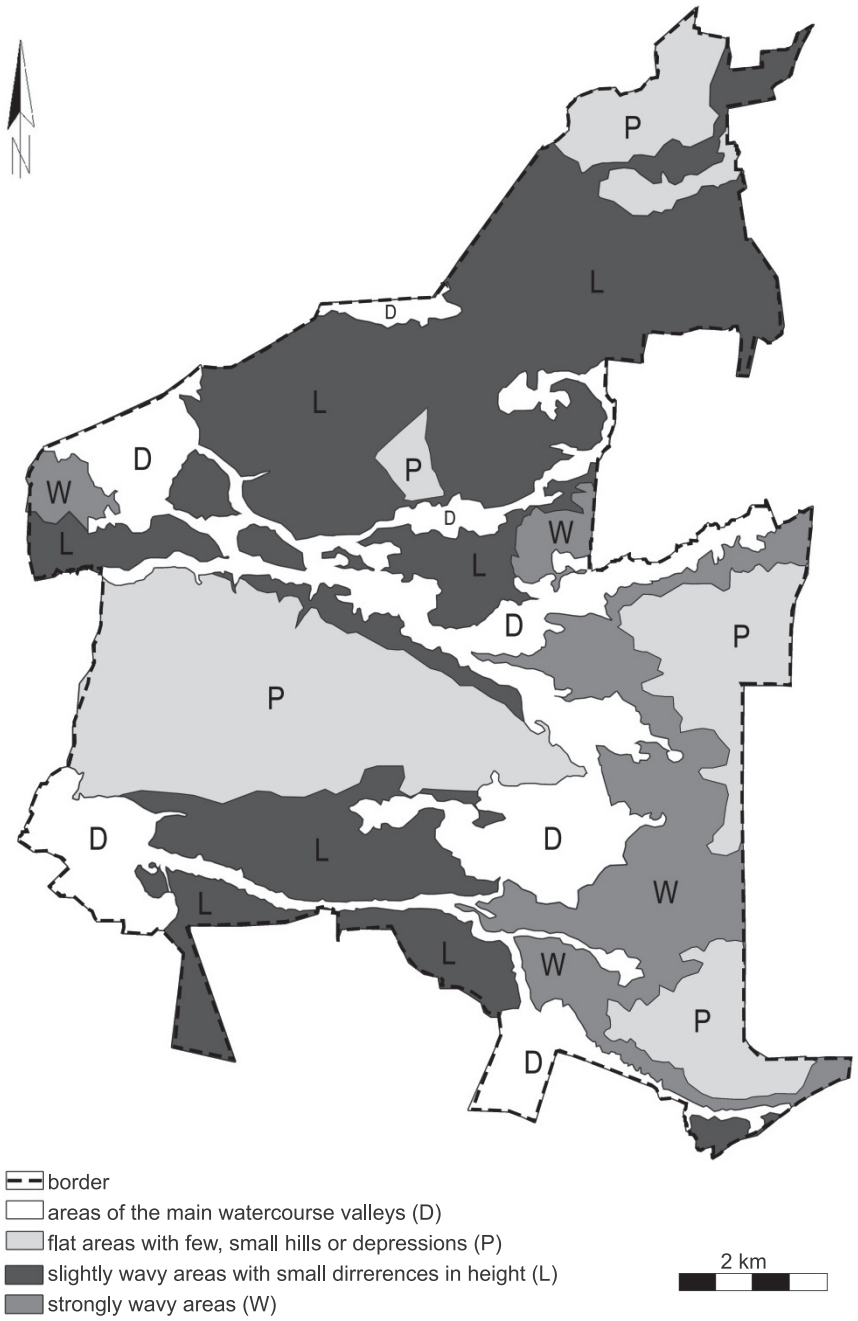


**Fig. 4.** Landforms in the Puchaczów commune
*Source*: Author's own work, 2019.

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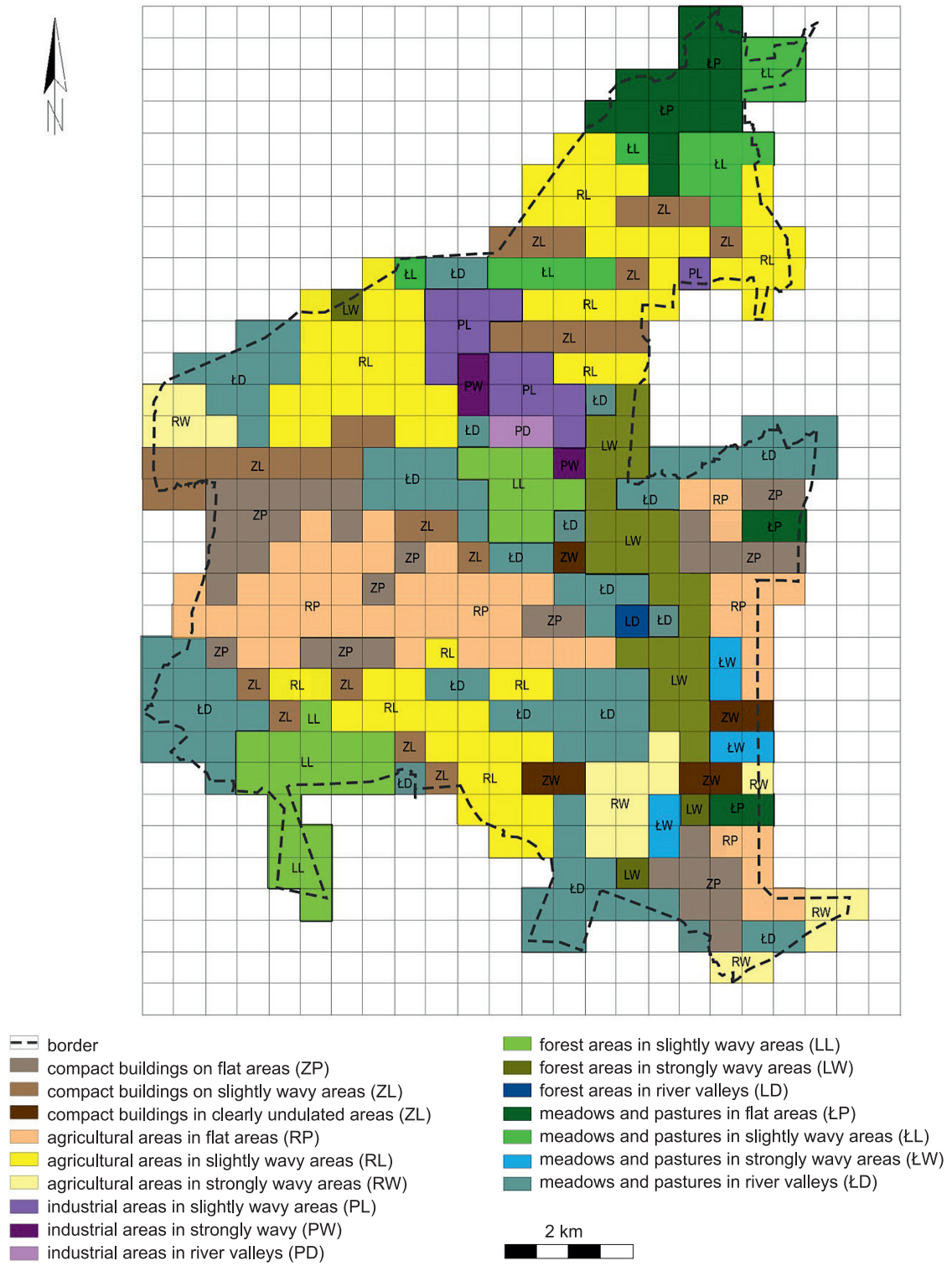


**Fig. 5.** Map presenting types of landscapes of Puchaczów commune based on a grid of squares with a side equal to 500 m
*Source*: Author's own work, 2020.


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The generalization by using geometric fields (squares) will facilitate the determination of the total size of units and in subsequent valorisation phases will allow for comparative assessment of vegetation transformations on the same surface of landscape types, as well as statistical analysis of research results. For this purpose, a grid of squares with a side equal to 500 m was used, and individual squares were assigned the dominant type of landscape in a given area. Due to the area of the commune in study examined the possibility of using squares whose dimensions were 1x1 km. The comparison of the degree of generalization of both research fields is presented in Table 1. For a square with a side of 500x500 m, the sizes of the units of landscape types are more accurate than for a square with dimensions of 1x1 km. The level of generalization of units in case with biger square turned out to be too high, as a result, which would reduce the number of landscape types. The disappearance of significant, although small, areas with a landscape that stands out in a particular environment would deform the results of the valorisation. This confirmed that the area should divided into a square with a side equal to 500 m. It should be emphasized that when performing this type of unit delimitation, the size of the geometric fields must be adapted to the study area each time.

## DISCUSSION

In general, valorisation of the landscape consists in assigning specific values to individual research units, which will enable the assessment of their use. Units should separate areas uniform in terms of landscape and structural. It should be noted that when determining units, it is not possible to take into account all biotic and abiotic elements of the environment, which is due to its complex structure [Richling & Solon, 1996]. The selection of criteria for the delimitation of research units depends primarily on the purpose and scale of landscape valorisation.

In the process of spatial planning at the regional level, including communal level, units of plant landscapes are most applicable. According to Matuszkiewicz [1978, 1979a, 1979b, 1981a, 1981b, 1993] the plant landscape is a typological group that was created to holistically describe the spatial and typological divergence of plant communities in regional units characterized by basic habitat diversity [Matuszkiewicz & Solon, 2015]. Their determination is based on various foundations, e.g. terrain geomorphology, while the source of information about vegetation is a map of real and potential vegetation or a map of community complexes. One of the most common methods in Poland includes the concept of landscape phytocomplexes proposed by Matuszkiewicz [1993], [Wysocki & Sikorski, 2014]. Landscape phytocomplexes are a spatial system of phytocoenoses characterized by a specific set of plant communities that actually occur in nature. They may refer to real or potential vegetation [Matuszkiewicz, 1981b]. Phytocomplexes are shaped primarily by abiotic factors of the environment and human activity [Richling & Solon, 1996]. The definition of phytocomplexes determines the general nature of units, but does not contain information on how to strictly demarcate them in space from other plant systems. The basic components of phytocomplexes are phytocoenoses, which in typological terms belong to different syntaxones. In addition, plant systems located on the border of two phytocoenoses are also components of phytocomplexes [Matuszkiewicz, 1981b].

