GREEN SURGE

REPORT ON THE POTENTIAL FOR INTEGRATING MONETARY AND NON-MONETARY VALUATION OF URBAN ECOSYSTEM SERVICES

WP 4
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Deliverable D4.3

SEVENTH FRAMEWORK PROGRAMME

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SUMMARY

Valuation of ecosystem services, and valuation of nature in general, has been increasingly discussed as an important topic related to decision-making and environmental protection. It has been argued that to make better decisions regarding the environment, decision-makers need to be aware of its value. In most of such discussions, value is associated with its economic, monetary dimension. However, because of the numerous political, technical and logical challenges to monetary valuation, there is a broad discussion on the usefulness of such an approach. Many alternatives have been put forward with the aim to provide a more comprehensive understanding of the value (or broader importance) of the environment, including those that capture other value dimensions and make it possible to depict trade-offs between value dimensions, broadly known as integrated valuation.

Within GREEN SURGE, integrated valuation has been one of the key issues for linking urban green infrastructure and green economy. In another GREEN SURGE report (Milestone 32) we analysed opportunities for integrating different sets of valuation approaches and methods, providing an overview of the different levels of valuation, and in this Deliverable we explore more specifically the potential for integrating monetary and non-monetary valuation methods using three in-depth studies.

Our selected monetary approach is hedonic pricing, one of the valuation methods most commonly used in the context of urban green spaces. We first performed a typical hedonic pricing study to test its usefulness in our case study city (Lodz in Poland) and to be able to refer our integrated valuation results to this baseline study. Then we tested the potential to integrate hedonic pricing with non-monetary valuation of urban green spaces: their perceived value captured through the use of softGIS, one of the public participation mapping methods, and their biocultural value, reflecting an interdisciplinary concept of biocultural diversity. In the former study, we found out that hedonic pricing and softGIS mostly reveal consonant values, but also trade-offs between certain aspects of value. Some green spaces are portrayed as valuable by the softGIS but not necessarily when using hedonic pricing, indicating that what is valued in non-monetary terms does not necessarily have monetary value, at least not for real estate buyers, whose preferences and choices are depicted with hedonic pricing. In the latter study, we found out that high biocultural value of an area does not necessarily positively influence real estate prices, which illustrates another trade-off between the different value dimensions. Still, we consider these two integrated valuation examples successful in that they satisfied the basic objectives for integrated valuation introduced in our Milestone: that the studied value dimensions are logically commensurable, and that the methods are technically compatible.

We conclude that the potential for integrated valuation is larger than it is commonly assumed to be, and that indeed, integrated valuation reveals a broader perspective on the value of the environment. Encouraged by these successful examples, we consider integrated valuation as a fruitful direction for future research. We consider the assumption that integrated valuation provides a more comprehensive picture of the value of urban green spaces for at least partially substantiated, and that it could be more widely used in the practice of urban green space management, which we will explore further in coming GREEN SURGE work.

1 INTRODUCTION

The knowledge of value is necessary in decision making. When buying a product, the buyer consciously or not is estimating its value and comparing it with its price and, if time permits, with the value of other products. This value is a subjectively weighted sum of sub-values of different aspects of the product. If the public investment, or spatial planning, is expected to satisfy social needs, a similar valuation process should precede and inform the relevant governmental decisions.

Ideally, every aspect of each option should be recognised and valued, and the weighted sum of these sub-values should be used to make decisions. Both experts and the public should be involved in deliberative valuation processes as their knowledge seems to be complementary: the public brings in the information on the direct and specific use value while the experts contribute with a broader perspective and sometimes more detailed account of the consequences of each decision. Even in the general practice of making public decisions, inputs from very different stakeholders are considered, and these stakeholders tend to express their different values in different ways. Still, in spite of such an idealistic vision of how decisions should be made only after a multi-criteria assessment, and in spite of a general practice of attempting this (at least to a certain extent) in most modern deliberations, valuation is frequently reduced to an economic process that yields results in monetary units (de Groot et al. 2002; Parks and Gowdy 2013).

As a step in the direction of making decisions and valuation more comprehensive, the so-called integrated valuation, which allows for recognising linkages (synergies and trade-offs) between different types of value, has recently emerged as a frontier issue in the study of ecosystem services (Gómez-Baggethun et al. 2014; Kronenberg 2014). Its objectives are to integrate economic, social/cultural and ecological value perspectives, as well as monetary and non-monetary valuation techniques. However, not all methods can be integrated, and a thorough consideration has to precede each attempt: do the methods seem to be technically compatible and are the selected value dimensions logically commensurable? Do they operate on the same kind of data? Is there an actual value added from such integration? We have explored these issues in another GREEN SURGE output – Milestone 32 (Kronenberg and Andersson 2016).

Since valuation is most often associated with monetary methods, the easiest way to perform integrated valuation seems to be by extending monetary valuation methods to cover non-monetary aspects of value. To test the potential for integrating monetary and non-monetary valuation of urban ecosystem services in practice, we focus on one of the most well-established economic (monetary) valuation methods, hedonic pricing. Apart from well-recognised advantages of this method (such as the fact that it is based on real market data and explores the revealed rather than stated preferences (Bade et al. 2015), or that it is the most popular for estimating the economic value of urban green spaces (Baranzini et al. 2008; Brander and Koetse 2011)), hedonic pricing also seems to be suitable for integration with non-monetary valuation methods (Kronenberg and Andersson 2016). This was the main reason for choosing it as a focus for our studies. We have also proposed hedonic pricing as one of the key methods for identifying indirect values of urban green infrastructure in other GREEN SURGE reports (Engström 2015; Andersson et al. 2015).

Hedonic pricing is an economic method for isolating the impacts of individual attributes of a good or a service on the price of that good or service. Although it can be used to deconstruct the prices of various goods/services (the first hedonic pricing conducted by Court in the late 1930s concerned cars (Goodman 1998)), it has gained recognition as a method for assigning value to non-market components of real estate sales or rental prices (Baranzini et al. 2008). In this specific case, hedonic pricing can be summarised as the estimation of the following multiple regression model:

$$P=\alpha S+\beta E+\gamma L+\varepsilon$$

where P is the vector of property sales or rental prices, and S, E and L are the sets of vectors of structural, environmental and locational attributes, respectively, of the analysed properties, and α, β and γ are the vectors of estimated regression coefficients, while ε is the vector of random error. The set of structural variables usually contains information about area, number of rooms, the age of the building, its technical condition, and other 'internal' characteristics of the analysed property that could influence the price. The environmental and locational variables are usually portrayed as distances to various amenities, such as the city centre or the nearest forest – measured either as Euclidean straight lines (Melichar and Kaprová 2013; Tyrväinen and Miettinen 2000) or using street routes (Nicholls and Crompton 2005; Tyrväinen 1997). Sometimes the environmental attributes have been represented by the visibility or "the view" of a green space (Borkowska et al. 2001; Luttik 2000; Nicholls and Crompton 2005). Other authors considered air and noise pollution as important environmental attributes (Bayer et al. 2009; Chattopadhyay 1999; Kim et al. 2007; Smith and Huang 1995; Łowicki and Piotrowska 2015). Thus, the number and character of variables considered in various hedonic pricing studies depend on the specific objectives of each study and the availability of data – and there is ample potential to include variables that introduce non-monetary valuation components into hedonic pricing, as we will demonstrate with our cases.

Hedonic pricing can be set up to distinguish between the different green space types or features, which makes it interesting for discussing the value of ecosystem services (Gómez-Baggethun and Barton 2013; Sander and Haight 2012; Tyrväinen and Miettinen 2000). However, in practice hedonic pricing usually focuses on very specific issues that, although to some extent influenced by ecosystems, are better described as approximations of specific environmental amenities or disamenities. For example, studies that could be thought to value noise abatement by ecosystems (Kim et al. 2007; Łowicki and Piotrowska 2015) usually focus on disamenities such as road noise level or noise exposure in general, which approximate traffic intensity or industrial noise pollution rather than the abundance of trees and their services. It is relatively difficult to find a hedonic model specification that would allow for the valuation of different ecosystem services and there are few readily available variables that could serve as accurate measures of individual ecosystem services in such designs. Many ecosystem services, e.g. many of the regulating and all of the supporting services, are not easily inferred or perceived by the ordinary buyer and therefore outside of the field of hedonic pricing. Furthermore, hedonic pricing is not powerful enough to separate the effects of individual ecosystem services, even if they were recognised by the buyer. Still, even if our focus in this report is on environmental amenities and disamenities rather than ecosystem services, we do suggest that the same general integrated valuation approach could be used to value ecosystem services.

Keeping the above in mind, we conducted three hedonic pricing studies: a classic set-up as a baseline, and then two studies following the logic of integrated valuation by incorporating variables that represent other dimensions of value of the analysed green spaces. In the first study, we estimated the economic value of the green spaces depending on their type and area. The second two studies focused on two dimensions of value (economic and social) and tree dimensions of value (economic and biological and social), respectively. In the first of these two we made an attempt to integrate hedonic pricing with public participatory softGIS, and in the latter with the biocultural diversity framework (see GREEN SURGE Deliverable 2.1 (Vierikko et al. 2015)). SoftGIS is a type of an online questionnaire in which the answers take the form of specific locations marked on a map by a respondent (in our case respondents were asked questions regarding which green spaces they considered particularly valuable). Biocultural diversity represents the dynamics and physical manifestations of the multiple and diverse social processes in the past and present that have intersected with biodiversity and the development of the present day ecosystems (Elands 2015), which for the purpose of hedonic pricing can be captured by biocultural value assessments.

All three of our studies are similar in terms of the specification of structural and locational variables, and differ only in which environmental variables they include (based on size and type vs. more elaborate green space categories referring to their non-monetary value). The structural variables consist of the age of the building, number of rooms, the total area of the apartment and the story on which the apartment is located. As we did not expect a linear relationship between the age of a building or the story and the apartment sale price we included these characteristics as dummy variables. The locational variables contain information on distances to the nearest sports and educational facilities as well as shopping centres, public transport hubs and the city centre. Additional locational variables are represented by the dummy variables indicating the district. The initial analysis of the residuals of the model enabled us to identify a set of outliers, all located in a new building in the city centre called “Solaris” (adjacent to a park). Therefore, we also included the dummy variable “Solaris.” The list of variables is complemented by the quarter price trend and we expected to see this downward trend in our studies.

In the following two chapters we present our case study city, Lodz in Poland, and an overview of the econometric analysis carried out in the three case studies. Then, chapters 4 through 6 summarise our studies: the baseline one, the one integrating hedonic pricing with sotfGIS social valuation, and the one integrating hedonic pricing with the biocultural value framework. Each chapter features a brief introduction, then the description of the environmental variables we used (including a broader presentation of what value dimensions they represent), the results and a specific discussion of those results. Full versions of the studies summarised in the following chapters have been published in peer-reviewed academic journals (Czembrowski et al. 2016a, 2016b; Czembrowski and Kronenberg 2016). Chapter 7 features a conjoint case discussion and conclusions regarding the potential for integrating monetary and non-monetary valuation of urban green spaces.

2 CASE STUDY CITY

Our study site was Lodz (Łódź), a city in central Poland with ca. 700,000 inhabitants and an area of 293 km^2. The real estate market in Lodz is relatively large and we consider it mature enough to reveal the preferences of buyers towards various attributes of the traded apartments. It should be noted that the free market was introduced in Poland only in 1989, and that this country well illustrates the drastic changes that have occurred in real estate markets in post-socialist countries (Augustyniak et al. 2014; Lux and Sunega 2014; Sillince 1990). The freedom to purchase houses and apartments has not only made it possible to capture peoples' preferences as reflected by the market, it has also brought socio-spatial changes in post-socialist cities (with suburbanisation, fragmentation of social space and gentrification of certain areas (Marcińczak and Sagan 2011; Tsenkova and Polanska 2014)). We collected the data on apartment sales for 2011–2013, which was a stable period with no major events in the real estate market, and only a slight downward price trend (Hładysz 2013).

Lodz is a very useful case study because different types of green space are unevenly distributed across the city and many areas that are otherwise similar have different availability of green space. Forests make up about 7% of the city area, parks 3%, allotment gardens 2%, and cemeteries 1%. Based on a statistical analysis of basic indicators related to urban green space planning, including changes in the area of green spaces, Baycan and Nijkamp (2012) observed that Lodz scored poorly in this field compared to other European cities. Lodz has also scored poorly in pan-European studies on urban green space availability (Fuller and Gaston 2009; Kabisch and Haase 2013), which suggests that the increasingly scarce green spaces should be a desired non-market good. Indeed, the only Polish study using a direct valuation method in the context of urban greenery was performed in Lodz and suggested that the inhabitants were willing to pay for more street trees in the city centre had they been given such an opportunity (Giergiczny and Kronenberg 2014).

In our studies, we focused on the formal green spaces officially recognised by city authorities. Figure 1 presents parks and forests in Lodz and Figure 2 presents gardens and cemeteries. The maps show the uneven distribution of green spaces throughout the city. In particular, the greatest part of the urban green space is provided by one large forest – Lagiewniki Forest – which is considered to be one of the largest forests within city boundaries in Europe. Because of its recreational importance and general renown, this forest required special treatment in our models.