A slightly different approach presents the division of the landscape into geocomplexes. Geocomplexes are defined as closed sections of nature that are connected through processes that take place between the components that build them [Barsch, 1979]. The components that build landscape geocomplexes are partial geocomplexes [Szponar, 2005]. As Haase [1964] reports, they reflect the variability of individual geocomponents referring holistically to the natural environment [Richling & Solon, 1996]. Due to the lack of uniform theoretical principles, the concept of geocomplexes in the 1980s and 1990s was questioned [Pietrzak, 2001]. Ambiguity in determining the boundaries of geocomplexes is a significant problem in landscape research [Pietrzak, 1998, Balon, 2007a]. According to Kot [2009], it results primarily from the lack of commonly accepted, ordered in size systems of units

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of all components of the natural environment. It is also believed that the method presented is labor-intensive and time consuming [Balon, 2007a]. Chmielewski and Solon [1996] dealt with the methodology for multi-criteria determination of spatial research units for the needs of spatial planning. Delimitation of basic natural spatial units (BNSU) involves the analysis of a number of superimposed layers of maps reflecting the terrain, soil characteristics, water relations, land use and the range of real vegetation. The isolated units are then grouped into higher order syndromes, i.e. physiocenosis and landscape complexes [Sowińska & Chmielewski, 2008].

The use of geometric fields is also a popular way of determining units for environmental research. Bajerowski et al. [2007] defined the conditions that should be met by basic fields. The publication emphasizes that the shape of the units should be similar to a circle, which is why hexagons are more and more often used in landscape assessments. However, it should be taken into account that the more common method is to use a grid made of square fields. An example may be studies on the assessment of tourist attractiveness [Chojnacka-Ozga & Gabryszewska, 2011, Dubel, 2004, Goosen & Langers, 2000], but also research on the natural environment [Balon, 2007b, Kot, 2014]. The disadvantage of geometric units is their unnatural.

As the analysis of the current state of knowledge shows, there is no single, universal spatial research unit. All research methods presented are based on a specific set of landscape features and highlight selected aspects of it. Therefore, when valorizing rural areas, one should choose a method of their delimitation adequate for the purpose and territory of research [Richling & Ostaszewska, 1993].

The unit determination method used in research combines two types of research fields: natural and geometric. The superimposition of a square grid on predefined landscape types resulted in the generalization of units. This has limited the unnatural resulting from the use of geometric fields, and at the same time, in a further stage of valorization, it will make it possible to compare squares of the same area. The reason for using this method of delimiting units is universality, which consists in the possibility of applying it to various types of areas and the possibility of obtaining statistical data.

## CONCLUSIONS

Currently, there are many methods of designating research units for landscape valorization. They can be divided into natural – based on the biotic or abiotic features of the terrain, and geometric ones, in which the basic research fields are e.g. squares. The model method of determining units presented in the article combines two types of research areas.

The author will plan to do the valorization of the degree of naturalness of the vegetation, and indirectly the assessment of landscape transformations. The basis for designating research units for the Puchaczów commune was land cover and its topography. The next stage of research was the generalization of the shape and surface of units of landscape types, which is of great importance from a methodical point of view. The article tested the possibility of using squares with sides equal to 500 m and 1 km. The results indicated that too high a degree of generalization of units would lead to a reduction in landscape types on the map.

Applying generalization with geometrical figures (squares) will make it easier to determine the total size of units. In further valorisation phases, it will allow comparative assessment of vegetation transformations on the same surface of landscape types and statistical development of research results.

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✉syszef@wp.pl

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✉syszef@wp.pl

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✉syszef@wp.pl

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# FREEWARE GIS TOOL FOR THE TECHNO-ECONOMIC EVALUATION OF RURAL ELECTRIFICATION ALTERNATIVES

Mirelys Torres-Pérez[1]✉, Javier Domínguez Bravo[2]✉, Cesar Hernández Leyva[3]✉, Marieta Peña Abreu[4]✉

[1] ORCID: 0000-0001-7266-420X
[2] ORCID: 0000-0002-9677-7265
[3] ORCID: 0000-0002-3605-6191
[4] ORCID: 0000-0002-7714-2205
[1] University of Las Tunas
Avenida 30 de Noviembre S/N, Reparto Aurora, 75100, Las Tunas, **Cuba**
[2] Center for Energy, Environmental and Technological Research (CIEMAT)
Centro de la Moncloa, Complutense, 40, 28040, Madrid, **Spain**
[3] Independent researcher, Calle Asturias #2, Aviles, 33404, Asturias, **Spain**
[4] University of Informatics Sciences
Carretera a San Antonio de los Baños Km 2 ½, Torrens, Boyeros, 19370, La Habana, **Cuba**

## ABSTRACT

Energy access is a crucial step for the socio-economic development of isolated communities and for preventing disease and fight pandemics across many parts of the world. In this research, is presented a freeware GIS tool for the techno-economic evaluation of rural electrification alternatives, based on a plugin for the QGIS (Quantum GIS) called LECGIS. The tool carries out an implementation of the IntiGIS model to perform the calculations, a flexible model capable of adapting to the realities of different scenarios. In addition, it allows the clustering of isolated houses, for a better modelling of the cost of the centralized systems. It is described the application of this tool in the Guamá (Cuba) case study and the comparisons of the results with the obtained in Intigis 1.0. It is concluded that the LECGIS plugin allows to calculate and compare seven technological options for the electrification of communities, supporting the decision-making in the planning of rural electrification projects.

**Keywords**: rural electrification, Levelized Cost of Electricity (LCOE), Renewable Energy Sources (RES), decision supporting tool, Geographic Information Systems (GIS), IntiGIS

## INTRODUCTION

Ensure access to affordable, reliable, sustainable and modern energy for all, is still a firm aspiration of the Sustainable Development Goal number 7 (SDG7). Energy services are key to preventing disease and fight pandemics across many parts of the world [ONU, 2020]. Methods for electrification planning are diverse, and go from the range of "rational" least-cost optimal [Ellman, 2015, Kemausuor et al., 2014, Mentis et al., 2017, Pinedo-Pascua, 2010], to highly participatory approaches [Cherni et al., 2007, González

✉mtperez@ult.edu.cu, ✉javier.dominguez@ciemat.es, ✉tatico890530@gmail.com, ✉mpabreu@uci.cu

Morera et al., 2017]. Technocratic methods to rational planning, benefit from their capacity to analyze large scale regions.

Computer based techno-economic models facilitate such scaling, nevertheless, these approaches fall short in their ability to incorporate context-specific considerations such as consumer qualities and preferences, political goals, and institutional inertia. At the other side, participatory approaches are highly context-specific and seek to involve final users in the decision-making process [Practical Action, 2016, Pritchett & Woolcock, 2004].

While this may enable better fine-tuning in comparison with the technocratic approaches; participatory does usually require more time, resources, coordination, and focus on small scaling. Therefore, are less capable to take advantage from technical efficiencies of greater scales.

Consequently, the two paradigms can be perceived more as complimentary than substitutive. For instance, techno-economic models can produce plans quickly and serve as a reference to planners, for answer regulatory and business model questions. Decision makers can subsequently deviate from them, according to local contexts and feedback from beneficiaries. Also, can be used to agile compare different systems designs, without incurring in the costs of physically building infrastructure. This is valuable because environments can be heterogeneous and computational tools, may account for details that are complicated for unassisted human planners [Lee, 2018].

Managing plans using GIS have been demonstrated save time and costs relative to classic master planning. A report by the World Bank's Independent Evaluation Group (IEG) [Independent Evaluation Group, 2016] compares "classic" (also referred to as "traditional") master plans to those aided by dynamic GIS mapping activities. The IEG details comprehensive geospatial planning efforts in Rwanda and Kenya, and states that they "each cost about US $1 million and took one year to prepare" [Independent Evaluation Group, 2016]. On the other side, "classic electrification master plan studies take two to three years, cost more than $2 million to prepare, and are based on a static framework that is not readily updated" [Independent Evaluation Group, 2016]. These documents can be quickly rendered out-of-date with changing technologies, policy agendas, economics for electricity access, and progress in electrification. The IEG instead recommends systematic least-cost planning supported by geographic information systems.

Several techno-economic electrification models that consider the spatial component (also referred to as LCEM, Least-Cost Electrification Models) have been proposed [Ellman, 2015, Kemausuor et al., 2014, Mentis et al., 2017, Pinedo-Pascua, 2010]. However, despite of the efforts made, there is not a methodology or model of planning, universally accepted. In this sense, there is a significant variability between the computational logics adopted for the models. The ways in which they fight with the missing data, and the different simplifications that they realize to face up to the computational complexity, that involves determining the ideal position of every technology. In the same way vary: the parameters are used, the technologies that are considered, as well as geographies (regions within countries, countries and continents) in which they are applied [Morrissey, 2019].

The creation of the planning analyses may also be limited, for the costs related to the use and/or acquisition of some models, since in general they are based on privative software. In order to achieve greater diffusion and accessibility, this is an important issue to solve, because some users can't afford this charge due to the limited budget of their projects. In line with the above, this paper describes a freeware GIS tool for the techno-economic evaluation of rural electrification alternatives. It carries out an implementation of the IntiGIS model to perform the calculations, a flexible model capable of adapting to the realities of different scenarios.

✉mtperez@ult.edu.cu, ✉javier.dominguez@ciemat.es, ✉tatico890530@gmail.com, ✉mpabreu@uci.cu

## RESEARCH BACKGROUND AND METHODOLOGY

In the middle nineties, the European Union decided to fund the research project SOLARGIS[1]: Integration of renewable energies for decentralized electricity production in regions of European Economic Community and developing countries [Solargis-Team, 1996]. The SOLARGIS methodology is based on a calculation and comparison of LCOE, pixel by pixel, of the kWh produced by the systems included in the analysis, both renewable and non-renewable. The methodology were applied with satisfactory results in the state of Karnataka in India [Mahmmud et al., 1996], on the island of Santiago (Cabo Verde) [Monteiro et al., 1998] and in several Tunisian cities [Vandenbergh et al., 1999].

This first version was improvement later to SOLARGIS II, in the frame of the collaboration established between the CIEMAT and UPM (Polytechnic University of Madrid). The aim of this collaboration was to determine the grade of uncertainty of the results provided by SOLARGIS and to develop a new application with high certainty in the results quality [Amador, 2000, Amador & Domínguez, 2005]. Special mention needs to be paid to the spatial sensitivity analysis implemented to check the stability of the results [Amador & Domínguez, 2006].

The continuity of the previous study, led into a new model for rural electrification with renewable energies: IntiGIS. This model included new advances in methodological questions as well as the incorporation of new renewable technologies and the application to new areas, specially, to Latin America countries [Domínguez et al., 2008]. Finally, Irene Pinedo in her PhD thesis create the first version of the IntiGIS tool [Pinedo-Pascua, 2010]. For the validation, study of three cases were carried out: Guamá (Cuba), Acandí (Colombia) and Cobán (Guatemala).

In addition, other cases study have been made: in the province of Carchi in Ecuador [Martínez Sarmiento, 2012], in Sao Tome Island (Africa) [Pons et al., 2013]. Also Alba Page Arias, made a case study for the entire Ghana country [Page Arias, 2015], and also started the work for the upgrade from IntiGIS 1.0 (ArcGIS 9.x) to IntiGIS 2.0 (ArcGIS 10.x). In this sense, a new Guamá case study was developed [Romero Otero, 2016]. All mentioned studies were done using an implementation of the model based on ArcGIS software, using raster data, and with six electrification alternatives.