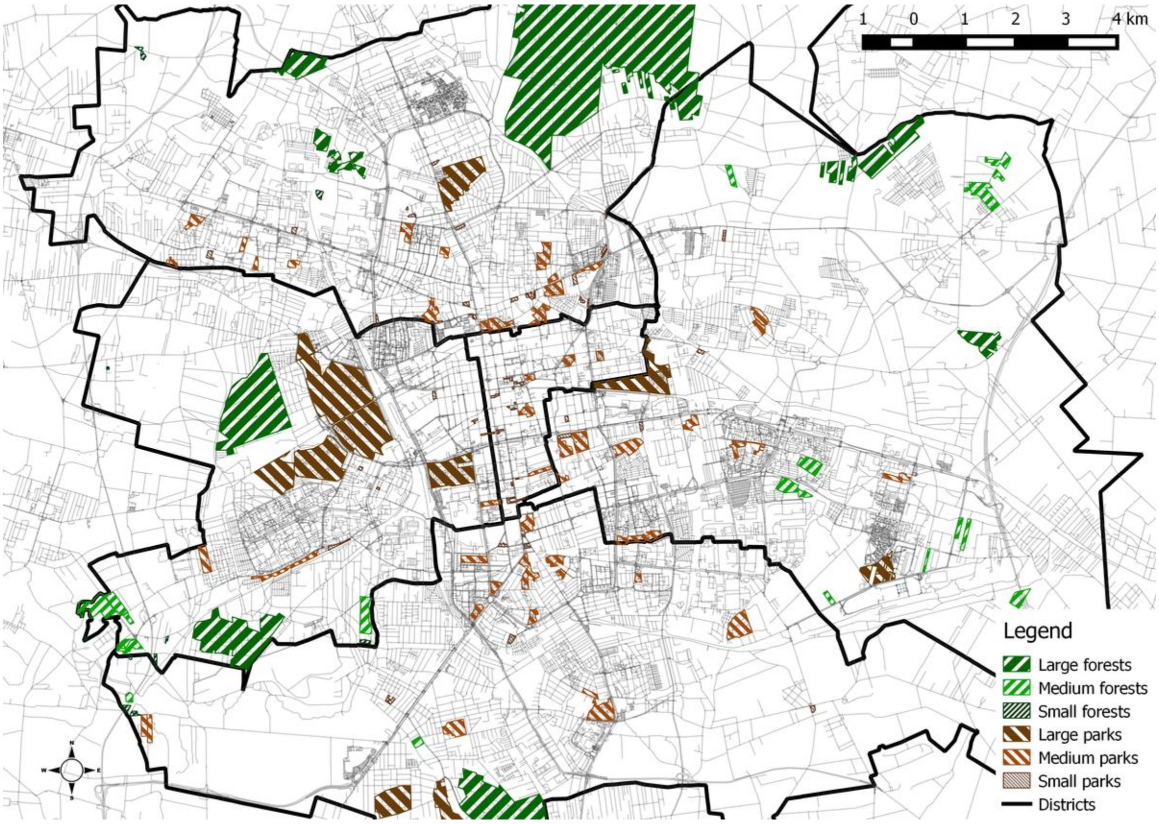

Figure 1: Parks and forests in Lodz.

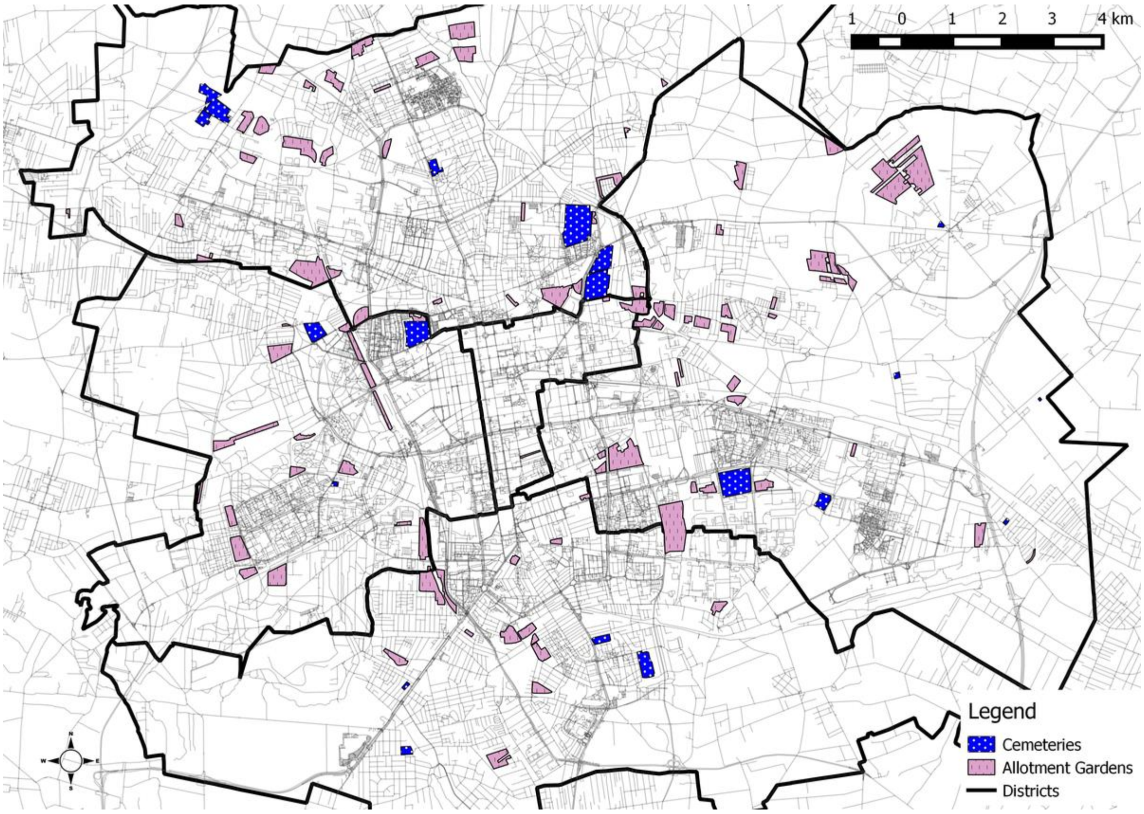

Figure 2: Cemeteries and allotment gardens in Lodz.

Only in the second study could we explicitly include the informal green spaces recognised by the inhabitants – thanks to the use of a map on which the users themselves indicated their preferred green spaces. This was possible because Lodz was one of the cities where the Sendzimir Foundation carried out a large scale green space assessment with the use of public participation GIS (softGIS) in 2014. For details on the softGIS study and the interpretation of its results, see section 5.2

Many green spaces in the centre of Lodz were founded at the turn of the 20th century by manufacturers representing four cultures: Polish, Jewish, German and Russian. The creation of these green spaces was connected to the rapid industrialisation of the city in the 19th century and to the large fortunes made by some manufacturers, who were then able to afford the luxury of creating private parks and gardens. Today, this historical legacy is recognised by the city authorities e.g. through the creation of the so-called Green Circle of Tradition and Culture, which was the subject of our third hedonic pricing study (see section 6.2).

The information on apartment sales' prices and attributes, as well as green spaces and additional amenities (such as educational and sports facilities), was provided by the Department of Real Estate Market Monitoring of Lodz City Geodesy Centre, which collects data on all property transactions done in Lodz (hence the dataset contains real transaction prices). We received data on all apartments sold between 1 January 2011 and 31 December 2013. The dataset initially contained more than 12,000 rows, but the elimination of incomplete records, wholesale transactions and outliers (exceptionally low and high prices) left 9346 valid observations. In the third study we focused on the Green Circle of Tradition and Culture and thus limited the sample to the area around it, i.e. the strict city centre, which left us 5018 observations.

3 ECONOMETRIC ANALYSIS

The bases of our econometric analysis were the same in all three studies, and it was only significantly extended in the third study, as explained in subsection 3.1. The estimation of regression coefficients in a hedonic pricing model is usually done with the use of the Ordinary Least Squares (OLS) or Maximum Likelihood method (Tyrväinen and Miettinen 2000). In the first study we did it both ways and found that the results were almost identical (which is typical for linear regressions), so in the end we present the OLS estimates only (and we only used the OLS estimates in the other two studies).

It is common to use transformations of explained or explanatory variables. Sometimes this is done for purely econometric reasons, and sometimes in order to better represent the relationship between the attributes and the prices. Expecting that the positive impact of green space (or negative impact of distance to these areas) is not linear but rather diminishes at high distances, we chose to use natural logarithms of these measures. This is somewhat contrary to the common hedonic pricing practice of using logarithms of prices and leaving distances untouched (Kong et al. 2007; Tyrväinen 1997; Tyrväinen and Miettinen 2000), but our choice seems to better represent the reality. We also found support for it in the Box–Cox test, which seeks the most appropriate functional form. It showed that logarithm of dependent variable is unnecessary and the expected parameter λ in the following equation:

$$P^{\lambda} = \alpha S + \beta E + \gamma L + \varepsilon$$

is close to 1, therefore we chose to stay with linear prices.

Researchers modelling property sale prices frequently face the problem of spatial autocorrelation of the error term (Basu and Thibodeau 1998; Larson and Perrings 2013). This is caused by the fact that the price of a property depends on the prices of neighbouring properties. Unless one takes preventive measures, this situation may lead to the autocorrelation of the error term, which may result in inaccurate levels of significance; in other words, the model will be inconclusive. The Moran's I test, designed to identify the spatial autocorrelation of the error term, gave positive results already in the case of the first, most comprehensive equation (before we even started the stepwise regression). The Lagrange multiplier test showed that we were dealing with the autocorrelation of both the dependent variable and the error term, so we had to use the SARAR model (spatial autoregressive model with a spatial autoregressive disturbance). We tested several spatial autocorrelation patterns to find that the use of the 'five-nearest neighbours' matrix gives the lowest variance of the error term (Hastie and Tibshirani 1996).

The other way to deal with spatial autocorrelation is to use spatial effects models. Although they are more common in modelling based on panel data, they may be applied in cross-section regressions. The easiest way to include the fixed effects into the model is by adding dummy variables for regions (or districts in the case of a city). However, because of the criticism of the fixed effects method (Bertrand et al. 2002; Clapp et al. 2008), we decided to estimate one model with and one model without the fixed effects and use them mainly to compare and check the robustness of the results.

Another challenge related to modelling spatial data is the potential heteroskedasticity of the error term. This means that the sample contains sub-populations with variances different from the others. This can be easily imagined with two neighbourhoods: one is completely new and prices are high only, and the other is old and has both cheap and expensive properties. This requires using the heteroskedasticity-robust estimators. The White and Breush–Pagan test revealed the presence of heteroskedasticity of error terms so we decided to use the generalised least squares method with robust estimators HC1.

Finally, to determine only the statistically significant variables, we conducted the stepwise regression.

In the second study, we only used the fixed effects model, and in the third study – a most comprehensive spatial quantile regression model as described below.

3.1 Spatial quantile autoregression model

The SQAR was employed to explore the differences in marginal willingness to pay for proximity of green spaces in different price segments while paying attention to spatial dependencies present in the data generating process. While in OLS, the estimated coefficient informs about the average change in the price produced by the one unit change of the explanatory variable associated with this coefficient, QR enables us to explore how differently real estate price levels react to one unit change of the predictor. For example, a regression of the 25th percentile of real estate prices on distance to a green space informs us about the impact of the one unit change of such distance on the 25th percentile of the property prices.

As indicated above, in a hedonic pricing model the impact of different attributes on the dependent variable is estimated using the linear (Tyrväinen 1997), semi-log (Kong et al. 2007) or log-log (Anderson and West 2006) specification, via the Ordinary Least Squares (OLS) method. This requires an assumption of spatial independence of residuals to obtain the unbiased and efficient OLS estimators (Anselin 2013; LeSage 2008). In practice, this assumption might be broken, because it is hard to control for all important locational characteristics (e.g. proximity externalities, accessibility or neighbourhood features), while omitting location characteristics leads to spatial autocorrelation. One of the first to handle this problem in the hedonic pricing model was Dubin (1988). Her approach, based on the incorporation of distance between properties in the model, might be treated as a simplified version of the spatial hedonic pricing model. Later, Can (1990) used the spatial weights matrix to capture the structure of spatial relations between observations. She estimated the effect of spatial dependence as the coefficient for the spatially lagged dependent variable. She compared the results from the spatial and non-spatial hedonic pricing models and concluded that the former are more accurate in the case of a residential real estate market.

Another problem arises when the impact of properties' attributes varies across the sample of real estate transactions. The most obvious approach to capture such heterogeneity of the explanatory variable influence – the truncation of the dependent variable and using OLS for a series of subsamples – produces the biased parameter estimates and should be avoided (Mak et al. 2010). Alternatively, quantile regression (QR) might be applied for the hedonic pricing model (Ebru and Eban 2009; Kim et al. 2014; Kostov 2009; Liao and Wang 2012). The great advantage of using QR is that it employs the full dataset and avoids the sample selection problem (Heckman 1979). The results from QR are more robust to outliers because the objective function minimises the weighted sum of absolute deviations. Finally, QR is more efficient than the OLS method when error term is non-normal (Uematsu et al. 2013).

As a consequence, variations in hedonic pricing estimates are commonly dealt with using QR (which is also necessary to verify the second hypothesis of our study). Analysing spatial dependence requires spatial econometrics models with spatially lagged dependent variable (SAR) or spatially correlated residuals (SEM). The result of combining both techniques is the spatial quantile autoregressive (SQAR) model:

$$\boldsymbol{Y} = \rho(\tau)\boldsymbol{WY} + \boldsymbol{X\beta}(\tau) + \boldsymbol{\varepsilon},$$

where: $\boldsymbol{Y}$ – nx1 vector of the dependent variable, $\boldsymbol{X}$ – nxk matrix of k explanatory variables, $\boldsymbol{W}$ – nxn row-standardised spatial weights matrix, ε – nx1 vector of error terms, ρ – parameter of spatial interaction, τ – the quantile of the dependent variable. With above equation, we depict different effects of the regressors on different points of the response variable distribution, heteroscedasticity in the disturbances and spatial dependence among the observations.