In 2017, the CIEMAT and ULT (University of Las Tunas, Cuba); sign an agreement frame of cooperation to establish the collaboration between the two institutions. The current investigation, is accomplished in this frame of cooperation, and aims to provide a continuity of the research [Torres-Pérez, 2018, Torres-Pérez et al., 2019] that describes a tool for the planning of rural electrification taking into account criteria of the territorial ordering. In this sense, was set the objective to create a version of the IntiGIS model in a free software environment and also add a new electrification alternative: mini-grid photovoltaic-diesel [Hernández Leyva, 2019]. Also, ULT is a collaborator of the HIBRI2 project[2], directed for the CIEMAT, and where several institutions from Spain and Cuba work togethers [CIEMAT, 2020].

### Model general process

As can be seen in the Fig. 1, the general process of the plugin LECGIS (acronym of Levelized Electricity Cost Geographic Information System) is based on four steps. The two first steps are related with the model inputs needed for the calculations of the Levelized Cost of Electricity (LCOE). 1) The user most set the data required for calculations. 2) The plugin will calculate

[1] Developed in the frame of the program JOULE II, this project was coordinated by the Centre d'Energétique Armines (France) and involved several European centers related with renewable energies: Conphoebus (Italy), CIEMAT (Spain), CRES (Greece), INESC (Portugal, RAL (Unite Kingdom) and NMRC (Ireland).

[2] "Integrated control system for energy supply through hybrid systems in isolated communities in Cuba. Phase II (2018/ACDE/000600)". Financed by Spanish International Cooperation and Development Agency (AECID), through its call for innovation projects 2018.

✉mtperez@ult.edu.cu, ✉javier.dominguez@ciemat.es, ✉tatico890530@gmail.com, ✉mpabreu@uci.cu

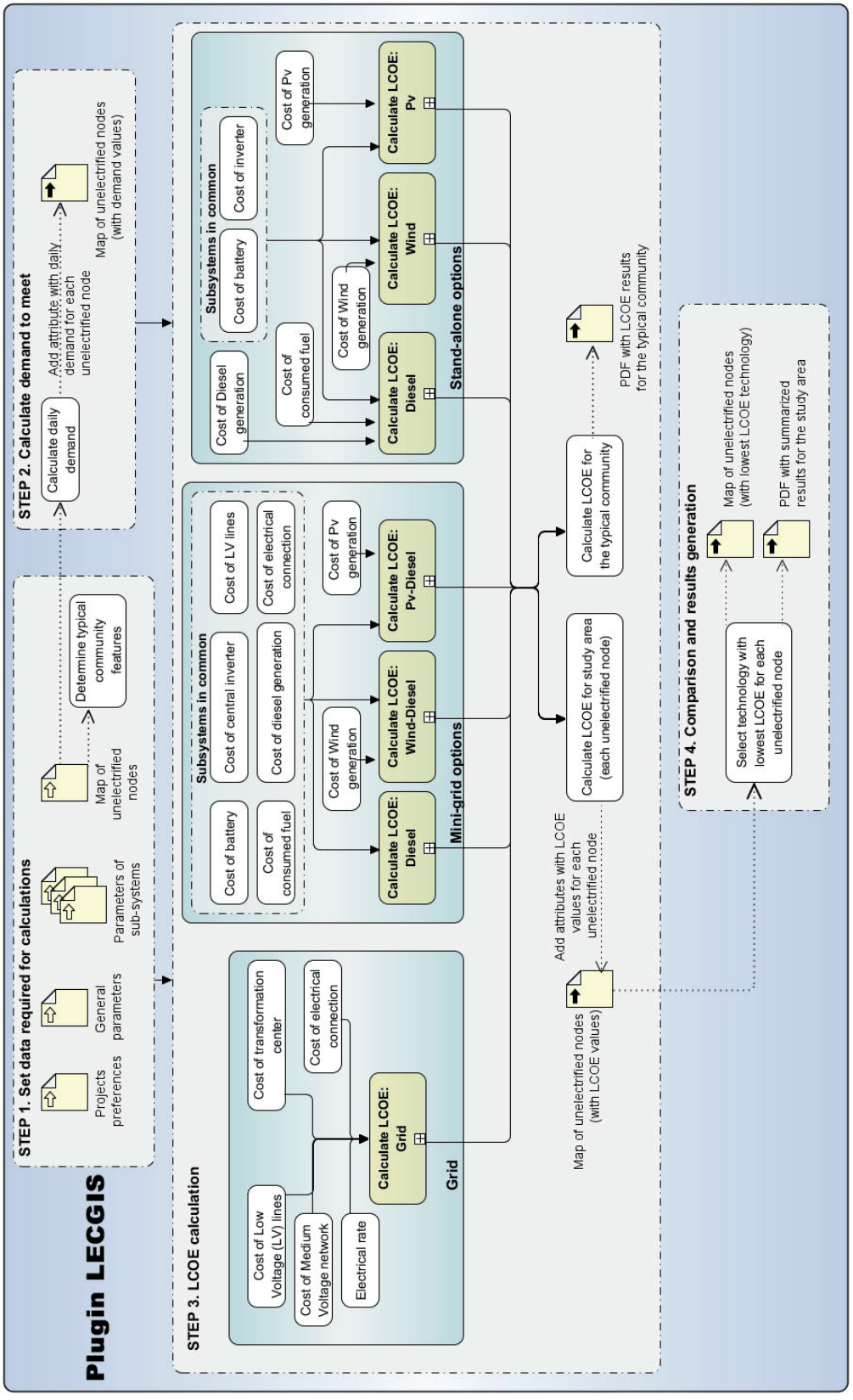


**Fig. 1.** General process diagram of the plugin LECGIS
*Source:* own study.



✉mtperez@ult.edu.cu, ✉javier.dominguez@ciemat.es, ✉tatico890530@gmail.com, ✉mpabreu@uci.cu

the demand of energy to meet for the electrification alternatives. 3) For each node of the study area will be calculated the LCOE (one or various, depending of the technologies selected by the user). 4) Comparison of rural electrification technologies, to determine the lowest LCOE value for each unelectrified node (this term refers to a register of the map that could represent a house, settlement or community). Additionally, the system will generate PDF reports with the results.

## Data requirement

For the use of the plugis is necessary a map in vector format with the geometries that represents the location of the demand nodes. Furthermore, this vector map should have as socioeconomic information associated to the geometries, the attributes: number of houses or people, longitude of low voltage lines, distance to the electrical network, solar radiation and wind speed.

The request of some and other parameters could vary, depending on the electrification alternatives that the user is going to analyze. For example, if the user is not going to analyze an alternative that use wind energy, the wind speed parameter won't be solicited. Figure 2 shows, how to employ the functionalities of the plugin ExamZonas [Torres-Pérez et al., 2019] for gather into a single map, the information needed for the later use of the plugin LECGIS.

## Description of the GIS tool

The tool developed is based on QGIS plugin, which is compatible with the versions 2.x. This implement the functionalities: manage projects, calculating data for a house or typical community, calculating demand for houses and communities, calculating LCOE for an area of study, compare systems of electrification and generate PDF reports with LCOE for house or typical community. The main user interface of the plugin (see Fig. 4) is composed for eight tabs: one for the general parameters and the following, for each one of the systems to be considered. At the bottom part there is a progress bar to indicate the advancement of calculations and next to it the icons: save data, editing project, calculate LCOE and compare systems of electrification, in that order from left to right.

For each tab there are two buttons located in the up-right part, for validate data (Fig. 3a) and edit data (Fig. 3b). When the validate button is pressure, the plugin verify the data introduced by the user, and if the data is correct, the button will turn into (Fig. 3c) and the form fields in the tab will disabled.

The user only will be able to edit again the fields, if presses the button edit data, with that the validating button will become red again. Hereafter will describe the data required for calculations and the steps to do in the tool for make the calculations.

First the user must set the project preferences (project name and path), after will appear the main

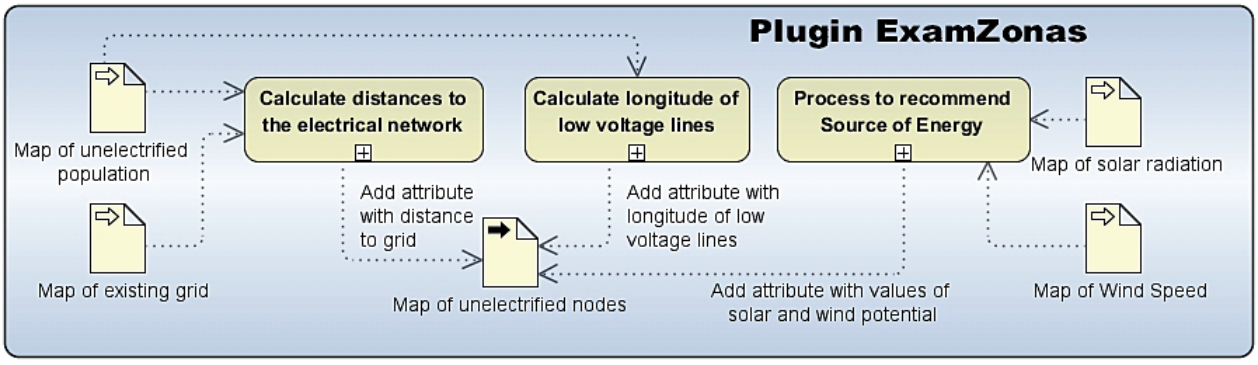


**Fig. 2**. Functionalities of the plugin ExamZonas to guarantee the data needed for later LCOE calculations
*Source*: own study.

✉mtperez@ult.edu.cu, ✉javier.dominguez@ciemat.es, ✉tatico890530@gmail.com, ✉mpabreu@uci.cu


**Fig. 3.** Buttons in the GIS tool: a) validate data, b) edit data, c) ready
*Source*: own study.

interface of the plugin. On the tab of the general parameters (see Fig. 4), must input the characteristics of the demand scenario and the economic parameters. Also, when loads the map of unelectrified nodes and select the attributes corresponding to each characteristic of the study area, the features of the typical community will be calculated automatically. If the field selected is correct, the result is displayed next to the right of each field, and the indicator of the field will convert to a green checkbox.

## Setting data required for calculations

Furthermore, it is possible to define if the analysis will be done for houses or communities, by marking the checkbox "analysis for houses". From this way, the tool can distinguish if each node of the map corresponds to a single house or community. In the analysis for houses, the user must select the clustering attribute (identifier of the group who belong each house) for the constructions of mini-grids. Finally, the user must enter the parameters of the rest of the subsystems. On the Fig. 5, can be see the parameters of the Photovoltaic-diesel system.