For the purposes of our study, we specified the components of the spatial weights matrix $\boldsymbol{W}$ in above equation similar to Dong and Harris (2015):

$$w_{ij} = \begin{cases} exp\left(-d_{ij}^2/d^2\right) \; if \; d_{ij} \leq d \\ 0 \; if \; d_{ij} > d \end{cases},$$

where: d_{ij} – geographical distance between properties i and j calculated using the Haversine formula, d – distance threshold, obtained using the empirical variogram of land prices. For the apartments data for Lodz, the calculated distance threshold was 1.3 km, which is similar to the value obtained by Dong and Harris (2015) for Beijing (1.5 km). As in the SQAR model equation, our spatial weights matrix $\boldsymbol{W}$ was row normalised. Hence, the value of the ρ parameter belongs to the interval from λ^{-1} to 1, where λ is the minimum eigenvalue of the spatial matrix $\boldsymbol{W}$. In previous hedonic pricing studies, the estimated value of ρ using spatial hedonic pricing model was usually 0.2–0.4 (Dong and Harris 2015; Kostov 2009), so we expected similar results for Lodz.

The SQAR model might be estimated using instrumental variable quantile regression (IVQR) method proposed by Chernozhukov and Hansen (2006) or the extension of the two-stage least squares (2SLS) provided by Kim and Muller (2004). In both of these approaches, the spatial lag $\boldsymbol{WY}$ is treated as an endogenous variable. In the 2SLS approach, $\boldsymbol{WY}$ is first regressed for the τ quantile, on a set of instrumental variables (typically $\boldsymbol{X}$ and $\boldsymbol{WX}$). Second, the predicted values of $\boldsymbol{WY}(\tau)$ and $\boldsymbol{X}$ are used as explanatory variables in the equation for $\boldsymbol{Y}$, estimated for the same τ quantile. In the IVQR, firstly we have to estimate OLS regression of $\boldsymbol{WY}$ on $\boldsymbol{X}$ and $\boldsymbol{WX}$. After that, the predicted values of $\boldsymbol{WY}$ and $\boldsymbol{X}$ are used as repressors for the dependent variable $\boldsymbol{Y} - \rho\boldsymbol{WY}$. Such a model is estimated for the τ quantile several times, using in each estimation a different value of ρ. After a series of regressions, we choose the predicted value of ρ as the one for which the coefficient on $\widehat{\boldsymbol{WY}}$ is the closest to zero. Finally, we regress $\boldsymbol{Y} - \hat{\rho}\boldsymbol{WY}$ on $\boldsymbol{X}$ for the same τ

quantile. In this study, we chose the IVQR method as, despite being more time-consuming than 2SLS, it is considered as more robust (Kostov 2009; Trzpiot 2013).

The quantiles we used in the SQAR are: 0.05, 0.15, 0.25, 0.5, 0.75, 0.95.

4 BASELINE STUDY

4.1 Introduction

As a baseline, we applied the hedonic pricing method in Lodz in a traditional (albeit a very specific) manner, dividing green spaces into nine categories that might potentially exert impacts on property prices (Czembrowski and Kronenberg 2016). We distinguished the following: small parks and small forests (smaller than 18,000 m^2); medium parks and medium forests (18,000–200,000 m^2); large parks and large forests (larger than 200,000 m^2); the single largest forest that constitutes a category on its own (over 13,000,000 m^2); cemeteries; allotment gardens; plus a percentage of greenery in a 500 m radius as a proxy of the more general ambient condition (for a graphical overview of the different green spaces' location, see Figures 1 and 2 in Chapter 2). The above division was meant to reflect the different needs that these green areas satisfy, or to some extent the different ecosystem services that they deliver.

4.2 Variables

To calculate the environmental variables related to distance, we first mapped all the entrances to the green spaces with the use of an orthophotomap. Then we selected the five nearest (in Euclidean sense) entrances to each type of green space for every building in our sample. In the next step, the distances between entrances and the buildings were calculated with the use of Google Distance Matrix API, which enables the user to calculate the shortest walking distance. Finally, the shortest of the five computed distances was selected to reveal the opportunity for recreational use of the analysed green spaces. We did this for each of the eight types of green spaces, and the other aspect of environmental attributes (general ambient condition) was captured as percentage of greenery in a 500 m radius.

4.3 Results

The estimated parameters are presented in Table 1. The stepwise regression reduced the number of variables from 48 to 24 in the standard model, and to 26 in the fixed effects model, 20 of which are common to both models. Most of the estimated parameters are very similar in both regressions, with noticeable differences only in the locational variables, which is intuitively understandable given the inclusion of the spatial dummy variables. The directions of impact are consistent with our expectations and with previous studies (Melichar and Kaprová 2013; Tyrväinen 1997; Tyrväinen and Miettinen 2000) and they are the same in both models. The difference in the estimates for the environmental variables between the standard and fixed effects model comes from district specific effects which have not been properly controlled for in the basic model. For example, the average square meter price is the highest in the city centre (SRODMIESCIE). This district is relatively far from the Lagiewniki Forest and small forests, and relatively close to large parks and cemeteries, and the impacts of these green spaces are respectively undervalued and overvalued if we do not take into consideration the special character of this district (Zhang 2010). So even though the comparison of variance of residuals gave no indication which model fits better we choose to interpret the results of the fixed effects model (the high statistical significance of the district variables was also of matter). As expected, the structural variables turned out to be the most significant, with a predominance of the age of the building over the story on which a premise is located. New apartments (built between 2011 and 2014) located in the city centre were the most expensive. The sixth to eighth stories were the most expensive, while premises located on the ground and first floor had significantly decreased prices.

Table 1. Ordinary Least Squares regressions results
(* – significant at 10% level, ** – significant at 5%, *** – significant at 1%)

		Standard model		Fixed effects model	
		Coefficient	Sig	Coefficient	Sig
1	Lagged dependent variable	0.22	***	0.21	***
2	Const	3656.90	***	4364.00	***
3	AGE_1850_1880	-245.42	***	-234.68	***
4	AGE_1881_1918	-1518.80	***	-1588.40	***
5	AGE_1919_1939	-1354.20	***	-1390.00	***
6	AGE_1945_1970	-924.30	***	-941.57	***
7	AGE_1971_1989	-775.27	***	-821.06	***
8	AGE_1990_2010			-76.58	**
9	STORY1	-149.92	***	-160.59	***
10	STORY2			-27.10	*
11	STORY6	140.26	***	145.68	***
12	STORY7	77.92	**	78.04	**
13	STORY8	90.20	**	98.93	**
14	ln(DIST_LAGIEWNIKI)	-60.12	**	-110.24	***
15	ln(DIST_FOREST_SMALL)	-67.75	***	-107.06	***
16	ln(DIST_PARK_LARGE)	-90.14	***	-57.33	***
17	ln(DIST_CEMETERY)	95.99	***	91.44	***
18	PERCENT_GREEN	2.85	**	3.95	***
19	SOLARIS	2301.50	***	2141.30	***
20	GORNA			-343.54	***
21	BALUTY			-371.74	***
22	WIDZEW			-270.64	***
23	POLESIE			-222.18	***
24	ln(DIST_NURSERY)	-30.78	**		
25	ln(DIST_MIDDLE_SCHOOL)	58.58	***	42.77	***
26	ln(DIST_UNIVERSITY)	-104.33	***		
27	ln(DIST_PLAYING_FIELD)	35.78	**		
28	ln(DIST_TRANSPORT_HUB)	38.91	**		
29	ln(DIST_SHOPPING_CENTRE)	96.45	***	75.47	***
30	QUARTER	50.21	***	51.12	***
	Lambda	0.3919		0.37127	
	Residual variance	332530		332540	
	N	9346		9346	

Five out of ten environmental variables turned out to be statistically significant. The Lagiewniki Forest, small forests and large parks, as well as the percentage of greenery in a radius were considered as amenities, whereas cemeteries were seen as unwelcome. The “Solaris” variable was highly significant, which proves the necessity for separating the subsample of apartments in this building with the use of a dummy variable. From the set of locational variables only the secondary schools and shopping centres were significant and seen as unwelcome. The coefficient for the QUARTER variable indicated that the prices were falling from quarter to quarter by 51 PLN (1 PLN = 0.24 USD, as of 10 September 2016) per square meter, which is consistent with the independent analyses of the Lodz real estate market (Hładysz 2013). The significance of the parameter of the spatially lagged dependent variable proved the necessity to use the SARAR model.

4.4 Discussion of the results

As expected, different types of green space exert different impacts on property prices. The environmental variables with the strongest impact were the distances to the Lagiewniki Forest and to large parks. The Lagiewniki Forest is unique in terms of its size and renown in the city, while the large parks are also well known and widely recognised. Interestingly, neither other parks nor large and medium forests had a significant impact on property prices, which indicates that what especially counts in the case of an environmental good may be the kind of a label that a particular good has, or at least its familiarity (LaRiviere et al. 2014). A one percent increase of the distance to the Lagiewniki Forest translated on average into the decrease of the price of an apartment by 110 PLN per square meter, i.e. 2% of the average square meter price. The positive impact of large forests on property prices has been frequently reported in other hedonic pricing studies (Mansfield et al. 2005; Melichar and Kaprová 2013; Tyrväinen and Miettinen 2000). Similarly, the strong, positive effect of large parks is no surprise (Larson and Perrings 2013; Sander and Polasky 2009). The loss of value resulting from a one percent increase of the distance to the nearest large park was estimated at 57 PLN, i.e. 1% of the average price of a square meter.

Small forests turned out to be significant in explaining the variability of apartment sales’ prices. In fact, the impact of green spaces of this type was estimated to be one of the strongest. However, we have doubts if this was not actually caused by the variables omitted in the model. Small forests tend to be located in the outskirts of the city, close to unofficial open green spaces and agricultural land, all of which might be seen as amenities. Unfortunately, we could not include these types of green space in our model due to the difficulties with determining their boundaries and their dynamic character (they tend to be developed in conjunction with suburbanisation).

Cemeteries, despite the fact that they provide many important ecosystem services (Andersson et al. 2007), were perceived by real estate buyers as unwelcome. A one percentage point increase of the distance to a cemetery translated on average into an increase of the apartment price by 61.28 PLN per square meter. These results are not unprecedented: Tse and Love (2000) found that a view of a cemetery significantly decreased the price of a property in Hong Kong; the same was found by Anderson and West (2006) in the Minneapolis–St. Paul metropolitan area. Lutzenhiser and Netusil (2001) found the distance to a cemetery to be insignificant in explaining property prices in Portland, Oregon (USA), although the estimated coefficient was also positive. A caveat here is that cemeteries are mostly used for recreational purposes by the elderly and the retired (Jakóbczyk-Gryszkiewicz et al. 2008) who relatively rarely buy apartments. Were these two social groups more active in the real estate market, perhaps the negative influence of these green spaces would be lower.

Other types of green space did not generate statistically significant impacts on apartment prices in Lodz, despite the fact that their importance to the residents of Lodz has been confirmed by other studies (Fundacja Sendzimira 2014; Giergiczny and Kronenberg 2014). However, looking at specific case studies of apartment buildings recently built next to medium-sized parks in the city centre, which sold apartments for the highest prices in our sample (including the special case of Solaris, depicted with a dummy variable in our model), and at the common focus on green surroundings in all kinds of advertisements of new apartments, we can assume that “greenery sells” in more general terms.

To some extent, the general importance of urban green space for apartment buyers was reflected in the percentage of greenery within a 500 m radius, which had a positive sign with 1% statistical significance. On average, an additional 1% of greenery increases the apartment sale price by 3.95 PLN per square meter. A similar positive result was obtained by Tyrväinen (1997), who found that an additional percentage point of greenery in housing district in Joensuu, Finland increased the price of a square meter by 7.36 FIM. Similarly, Melichar and Kaprová (2013) observed that the increase of urban parks and forests over the cadastral areas in Prague by 1% would lead to an average increase in the sales prices by 12,354 CZK and 3697 CZK respectively (they used the total sale price as the explained variable). Increasing other types of green space within a 500 m radius also brought positive impacts on apartment prices in Prague. Our results are also in line with the conclusion of Kong et al. (2007), who stated that each percentage point of a green space within a 300 m radius adds about 2.1% to the property price per square meter in Jinan City, China.

In short, despite our attempt to capture a very detailed picture of the value of urban green space with the use of multiple green space types and categories, we were only able to depict the most important aspects. Meanwhile, other types of urban green space, which we know to be of value for the inhabitants of Lodz based on other studies, did not reveal equal importance in the case of the present hedonic pricing study. This illustrates the limited “sensitivity” of hedonic pricing, i.e. its ability to depict only the most important or characteristic issues. However, we can still consider that a simple division of green spaces based on their different size and type does not properly reflect people’s preferences regarding those green spaces. What is necessary is a more elaborate division of green spaces in a hedonic pricing model, taking into account the preferences towards those green spaces revealed in some other way. Striving to obtain such a more specific picture is the basis of our concept of integrated valuation, as described in the following chapter.

5 INTEGRATING MONETARY AND NON-MONETARY (SOCIAL) VALUATION

5.1 Introduction

Based on the abovementioned assumption – that in hedonic pricing we need a more accurate categorisation of green spaces that would incorporate people's preferences towards those green spaces revealed in some other way – we decided to use a non-monetary (social) evaluation of green spaces as an input to another hedonic pricing model (Czembrowski et al. 2016a). More specifically, we used public participation GIS (softGIS) green space evaluations based on the residents' own experiences to divide green spaces of high perceived value, low perceived value and those towards which there was no net preference. Such a categorisation was meant to ensure that our categorisation captured what counts for the people, rather than more general formal types and sizes of green spaces (note that it is always possible that for example one large park is desired while another is not because of reasons other than size). In this context, we formulated two hypotheses:

1. *that areas identified as valuable in the softGIS survey will also positively affect apartment sale prices in a hedonic pricing study, while areas evaluated negatively will negatively affect apartment sale prices; and*
2. *that these two valuation methods can be used complementarily, and that softGIS survey results constitute a useful contribution to a hedonic pricing study by providing distinctions between various urban green spaces based on people's revealed perception of the value of nature, which seems more accurate than the traditional one based only on the green space area.*