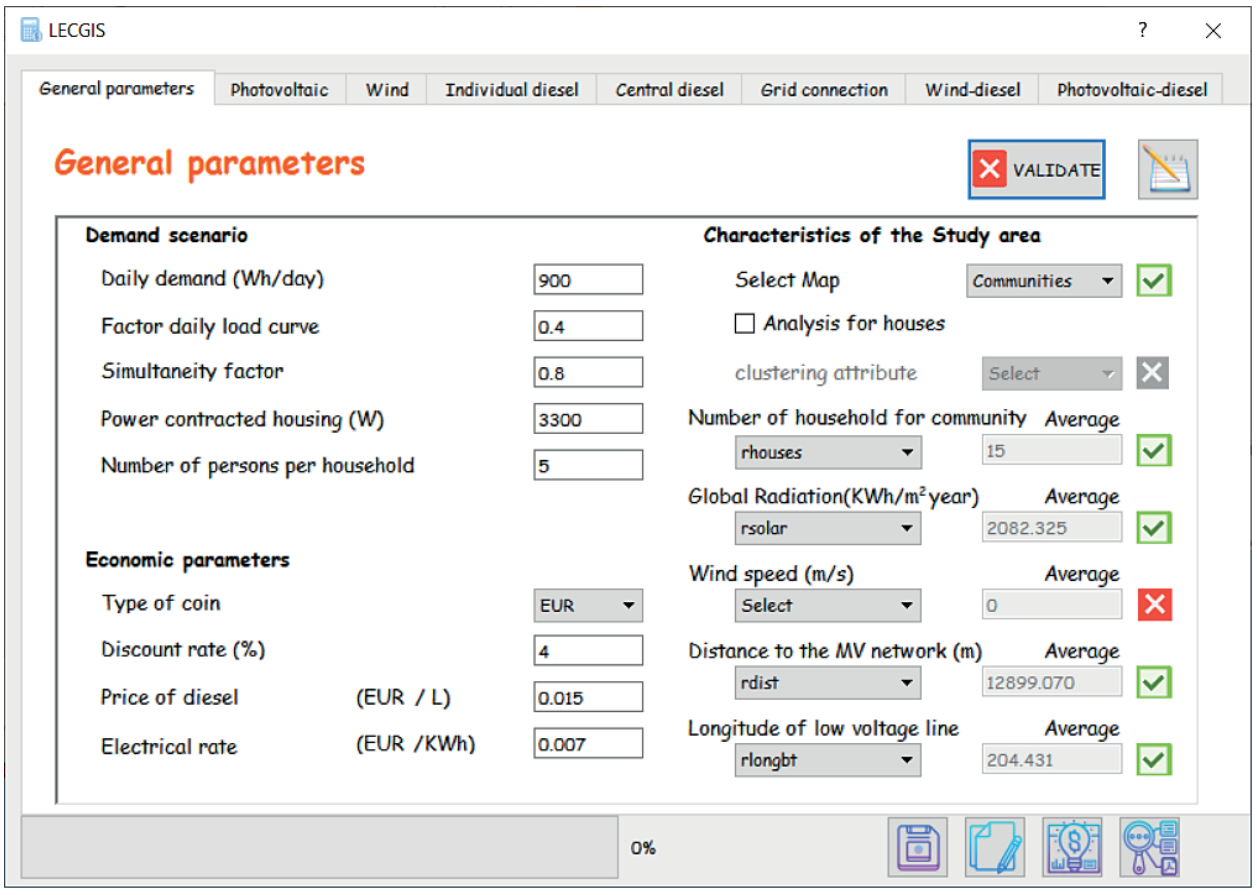


**Fig. 4.** Tab of the general parameters with data of the Guamá study case
*Source*: own study.

✉mtperez@ult.edu.cu, ✉javier.dominguez@ciemat.es, ✉tatico890530@gmail.com, ✉mpabreu@uci.cu

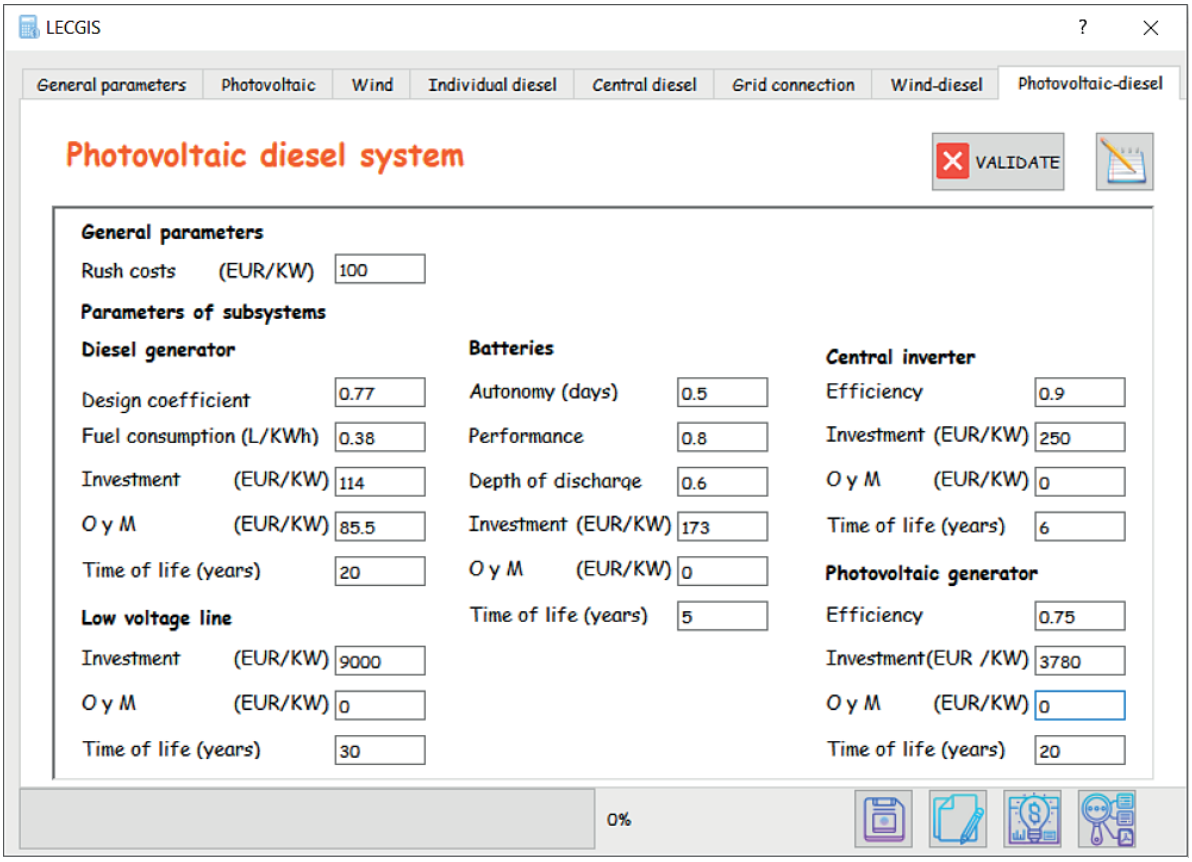


**Fig. 5.** Fields of the Photovoltaic-diesel system and subsystems
*Source*: own study.

## Calculate demand to meet and LCOE

When the user presses the button for calculate LCOE, will be displayed the interface to select the systems for which the LCOE will be calculated (see Fig. 6). Systems whose data have not been previously validated will appear disabled on the interface, as happen with individual diesel and wind-diesel systems. Also, can select if want to perform the analysis for the study area, typical community or both.

If the user selects the study area analysis, for each node in the map will be calculated the daily demand to meet. The annual demand is a product from the daily demand for 365. Subsequently, for every node of the study area will be calculated the LCOE corresponding to each electrification option. As can be seen in the Fig. 1, the cost of each alternative

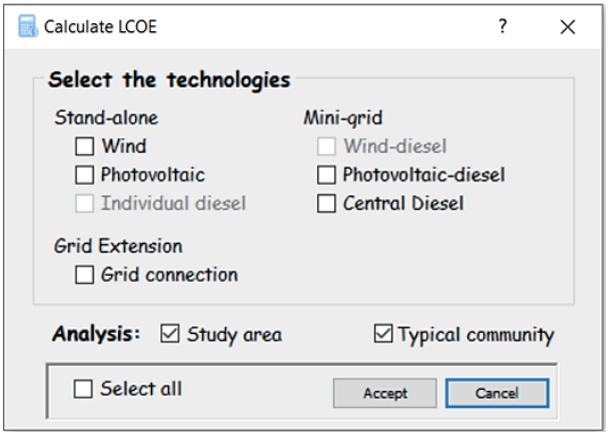


**Fig. 6.** Interface to select the systems for which the LCOE will be calculated
*Source*: own study.

✉mtperez@ult.edu.cu, ✉javier.dominguez@ciemat.es, ✉tatico890530@gmail.com, ✉mpabreu@uci.cu

of electrification, is a summation of the subsystems that compose it. For more information about the LCOE formulas, consult the thesis [Amador, 2000]. The values of the LCOE will be added to the map, in a new column, when the calculus operations are completed. In the case that be selected a typical community analysis, the system will generate a report in pdf format with the results.

## Comparison and result generation

The functionality for compare systems of electrification in a study area, display an interface similar to the Fig. 6, for the selection of the systems to compare. When the accept button is pressed the plugin will select the best alternative of electrification for each node of the study area. Also, a report in pdf format will be created with the results of the comparison of the technologies summarized.

Will be described below, the application of the tool in the municipality of Guamá (Cuba), the maps and parameters (general and for all systems, except photovoltaic-diesel) used was the corresponding to the realized for [Romero Otero, 2016] from a revision of the study case accomplished by [Pinedo-Pascua, 2010] with IntiGIS 1.0. Nevertheless, the distance to the electrical network was calculated using the functionality for calculate distances to the electrical network of the plugin ExamZonas, and employing as inputs the vector layer (points) of the unelectrified communities and the vector layer (lines) of the electrical network, from the study of 2010. As was expected, the obtained distances were different, because in IntiGIS 1.0, the aforementioned vector layers were rasterized to a resolution of 500 m, causing a deviation to the measure of the distances.

The maps of solar radiation, wind speed and longitude of low voltage lines, were converted from raster to vector for their use in LECGIS. Finally, all attributes were gathered into the map of the unelectrified communities. As it was described in previous sections, the parameters (see Fig. 4 and Fig. 5) required for calculations were established, and also were calculated the demand to meet and the LCOE for the seven electrification alternatives.