5.2 SoftGIS as a social, non-monetary valuation method

To incorporate the perceived value of urban green space in place-based research, it is necessary to represent participant perception of this value with geographical features, preferably in a GIS environment. Talen (2000) proposed incorporating local knowledge of urban residents directly into GIS to facilitate the data collection process and support planning by better reflecting the needs and concerns of residents. SoftGIS is a specific variant of such a public participation GIS (PPGIS) approach, rooted in environmental psychology and humanistic geography. It is used to capture spatially explicit perceptions of the quality of urban green space, based on individual experiences in and of the living environment (Kyttä et al. 2013; Rantanen and Kahila 2009). Respondents' responses are marked on interactive maps or geo-questionnaires, which makes them easily incorporated into the GIS environment, integrated with other types of data. Thus, they can be analysed and synthesised using quantitative and spatial methods, thus providing new location-based research possibilities (Jankowski et al. 2015, 2015; Kahila and Kyttä 2009). In a similar vein, participatory mapping and PPGIS have been used to elicit values attributed to environmental amenities in natural resources management, forestry and tourism planning (Alessa et al. 2008; de Vries et al. 2013; Sijtsma et al. 2012). In the context of urban green spaces, researchers have used PPGIS to elicit attitudes (Balram and Dragićević 2005) and values attributed to green spaces (Tyrväinen et al. 2007; Pietrzyk-Kaszyńska et al. 2016), and to measure physical activities and health benefits in urban parks (Brown et al. 2014).

The softGIS data we used had been collected as part of the "Count on green" ("Licz na zieleń") project conducted by the Sendzimir Foundation, which aimed at incorporating local knowledge of residents into the governance of participatory green spaces in Lodz and two other Polish cities. The project involved a softGIS study, which elicited use patterns and the perceived value of urban green space. This study used a geo-questionnaire, which allowed identification of green spaces where respondents spent time and other valuable green spaces, as well as unkempt green spaces, badly-designed green spaces, and places with not enough greenery. The respondents of the geo-questionnaire did not see the answers or geographical features marked by the other respondents. The study captured qualitative values of urban green spaces, which we could then translate into variables describing more and less preferred urban green spaces.

The data were collected in 2014, between March 6th and September 11th. Participant recruitment followed a mixed approach: besides postal invitations sent to randomly selected households, the questionnaire was openly available on the Web, advertised in local media and social networking sites, as well as presented during workshops and meetings with stakeholder groups. The target population consisted of all city residents aged 15 or more. Overall, 505 people took part in the survey in Lodz, marking 4224 geographical locations (Table 2). The participants marked more positive than negative green space features, which is a familiar pattern in softGIS studies (Kyttä et al. 2013).

People aged between 15 and 29 were over-represented in the sample, people aged between 30 and 44 had representation in the sample close to that in the target population, and people aged 45 and more were under-represented. Close to half of participants (48.3%) reported having bachelor degree. The percentage of women in the sample was equal to that of the target population (ca. 55%). The softGIS data used in this study were thus biased towards younger and better educated demographic groups. SoftGIS data may also be subject to spatial bias, which results from relationships between location of participants' place of residence and their knowledge, experiences, and preferences related to the studied locations (Brown and Kyttä 2014). The Pearson coefficient measuring the correlation between the number of residents and the number of respondents in each of 36 neighbourhoods of Lodz, calculated to assess the bias, was 0.71 and statistically significant. The level of spatial representativeness was satisfactory, albeit it is worth noting that the residents of some of the suburban neighbourhoods were under-represented in the sample.

Table 2. Categories of green space in Lodz elicited using a geo-questionnaire, with the number of markings in each category

Category of green space	Definition	Number of markings
Frequented green spaces	Places where respondents spend time surrounded by greenery (e.g. parks, forests, courtyards, alleys, individual trees, gardens, wastelands, squares, etc.).	1761
Other valuable green spaces	Other places considered valuable surrounded by greenery (valuable for reasons other than spending time).	527
Unkempt green spaces	Places where greenery has not been properly maintained.	653
Badly-designed green spaces	Places where greenery exists but where users are concerned about how it is designed.	416
Lack of green spaces	Public spaces where the lack of greenery is particularly acute and where greenery should be introduced.	867

5.3 Variables

We chose to distinguish between groups of markings located within and outside of formal green spaces (i.e., those recognised by the city authorities). This distinction comes from the assumption that the relatively dispersed small patches of informal green spaces influence real estate prices to a much lower extent than the bigger formal ones.

Respondents had the possibility to mark up to 15 locations within each green space category distinguished in the softGIS survey. Some provided several markings close to each other to depict very specific features of a given location (in an extreme case, one user found 15 unkempt green spaces within an area of 0.5 km^2). Therefore, we measured the popularity of a formal green space by subtracting the number of users pinning the negative (unkempt and badly-designed) and “lack of green space” markings from the number of users pinning the positive markings within its boundary. Based on such a “net number of users,” we divided the formal green spaces into the following three categories:

1. *4 and higher – “high perceived value”;*
2. *-2–3 – “no net preference;” and*
3. *less than -2 – “low perceived value”.*

The exception are cemeteries and allotment gardens, which had too few markings to allow for division into such categories. As a result of this division we obtained three categories of parks and two categories of forests (there were no forests of low perceived value in Lodz). Also, we decided to separate the Lagiewniki Forest from the cluster of forests of high perceived value as this large forest is the most important recreational area in the city. It plays a markedly different role in satisfying the recreational needs of Lodz inhabitants than any other green space in the city (Jakóbczyk-Gryszkiewicz et al. 2008). The above categories of green spaces are shown in Figure 3.