Another difference was found in the characteristics of the typical community, for illustrate the variation will be taken as example the solar radiation parameter. In this sense, IntiGIS 1.0 calculate de average from all the values existing in the map of solar radiation, but LECGIS calculate the average from the values of the radiation presented in the communities. The Table 1, show the comparison of the values for the Guamá typical community in both tools. In the case of the IntiGIS's wind-diesel system, the cause of the variations was that instead of using 114 €/kWh as the investment for the diesel generator, was used 380 €/kWh (the investment of the individual diesel system). Small variations were got in the others systems, due to the changes in the characteristics of the typical community. All calculations, were verified in the software Mathcad.

**Table 1.** Comparison of the results obtained in IntiGIS 1.0 and LECGIS tools for the Guamá typical community

| Characteristics | IntiGIS 1.0 | LECGIS |
|---|---|---|
| Number of houses | 15 | 15 |
| Solar radiation (kWh/m$^2$ year) | 2065,9 | 2082.325 |
| Wind speed (m/s) | 4.5 | 4.5 |
| Distance to the MV network (m) | 12672,01 | 12899.07 |
| Longitude of LV line (m) | 204,44 | 204.431 |
| LCOE (cts €/kWh) | | |
| Photovoltaic | 62.436 | 62.255 |
| Wind | 80.091 | 80.091 |
| Individual diesel | 282.887 | 282.887 |
| Central diesel | 145.098 | 145.096 |
| Grid connection | 303.906 | 308.484 |
| Wind-diesel | 117.25 | 81.962 |
| Photovoltaic-diesel | - | 166.181 |

*Source*: own study.

The results for the study area with the LECGIS tool (see Fig. 7), show a clear prevalence of the photovoltaic system, being the most competitive technology in 58 of the 68 communities. In four communities (number 12, 28, 45 and 62, indicated with red stars in the map), was obtained the photovoltaic system as best alternative, when IntiGIS 1.0 showed the grid connection.

✉mtperez@ult.edu.cu, ✉javier.dominguez@ciemat.es, ✉tatico890530@gmail.com, ✉mpabreu@uci.cu

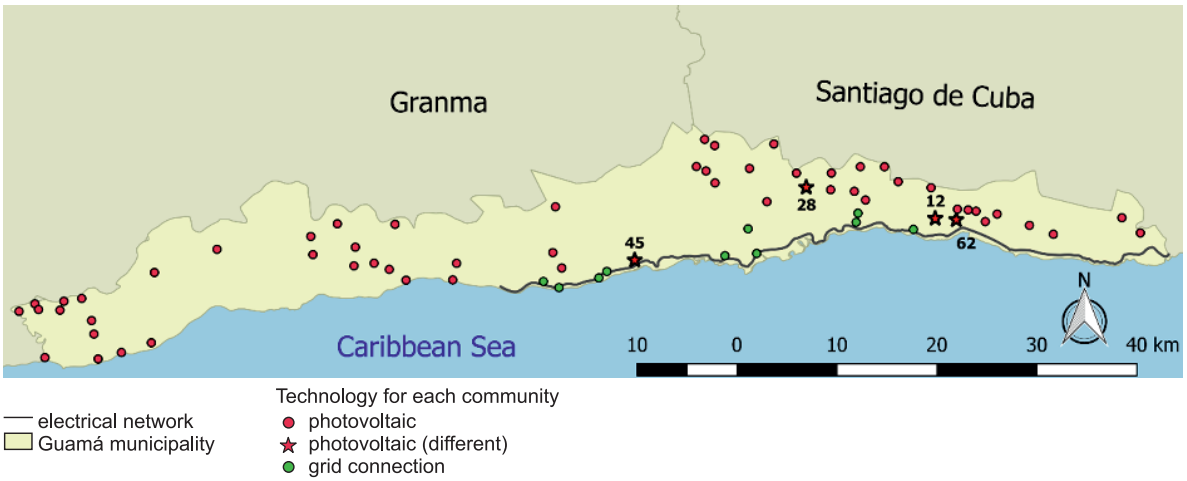


**Fig. 7.** Most competitive technology for each community of the study area with LECGIS
*Source*: own study.

**Table 2.** Comparison of the obtained results with IntiGIS 1.0 and LECGIS tools in the communities' number 12, 28, 45 y 62 of Guamá

| Characteristics | 12 | | 28 | | 45 | 62 |
|---|---|---|---|---|---|---|
| | IntiGIS 1.0 | LECGIS | IntiGIS 1.0 | LECGIS | LECGIS | LECGIS |
| Number of houses | 40 | 40 | 62 | 62 | 4 | 10 |
| Solar radiation (kWh/m$^2$ year) | 2054.95 | 2054.95 | 2061.15 | 2061.15 | 2149.48 | 2168.83 |
| Wind speed (m/s) | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Distance to the MV network (m) | 1500 | 1634.48 | 4924.42 | 4660.14 | 455.47 | 971.05 |
| Longitude of LV line (m) | 329.20 | 329.20 | 198.32 | 198.32 | 216.89 | 157.91 |
| | | | LCOE (cts €/kWh) | | | |
| Photovoltaic | 62.55 | 62.55 | 62.48 | 62.48 | 61.54 | 61.34 |
| Wind | 80.09 | 80.09 | 80.09 | 80.09 | 80.09 | 80.09 |
| Individual diesel | 282.88 | 282.88 | 282.88 | 282.88 | 282.88 | 282.88 |
| Central diesel | 145.09 | 164.86 | 145.09 | 144.12 | 147.07 | 137.72 |
| Grid connection | 34.29 | 74.55 | 38.32 | 62.94 | 110.53 | 74.99 |
| Wind-diesel | 117.25 | 101.73 | 117.25 | 80.99 | 83.93 | 74.59 |
| Photovoltaic-diesel | - | 186.18 | - | 130.18 | 132.18 | 122.63 |

*Source*: own study.

One cause was that IntiGIS 1.0, assigned automatically the grid connection as most competitive option for nodes located less than 800 meters from the electrical network. That is the case of the communities' number 45 and 62[3] and the reason why in the Table 2, only appears the LECGIS's values for these communities. Besides, the values of the grid connection for Intigis 1.0 aren't correct, something that was pointed by [Romero Otero, 2016] on his revision of this study case, with Intigis 1.0, and that we confirmed through the Mathcad. It is notable that the values for this system are lower in IntiGIS 1.0, and that's why it was indicated the grid connection as the best alternative for the communities 12 and 28.

The values for the individual systems (photovoltaic, wind and diesel) are the same in both tools, but the values for the central diesel and wind-diesel,

[3] In Intigis 1.0 the distances obtained to the MV network for these communities were 500 m and 707.10 m respectively.

✉mtperez@ult.edu.cu, ✉javier.dominguez@ciemat.es, ✉tatico890530@gmail.com, ✉mpabreu@uci.cu

do not match. In addition, the communities 12 and 28 have the same values for the centralized systems in IntiGIS 1.0, even when the characteristics of these communities are distinct. It was confirmed through the Mathcad, that the values that correspond to the centralized systems, are the ones that LECGIS returned.

## DISCUSSION, CONCLUSIONS AND NEXT STEPS

The plugin developed in this paper constitutes an effort in the contribution for planning the electrification in developing countries at a national and regional level. The presented approach is complementary to already existing energy planning models, which do not consider the geospatial characteristics of energy resources. In concordance with the aforementioned, the LECGIS plugin allows to calculate and compare the LCOE of a set of seven electrification options: stand-alone (photovoltaic, wind, diesel), mini-grid (diesel, wind-diesel, photovoltaic-diesel) and grid connection, supporting the decision-making in the planning of rural electrification projects. Allows the clustering of isolated houses, for a better modelling of the cost of the centralized systems.

The complementary use of LECGIS with the tool ExamZonas, will improve the electrification strategies towards the implementation of sustainable solutions, with the consideration of criteria and concepts of the territorial ordering, so as to avoid conflicts in land-use or the preservation of resources and the environment. Also, improve the calculation of the longitude of LV lines, considering the geometric center of a group of houses, and no the center of the pixel like the previous versions of IntiGIS based on raster. This have a direct repercussion in the cost of the centralized systems, based on mini-grid.

The development of the tool with freeware facilitates the enlargement of additional components and its employment and diffusion. The tool is currently being further developed, and the improvements will be presented in future publications. Some of the next steps in the progress include: improving the extension algorithm of the grid and the clustering of households, for deciding whether to serve them with electrification alternatives based on mini-grid or with the grid. Also, may include additional hybrid-technologies combinations.

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✉mtperez@ult.edu.cu, ✉javier.dominguez@ciemat.es, ✉tatico890530@gmail.com, ✉mpabreu@uci.cu

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✉mtperez@ult.edu.cu, ✉javier.dominguez@ciemat.es, ✉tatico890530@gmail.com, ✉mpabreu@uci.cu

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✉mtperez@ult.edu.cu, ✉javier.dominguez@ciemat.es, ✉tatico890530@gmail.com, ✉mpabreu@uci.cu

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# ANALYSIS OF THE PROCESS OF PUBLIC PROPERTY DISPOSAL. MUNICIPALITY OF KRAKOW – THE CASE STUDY

Anna Trembecka✉

ORCID: 0000-0001-5098-7649
AGH University of Science and Technology
Mickiewicza avenue 30, 30-059 Krakow, **Poland**

## ABSTRACT

This research paper analyses the process of public property disposal on the example of the Municipality of Krakow, especially focusing on the scope of the real properties covered by this process in years 2017–2019, the disposal methods used and the revenues obtained.
The research problem is to answer the question of how the scope of real properties disposed of by the Municipality, the forms of their disposal and the revenue obtained have changed when compared to the previous years, i.e. the period 2010–2014. This paper also attempts to identify the conditions hindering the process.
In order to assess the trend of changes, a comparative analysis of the data on the disposal process in the analysed years was performed. Part of the research area was devoted to limitations in real property disposal in terms of former owners' claims for restitution.

**Keywords:** municipal real property management, modes of property disposal, revenue, claims for restitution

## INTRODUCTION

Real property management is a term which covers all factual and legal actions performed with respect to real properties. The Act of 21 August 1997 on Real Estate Management specifies the types of these activities in relation to the properties that belong to public resources.

Competent authorities are obliged to manage public properties in accordance with the law and, at the same time, in a rational manner. This means that it is necessary to analyse the benefits and losses for the local government unit or the State Treasury resulting from the actions taken, as well as the assessment of other factors that affect the legitimacy of taking a specific action.

One of the goals of proper real estate management is to invest effectively in order to achieve maximum benefits and the greatest social utility. However, it should also be taken into consideration that public property resources may include some properties that do not generate income, e.g. those that are protected due to their social purposes, used for the performance of public tasks, or intended for use by all residents.

Proper management also includes making rational decisions regarding the disposal and purchase of real estate, taking into account both economic aspects and the necessity to perform public tasks. In the disposal process, it is important for public entities

✉trembec@agh.edu.pl

not only to obtain income but also to organise the spatial structure of the properties and to regulate their legal status for the benefit of owners in order to prevent the process of acquisitive prescription.

One of the sources of the municipal revenue is the sale of their property. Not always, however, the planned revenues will support their budgets because, first of all, legal regulations, secondly, the desire to obtain the highest possible price, and thirdly, the expectations of a potential buyer, often form an insurmountable barrier. As a result, the municipality does not generate income that could be spent on investments, and moreover, it incurs additional costs related to the property that could not be sold [Kotlińska, 2013].

In the light of the provisions of the Act on Real Estate Management, as well as other acts, public property should be managed as follows [Bończak-Kucharczyk, 2020], and in particular:
- according to the law;
- respecting the principle of purposefulness and economy;
- rationally in economic terms and effectively;
- observing the principle of openness;
- enabling social control over whether the manner of managing these assets serves the achievement of socially accepted goals and principles.

According to Kotlińska, it is advisable to prepare:
- a multiannual document defining the (physical and legal) condition of local government properties, their value, related financial flows, etc., with the detail enabling to decide which of them should be included in the local government resource because they are necessary or useful, and for which there is no place in this resource;
- an annual reporting document on the management of local government properties, which would be helpful in the assessment of this economy and the entities conducting it [Kotlińska, 2014].

The subject of Marona [2018] is the management of municipal real properties as an area of theoretical considerations and empirical research within the subdiscipline of public management. The aim of the study of Hełdak [2009] is to present the legal conditions for managing the municipal real property resource and to evaluate the management of real properties included in the urban-rural real estate resource of the commune of Gostyń. The paper of Nalepka [2008] analyses the organisational problems of managing the municipal real property resource.

The issue of real estate management, especially in theoretical terms, has been tackled in numerous works, including [Bończak-Kucharczyk, 2020, Jaworski et al., 2009, Klat-Górska & Klat-Wertelecka, 2015].

The commentaries to the selected procedures regarding real estate management are presented in the book [Źróbek et al., 2012]. The publication [Trembecka, 2015] lists proposed methods to be implemented in the process of practical real estate management, taking into account surveying and legal problems that may emerge.

An important factor limiting public property disposal are the provisions on the rights of former owners of expropriated real estate. The publication [Trembecka & Kwartnik-Pruc, 2018] deals with the effect of the claims for the restitution of expropriated real properties on the process of public property management. The restitution of expropriated properties is known in many countries. Should the expropriating authority fail to use the property within a specified time for the intended purpose, the property may return to the former owner, e.g. in Canada under the Act respecting the expropriation of land [Act respecting the expropriation of land, 1985] or in Germany under the Baugesetzbuch [Baugesetzbuch, 1960]. On the other hand, in France, the Code de l'expropriation pour cause d'utilité publique [2015] provides for a retrocession for 30 years in relation to property expropriated and not developed within five years. This issue regarding the post-communist countries before 1990 is discussed in [Lux & Mikeszova, 2012, Padure & Tutuianu, 2015, Triantis, 2018].

The aim of this research paper is to analyse the disposal process of public properties on the example of the Municipality of Krakow, in particular to determine the scope of the properties covered by this process in years 2017–2019, the modes that were used and the revenues that were obtained.

✉trembec@agh.edu.pl

The research problem involves providing the answer to the question of how the scope of real properties disposed of by the Municipality, the forms of their disposal and the revenues obtained have changed when compared to the period 2010–2014. This paper also attempts to identify the conditions hindering the process, especially the effect of potential claims of the former owners on the scope of the properties planned for disposal.

In order to assess the trend of changes in the scope of the municipal properties being disposed of, the data on the disposal process from the period 2017–2019 was compared with the data from the period 2010–2012 as far as tender procedure is concerned, and with the data from the period 2012–2014 with regard to a non-tender mode.

The research hypothesis is the statement that one of the reasons limiting the process of public land disposal is the obligation to notify former owners about the possibility of restitution of the expropriated properties.

This study is a continuation of the research of Trembecka [2014 & 2016] on the process of real property disposal performed by the Municipality of Krakow. The research material consisted of the data collected from the City Treasury Department of the Municipal Office of Krakow on the implementation of tasks in property management in years 2010–2019, the budget of the City of Krakow and the legal acts on public property management, both generally applicable and those constituting the local law.

## LEGAL FORMS OF PROPERTY MANAGEMENT IN THE MUNICIPALITY OF KRAKOW

Real property management of the Municipality of Krakow is based on generally applicable legal acts [Act on Real Estate Management, 1997, Civil Code, 1964], separate provisions concerning real estate management contained in Article 2 of [Act on Real Estate Management, 1997] as well as acts of local law included e.g. in the resolutions of the Krakow City Council [Resolution on the real estate management, 2003, Resolution on the sale of commercial premises, 2006, Resolution on the rules of disposal of residential premises, 2008].

As of 31 December 2019, the area of land in the resources of the Municipality of Krakow amounted to 5,535 ha, with 3,039 ha remaining in the permanent management of municipal organisational units and in the statutory management as roads. The publication [Trembecka, 2017] presents the importance of this form of managing public land in the city of Krakow.

Public properties may be object of trade [Trembecka, 2015], including in particular:

- disposition, i.e.: sale, exchange, donation, renunciation, making in-kind contributions to companies, bestowing on established state enterprises, transferring as property of established foundations;
- letting into perpetual usufruct;
- encumbrances with limited material rights, i.e. right-of-way, usufruct, mortgage;
- free of charge transfer by contract to a private partner or company, for the duration of the project under public-private partnership;
- bond agreements, i.e. rental, lease, lending;
- letting into permanent management.

The activities listed above are defined in Article 13 sections 1 and 1a of the Act on Real Estate Management [1997] with the term "real estate transactions". In this context, it should be understood as any legal action leading to a change of the entity that is entitled to any right to real estate which, before this action (and often also after its execution), was owned by the State Treasury or owned by a local government unit.

The catalogue of legal forms contained in Article 13 section 1 of the Act on Real Estate Management [1997] is a non-exhaustive one as there is no prohibition on concluding contracts not listed therein, including unnamed contracts (e.g. leasing contracts). The basic activities of real property resource management include its sale and purchase, mainly aimed at ownership right transfer [Hełdak, 2009].

This research paper will present the process of managing the properties owned by the Municipality of Krakow in terms of their disposal and the attempts to identify the conditions hindering the process,

✉trembec@agh.edu.pl

especially the effect of potential claims of the former owners on the scope of the properties planned for disposal.

The conducted analyses demonstrate that in years 2017–2019, the properties owned by the Municipality of Krakow were most frequently sold. They were also let into perpetual usufruct, but to a very limited extent. Other forms of disposal including donation, renunciation, making in-kind contributions to companies, bestowing on established state enterprises or transferring as property of established foundations were not used. As far as real estate exchange is concerned, these procedures were used in exceptional cases and therefore they were omitted from further analysis.

## DISPOSAL OF REAL PROPERTIES OWNED BY THE MUNICIPALITY OF KRAKOW UNDER TENDER PROCEDURE

The freedom to intend a given property for disposal is limited – the municipality is obliged to separate properties for administrative purposes that are necessary for its proper functioning as well as for public purposes such as urban greenery, sports and recreation areas, roads [Cymerman, 2009].

The decision on the form of property disposal depends on many factors, including e.g.: property type, its location, configuration, area, legal status, land use or the current method of use, as well as possible limitations in exercising the ownership right.

The disposal of real properties or letting land into perpetual usufruct was implemented by public tender (which is the general statutory rule) or without the tender procedure.

The tender procedure for selecting a buyer is primarily to ensure full transparency in this activity and contribute to the maximisation of profit from the distribution of the property right by a public entity [Sanakiewicz, 2015].

In 2017–2019, under the public tender procedure, the Municipality disposed of 15 undeveloped land properties with a total area of 2.9427 ha and obtained the revenue of approximately PLN 8.8 million, 18 built-up land properties with a total area of 2.3860 ha of land and 3,868 m² of usable floor space of buildings and earned over PLN 35 million. The Municipality also sold 95 premises (including 73 residential premises) with a total usable floor space exceeding 5,305 m² for over PLN 11 million (see Tab. 1–3). The total sale price of municipal real estate exceeded PLN 55 million. For example, in 2005–2007, the commune of Gostyń sold 48 properties for the price of approximately 2.8 million [Hełdak, 2009].

In each case, these were open oral tenders, and the starting price was determined at the market value specified by a property appraiser plus 23% VAT if the sale of such real estate was taxable. If the first tender ended with a negative result, the starting price in the second tender procedure was set lower than its value, but not less than 20% of this value (pursuant to Article 67 section 2 clause 2 of Act on Real Estate Management [1997], the reduction may not exceed 50%).

The majority of these activities required the consent of the governing body of the Municipality, as the Krakow City Council, in its resolution [Resolution on the real estate management, 2003], reserved to its competence to consent to the disposal and perpetual usufruct of real properties under the tender procedure, except for those intended for single-family housing, for the construction of garages with an area not exceeding 50 m² and for the implementation of technical infrastructure. Investment areas suitable for independent development are usually disposed of in this mode.

**Table 1.** Undeveloped land properties disposed of by Municipality of Krakow under tender procedure in years 2017–2019

| Years | Number of properties | Total area of undeveloped land [ha] | Revenue from disposal of undeveloped land [PLN] |
|---|---|---|---|
| 2017 | 10 | 1.3313 | 6,664,661 |
| 2018 | 4 | 1.3975 | 1,532,982 |
| 2019 | 1 | 0.0835 | 141,000 |
| Total | 15 | 2.9427 | 8,780,156 |

*Source*: own elaboration.



✉trembec@agh.edu.pl

**Table 2.** Developed land properties disposed of by Municipality of Krakow under tender procedure in years 2017–2019

| Years | Number of properties | Total area of developed land [ha] | Usable floor space of buildings [m²] | Revenue from disposal of developed land [PLN] |
|---|---|---|---|---|
| 2017 | 5 | 0.3146 | 1,683.9 | 15,800,370 |
| 2018 | 6 | 1.5427 | 1,044.24 | 8,222,006 |
| 2019 | 7 | 0.5287 | 1,140 | 11,809,744 |
| Total | 18 | 2.3860 | 3,868.14 | 35,390,607 |

*Source*: own elaboration.

The research confirmed the changes in the type of real estate disposed of over time, including a decrease in the number of undeveloped land offered for sale and an increase in the number of premises. In years 2017–2019, the Municipality of Krakow disposed of only 15 undeveloped land properties, while in 2010–2012 it was a total of 67. On the other hand, as many as 73 residential premises were sold in the analysed period, and in 2010–2012 this number was 31.

The total revenues from the disposal of municipal properties in the analysed period exceeded PLN 55 million, while in the period 2010–2012 it was approximately PLN 100.5 million.

The local government income from property disposal is determined by numerous factors. Firstly, the local government resource must contain such property that can be intended for sale. Secondly, the tender procedure of sale must be followed, which usually lasts for many months. Thirdly, there must be entities willing to buy the property, who will have the appropriate financial resources [Kotlińska, 2013].

The above conditions can also be applied to the process of property disposal carried out by the Municipality of Krakow.

In addition, an important factor responsible for the reduction in the number of real properties intended for disposal in Krakow are claims of third parties, i.e. mainly of the former owners, for the restitution of the expropriated real estate. This issue will be discussed in the next Chapter.

Real properties with priority rights are excluded from the tender [Article 34 sections 1 and 6 of Act on Real Estate Management, 1997]. Pursuant to this provision, in the case of disposal of properties owned by the State Treasury or local government units, priority in their purchase (Tab. 4) is granted to a person who meets certain conditions (the so-called statutory priority). It covered a wide range of tenants of residential premises, if the lease was concluded for an unspecified period.

**Table 3.** Disposal of premises by the Municipality of Krakow under tender procedure

| Years | Type of premises | Number of premises | Total floor space of premises [m²] | Revenue from disposal [PLN] | Total annual revenue from disposal [PLN] |
|---|---|---|---|---|---|
| 2017 | residential | 26 | 2,195.43 | 12,011,010 | 1,281,730 |
| | commercial | 2 | 50.61 | 256,852 | |
| | garages | 8 | 202.45 | 467,425 | |
| | attic | 1 | 91.9 | 82,020 | |
| 2018 | residential | 35 | 1,592.93 | 12,164,642 | 1,274,657 |
| | commercial | 3 | 104.46 | 506,651 | |
| | garages | 2 | 24.74 | 75,270 | |
| 2019 | residential | 12 | 958.22 | 8,392,530 | 8,772,462 |
| | commercial | 2 | 31.97 | 224,264 | |
| | garages | 4 | 67.96 | 155,668 | |
| Total | | 95 | 5,305.66 | 11,328,849 | 11,328,849 |

*Source*: own elaboration.

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**Table 4.** Statutory (obligatory) and discretionary (optional) priority

| Entities with obligatory (statutory) priority right | Entities who may be entitled to discretionary (optional) priority right |
|---|---|
| Persons with a claim for the purchase of a property under the Act on real estate management or separate regulations | Tenants or lessees of commercial premises |
| Previous owners of the property subject to disposal, deprived of the ownership of this property before 5 December 1990, or their heirs | Tenants or lessees of residential and commercial premises which are entirely subject to tenancy or lease |
| Tenants of residential premises if the tenancy was concluded for an unspecified period | Tenants of residential premises with contracts concluded for a specified period |

*Source*: own elaboration.

The right of priority should be distinguished from the right of preemption and repurchase regulated in other legal provisions. Priority may be exercised by the entitled persons only when the State Treasury or a local government unit allocates a given property for sale, publishing its catalogue.

In addition, the Act allows for the possibility of extending the right of priority in the purchase of premises to tenants other than those listed in Article 34 section 1 clause 3, or lessees. The decision on granting this priority is made, respectively, by the provincial governor by way of an ordinance, or by the municipal or county council or the regional assembly, in the form of a relevant resolution (optional priority). In the case of the Municipality of Krakow, the decision-making body gave priority to tenants of commercial premises [Resolution on the sale of commercial premises, 2006] and to tenants of residential buildings which are entirely subject to tenancy [Resolution on the sale of residential buildings with one premises, 1997].

The Act makes the exercise of priority by the person who is entitled to the claim dependent upon two conditions [Bieniek et al., 2013]:

– the entitled person must submit an application for acquisition before the expiry of the period specified in the property list, not shorter than 6 weeks prior to that date;
– the authorised person makes a declaration that he or she agrees to the price determined in the manner specified in the Act.

## DISPOSAL OF PROPERTIES OWNED BY THE MUNICIPALITY OF KRAKOW WITHOUT TENDER PROCEDURE

The non-tender procedure may only be applied in cases indicated directly in the provisions of the Act on Real Estate Management, and an extended interpretation is impermissible. Exceptions to the obligation to dispose of a property in the tender mode are unambiguously listed in Article 37 section 2 of [Act on Real Estate Management, 1997]. Some of them, by their nature, cannot be subject to tender [Jaworski et al. 2009]. These include: donation, exchange, real estate as an in-kind contribution to a company, others are associated with the entity purchasing the real estate. In addition, there is a possibility of optional exemption from the tender procedure in certain cases, with the consent of the provincial governor with regard to properties owned by the State Treasury and, respectively, of the council or the regional council in relation to properties owned by local government units.

In the period 2017–2019, as part of the real estate management policy, the Municipality of Krakow disposed of a total of 222 cadastral parcels with a total area of 4.4705 ha without the tender. 215 parcels with a total area of 4.1680 ha were sold (Tab. 5). From the sale, the Municipality of Krakow earned a total of approximately PLN 22.9 million, and for the first perpetual usufruct fee (set at 25% of the price of the land property) it was approximately PLN 1.11 million. Total revenues from the disposal of cadastral parcels without the tender procedure in the period 2017–2019 amounted to over PLN 23.2 million.

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**Table 5.** Number, area and price of cadastral parcels disposed of by the Municipality of Krakow in 2017–2019 without tender procedure

| Year | Form of disposal | Number of parcels | Area of land [ha] | Total area of land disposed of in a year [ha] | Property price [PLN] | Total price of disposed land plots [PLN] |
|---|---|---|---|---|---|---|
| | | | | | 1st fee for perpetual usufruct [PLN] | |
| 2017 | sale | 108 | 2.8930 | 2.9798 | 15,302,392 | 15,527,008 |
| | letting into perpetual usufruct | 2 | 0.0868 | | 224,616 | |
| 2018 | sale | 53 | 0.6487 | 0.7190 | 3,817,035 | 3,857,109 |
| | letting into perpetual usufruct | 4 | 0.0703 | | 40,004 | |
| 2019 | sale | 54 | 0.6263 | 0.7717 | 3,798,318 | 3,816,724 |
| | letting into perpetual usufruct | 1 | 0.1454 | | 18,406 | |
| Total | | 222 | 4.4705 | | 23,200,841 | |

*Source*: own elaboration.

For comparison, in the period 2012–2014, both the number of parcels disposed of without the tender procedure (220) and the total price of 22.8 million were similar. However, the area of the land differed significantly, which previously was 8.7865 ha, and currently 4.4705 ha. It follows that the Municipality obtained comparable revenue for the land with almost twice as small area. The main reason is the increase in real estate prices compared to the period 2012–2014. The form of disposal is also different: sales predominate, and only 7 parcels were let into perpetual usufruct (previously it was 49). Importantly, the non-tender procedure is a consequence of the submission of an application by interested parties and the fulfilment of statutory requirements by the applicants. For this reason, unlike in the tender procedure, it is not possible to predict property disposal in this mode, which makes it difficult to plan revenues.

Within the analysed period, the Municipality of Krakow disposed of the largest number of land plots, i.e. 198, without the tender procedure, in order to improve the conditions for the development of the adjacent property, under the so-called "complement" procedure (Tab. 6) pursuant to Article 37 section 2 clause 6 [Act on Real Estate Management, 1997].

This legal norm can be applied if the following three conditions are met jointly:

- the property is to improve the conditions for the development of only one adjacent property;
- the owner or perpetual user expresses the will to purchase this property;
- the property intended for disposal may not be developed as a separate property.

This procedure may be used when only one person is interested in the purchase, because organising a tender would not make sense then. Should this property subject to disposal, or a part of it, have a functional relationship with more than one adjacent parcel, such sale procedure is impermissible. This view results from the judicial and administrative judgements [Judgement of the Supreme Court of 2006, Judgement of the Supreme Court of 2009].

The fact that individual plots of land cannot be developed should not be justified only by their small area. The adoption of such reasoning would lead to the possibility of multiple separation of a small part of a given plot of land, always with the justification of the inability to develop it as a separate property, which suggests that this premise is circumvented [Klat-Górska & Klat-Wertelecka, 2015].

Land plots disposed of under the "complement" procedure usually had a small area (from 0.0020 to 0.0300 ha) or an unfavourable shape, which meant that they could not be developed as separate

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**Table 6.** Number and area of land plots disposed of by Municipality of Krakow in order to improve conditions for development of neighbouring properties and the price obtained

| Year | Form of disposal | Number of land plots | Area of land [ha] | Total area of land disposed of in a year [ha] | Property price [PLN] | Total price for property disposal [PLN] |
|---|---|---|---|---|---|---|
| | | | | | 1st perpetual usufruct fee [PLN] | |
| 2017 | sale | 96 | 0.9211 | 1.0079 | 4,715,514 | 4,940,130 |
| | letting into perpetual usufruct | 2 | 0.0868 | | 224,616 | |
| 2018 | sale | 47 | 0.4522 | 0.5225 | 2,926,360 | 2,966,364 |
| | letting into perpetual usufruct | 4 | 0.0703 | | 40,004 | |
| 2019 | sale | 49 | 0.4494 | 0.4494 | 2,404,614 | 2,404,614 |
| | letting into perpetual usufruct | 0 | 0 | | 0 | |
| Total | | 198 | 1.9798 | | 10,311,108 | |

*Source*: own elaboration.

properties. These lands were often occupied without a legal title, and therefore their disposal contributed to the ordering of the legal and geodetic status of the property.

The number of cadastral parcels disposed of in order to improve the conditions for the development of an adjacent property was comparable to the period 2012–2014, however, there was a significant difference in their area. In 2017–2019, for the plot of land with an area of almost twice as small, i.e. 1.9798 ha (c.f. 3.7745 ha), the price was higher by over PLN 1.5 million.

The data on the number of parcels of the Municipality of Krakow disposed of under the non-tender procedure for the benefit of individual entities, their area and prices are presented in Table 7.

**Table 7.** Number, area and total revenues from disposal of parcels owned by Municipality of Krakow under non-tender procedure for the benefit of individual entities (except for the "complement" procedure)

| Purchasing entity | Number of parcels | Land area [ha] | Total price obtained [PLN] |
|---|---|---|---|
| People who carry out non-profit charity, care, cultural, medical, scientific activities | 2 | 0.2584 | 1,126,813 |
| Perpetual users | 14 | 2.1865 | 11,298,734 |
| Autonomous possessors | 7 | 0.1126 | 430,186 |
| Total | 23 | 2.5575 | 12,855,733 |

*Source*: own elaboration.

The Municipality of Krakow concluded 14 contracts for the sale of properties to perpetual users, which resulted in the expiry of the right of perpetual usufruct and separate ownership of buildings and facilities located on this land. This group included only those properties for which there were no conditions for the transformation under the Act on the transformation of the right of perpetual usufruct into ownership title.

The non-tender procedure is widely used in relation to persons who have priority in the acquisition of public properties, including tenants of residential premises who, in the analysed period, acquired 1,154 premises for a total price of approximately PLN 29.2 million (Tab. 8). This price included the discount granted by the Krakow City Council, which predominantly was 90% of the price. Tenants have priority in the acquisition only if tenancy has been concluded for an unspecified period. In the period 2012–2014, a total of 2,505 residential premises were sold for a total price of over PLN 56.5 million. These numbers were more than twice lower than in the period 2012–2014 because the sale prices

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of premises to tenants remained at a similar level. It was associated with high discounts granted by the Krakow City Council, which was not profitable for the municipality from the budgetary point of view.

**Table 8.** Number of premises disposed of in 2017–2018 to their tenants and the total price

| Years | Number of premises | Total price for premises (including discounts) [PLN] |
|---|---|---|
| 2017 | 527 | 12,199,063 |
| 2018 | 554 | 14,077,556 |
| 2019 | 73 | 2,917,338 |
| Total | 1,154 | 29,193,957 |

*Source*: own elaboration.

The sale of residential premises to tenants is a continuation of the long-term policy of privatisation of municipal flats. Other large Polish cities, e.g. Szczecin, also grant such high discounts [Sawicka, 2012].

## CONDITIONS LIMITING MUNICIPAL PROPERTY DISPOSAL

Revenues from real property disposal in the Municipality of Krakow in 2019 (Tab. 9) constituted a small share in the income related to property management. It results from the successively decreasing area of the land offered for disposal.

The conducted research allowed to identify the reasons for limiting the process of public property disposal. In addition to the common requirements of the validity of a legal act, in particular its form and the prohibition of performing activities contrary to the act or aimed at circumventing the act [Article 58 § 1 of the Civil Code, 1964], the limitations may result from specific provisions.

One of the restrictions on public property disposal are the provisions contained in the so-called "Special Acts" excluding such possibility with respect to the properties intended for the implementation of a specific public purpose investment. An example of a provision introducing such a limitation

**Table 9.** Revenues from the Municipality of Krakow's property management in 2019

| Revenue source | Revenues [PLN] |
|---|---|
| Permanent administration, usufruct and right-of-way | 14,271,364 |
| Rent and lease of assets as well as other contracts of a similar nature | 114,764,806 |
| Conversion of the right of perpetual usufruct vested in natural persons into | 45,017,284 |
| Acquisition of the ownership right for consideration and the right of perpetual usufruct of a property | 34,961,570 |
| Sale of assets | 251,111 |
| Fees for perpetual usufruct | 28,260,347 |
| Penalties and damages under the concluded contracts | 11,751,100 |
| Total | 249,277,582 |

*Source*: own elaboration based on information on the state of municipal property.

is Article 11d section 9 of the Special Road Act, which establishes the invalidity of a legal act performed in breach of this restriction. According to this provision, upon the effective notification of the initiation of the procedure subject to the application for a permit for the implementation of a road investment until the decision on such a permit becomes final, any change in the legal status of the property owned by the State Treasury or local government units is unacceptable. In the analysed period, 60 decisions were issued on the permit for the implementation of a road investment in Krakow.

The most important limitation is the obligatory restitution of the expropriated property to the former owner in a situation where this property has not been used for the purpose of the expropriation.

If the property was acquired by expropriation, then before its disposal it is necessary to determine whether the purpose of the expropriation has been implemented and whether the former owners are entitled to claims for restitution, and then take steps to notify them of the possibility of such restitution. The obligation to notify former owners is a consequence of the guideline contained in Article 136 section 1 of Act on Real Estate Management [1997],

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under which the expropriated property can not be used for any purpose other than the one specified in the expropriation decision.

Due to the imprecise definition of the purpose of expropriation in the former expropriation decisions and the lack of source documentation, it is currently difficult to assess its implementation and, as a consequence, notify the entitled persons. Moreover, finding former owners and their addresses requires arduous, long-lasting search, which does not always bring the desired results.

According to the research conducted over the period of 3 years [Trembecka & Kwartnik-Pruc, 2018], the former owners and their heirs were notified of the possibility of restitution due to the failure to implement the purpose of expropriation in relation to 29 properties planned for disposal by the Municipality of Krakow (by tender procedure). As a consequence, it eliminated these properties from the disposal process. The number of the properties covered by this notification constituted approximately 25% of those planned for disposal. This meant that they could not be sold or used for investment by the city.

The legislator has currently extended the scope of the regulations on restitution as a result of which, with the amendment to the Act on Real Estate Management, restitution of a share in the property or of its part is also possible since 14 May 2019. Previously, restitution was not permissible where the application came from an incomplete circle of heirs.

The procedure for public property disposal may not apply to properties in relation to which proceedings are pending to declare the invalidity of the decision based on which the State Treasury or local government unit purchased the property, the resumption of proceedings in similar cases, or an action to update the contents of the land and mortgage register according to the actual legal status.

The process should also take into account the right of priority [Article 34 of the Act on Real Estate Management, 1997], including claims by various entities for "enfranchisement" under the Act on Real Estate Management and other acts [e.g. Article 231 of the Civil Code, 1964], which are to resolve the problem of the transformation of property relations as a result of the political transformation.

A separate factor that limits the revenues is property sale with a discount on the price. Apart from the cases of optional granting of the discounts set forth in Article 68 section 3 of the Act on Real Estate Management (with the consent of the decision-making authority), there is an obligatory discount applied to the sale price of the property or its part entered into the register of monuments. The amount of the discount is 50% of the price, however, the competent authority may increase or decrease the discount with the consent of the provincial governor or the regional council, respectively. In the analysed period, the Krakow City Council determined the discount at the level of 5% when selling historic properties. Discounts for the sale of residential premises to tenants were adopted at the level of 90%.

Another limitation is the necessity to act in accordance with the public interest, which means that in the event of an intended disposal, an assessment must first be made of the use of the property for the performance of public utility tasks by public entities. The economic factor cannot be decisive in many cases, which means that e.g. it is a rational management decision to leave a property of high natural, historical or cultural importance in the municipal resources so that it is available to the residents, regardless of the decreased revenue. In the current legal system, as far as the real estate management process is concerned, it is difficult to speak of a uniform, objective and universal catalogue of principles of rational economy.

The legislator does not indicate whether in problematic situations, when making a decision on the method of disposing of a given property, one should be guided by economic or social presumptions, to name but a few [Sanakiewicz, 2015].

## SUMMARY AND CONCLUSIONS

The analysis of the scope and structure of the disposed properties owned by the Municipality of Krakow has demonstrated that in the period 2017–2019, a total of 9.7992 ha of land was sold, with 5.3287 ha sold under

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the tender procedure and 4.4705 ha without the tender procedure. This is a small part of the total area of land in the resources of the Municipality of Krakow, which accounts for 5,535 ha (as of 31 December 2019).

The research on the structure of the Municipality of Krakow's income in 2019 has revealed that the revenues from the sale of properties account for about 14% of all income related to property management. The revenues of about PLN 34 million are more than 2 times lower than those planned in the 2019 budget for the sale of the municipal properties, which were planned at the level of PLN 89 million.

On the other hand, the transformation of the right of perpetual usufruct into the ownership title in 2019 generated an income of approximately PLN 45 million, which was more than 30 times the amount planned in the budget. The reason lies in the fact that the new regulations on the transformation entered into force on 1 January 2019 [Act on the transformation of the right of perpetual usufruct, 2018] and the resolution on a discount granted in the event of paying a one-off fee in the year in which the transformation took place was adopted by the City Council. These regulations resulted in great interest in paying the one-off transformation fee in 2019, instead of extending the payment for a period of 20 years.

The conducted research has allowed for the conclusion that there are many reasons behind the reduced number of properties offered for disposal by the Municipality of Krakow by public tender, including:

- a limited number of properties that would be suitable for independent development;
- undetermined legal status of properties (necessity to take appropriate surveying and legal actions);
- unspecified land use of properties due to the lack of a land use plan;
- a tendency to change the land use of municipal properties to public greenery in the local land use plan;
- no access to a public road;
- an obligation to notify former owners of the expropriated properties about the possibility of their restitution;
- property restitution proceedings;
- other re-privatisation claims (e.g. the annulment of expropriation).

The above conditions limit the rational property management or hinder the possibility of property disposal and, consequently, impede the planning of the municipal revenues.

As far as the non-tender procedure was concerned, the disposal in order to improve the conditions for the development of the adjacent property was the most frequent. It covered 198 plots of land with a total area of 1.9798 ha. In these cases, the sale was triggered by the request of the interested entity and was of a regulatory nature: its purpose was to bring the actual status into compliance with the legal status, stop the course of acquisitive prescription by spontaneous possessors and improve the spatial structure of the area.

The analysis of the process has revealed that the prices of the properties sold were almost twice as high compared to the period 2010–2014, which reflected the trends prevailing on the real estate market.

The claims of the former owners constitute a significant obstacle in the disposal process.

The conducted research has confirmed the formulated thesis that one of the reasons for limiting the process of public land disposal is the obligation to notify the former owners about the possibility of restitution of the expropriated properties. Lengthiness of the restitution proceedings results in the final settlement involving a decision on restitution or refusal of restitution being issued, taking several years. During this time, these properties cannot be developed in a way that prevents their restitution or changes their value.

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Uchwała nr CX/1099/06 Rady Miasta Krakowa z dnia 24 maja 2006 r. w sprawie sprzedaży lokali użytkowych stanowiących własność Gminy Miejskiej Kraków (Resolution No. CX/1099/06 of the Krakow City Council of 24 May 2006 on the sale of commercial premises owned by the Municipality of Krakow) (Dz. Urz. Woj. Małop. 2016, item 8112) (Poland).

Uchwała nr XLVI/568/08 Rady Miasta Krakowa z dnia 11 czerwca 2008 r. w sprawie zasad zbywania lokali mieszkalnych stanowiących własność Gminy Miejskiej Kraków oraz określenia warunków udzielenia bonifikaty i wysokości stawek procentowych (Resolution No. XLVI/568/08 of the Krakow City Council of 11 June 2008 on the rules of disposal of residential premises owned by the Municipality of Krakow and determination of the conditions for granting discounts and the percentage rates) (Dz. Urz. Woj. Małop. 2016, item 7759) (Poland).

Uchwała nr CXV/3022/18 Rady Miasta Krakowa z dnia 7 listopada 2018 r. w sprawie warunków udzielania bonifikat od opłat jednorazowych z tytułu przekształcenia prawa użytkowania wieczystego gruntów stanowiących własność Gminy Miejskiej Kraków w prawo własności tych gruntów i wysokości stawek procentowych tych bonifikat (Resolution No. CXV/3022/18 of the Krakow City Council of 7 November 2018 on the conditions for granting discounts on one-off fees for the transformation of the right of perpetual usufruct of land owned by the Municipality of Krakow into the ownership right to this land and the percentage rates of these discounts) (Dz. Urz. Woj. Małop. 2018, item 7736) (Poland).

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✉trembec@agh.edu.pl

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