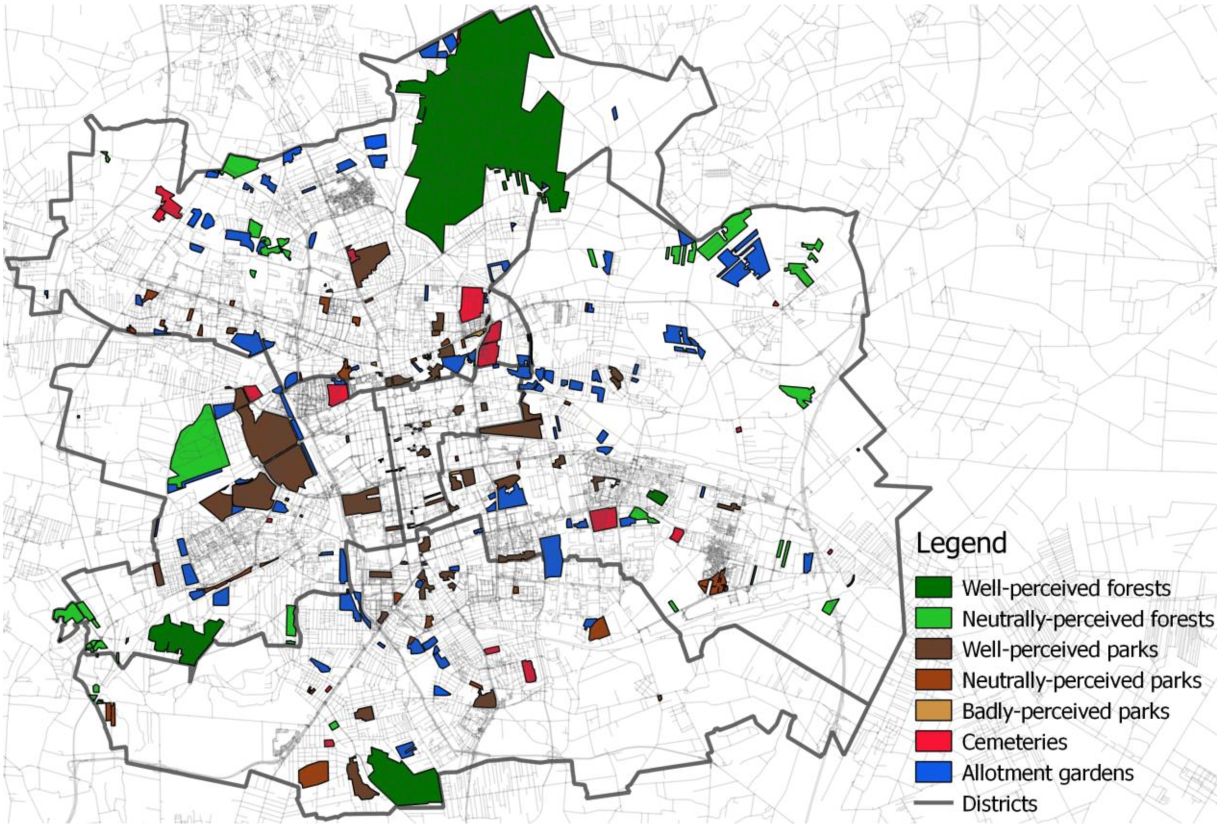

Figure 3. Perception of the formal green spaces in Lodz based on the softGIS survey – different types of green spaces distinguished in this study

Because informal green spaces have no clearly demarcated boundaries within which we could count the net number of positively- or negatively-perceiving users, we identified individual clusters of "positively-perceived" and "negatively-perceived" green spaces, as well as places "lacking greenery." To identify these clusters, we used the kernel density estimation with raster cell size and density thresholds chosen according to the specific spatial pattern of the markings, the spatial extent of the study, and the heuristics used in similar studies (Brown and Reed 2012). Each of the clusters was then represented as a polygon feature with a value corresponding to the number of users that provided markings contributing to the cluster. As initial regressions revealed that clusters with fewer than four active users had no significant influence, we decided to keep only those with four or more active users. Since the visualisation of the selected clusters showed us that the negatively-perceived green spaces and places lacking greenery mostly overlap, we decided to treat them as one category. This is in line with how we calculated the number of users within formal green spaces. A summary of the different green space categories is shown in Figure 4.

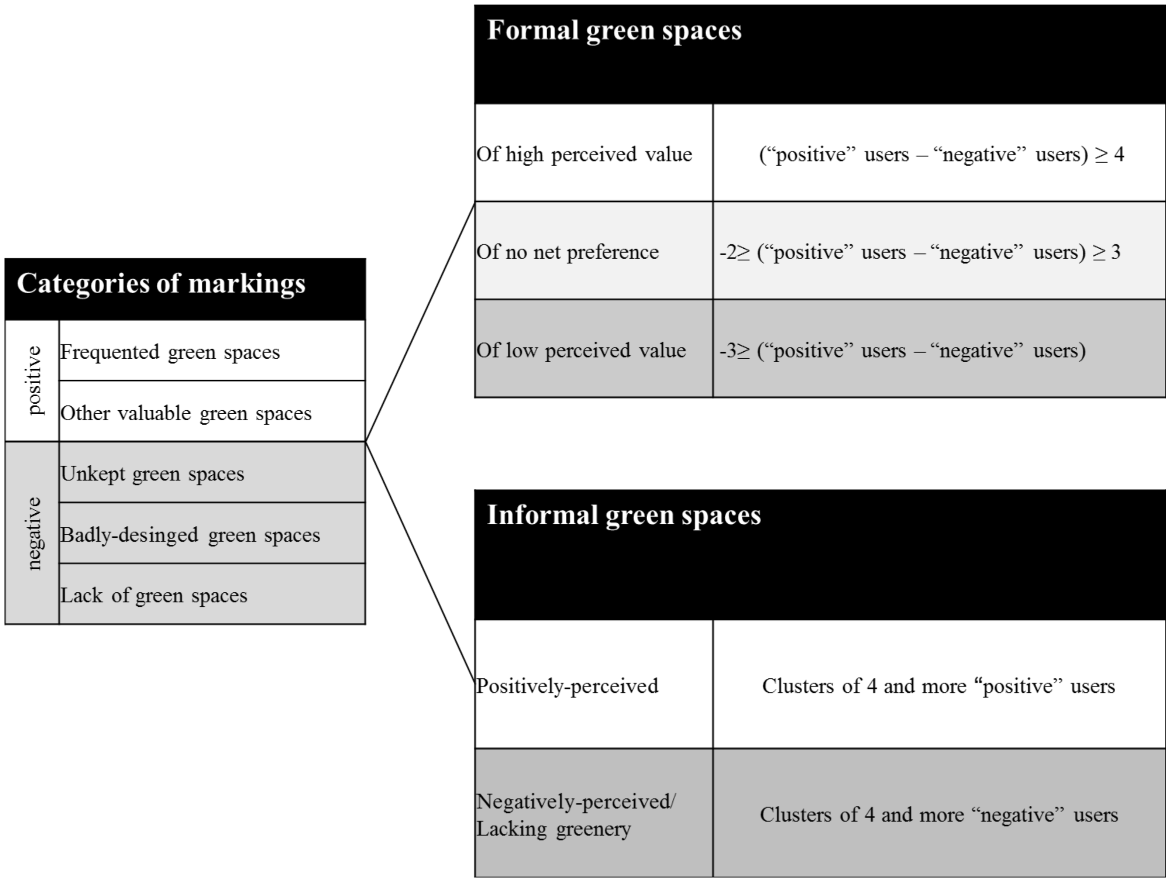

Figure 4. Summary of how the softGIS categories of green space were translated into the green space categories considered in this study

We calculated distances from each apartment to the nearest area of each type using the Route algorithm in ArcGIS 10.2 Network Analyst. The algorithm calculates the shortest paths along street network between pairs of origins (properties) and destinations (entrances to green spaces or clusters). Using network distances is preferable to the more common Euclidean distances, as it more accurately reflects pedestrian accessibility (Apparicio et al. 2008; Higgs et al. 2012). We used entrances to formal green spaces instead of their centroids to further improve our measurement accuracy (Higgs et al. 2012). In the case of informal green spaces, we calculated the distance to the nearest marking belonging to a given cluster. We derived the street network data from OpenStreetMap, a volunteered geographic information (VGI) of high quality (Haklay 2010), as it was the only available dataset consisting of pedestrian infrastructure, which is crucial for accurately calculating pedestrian distances (Chin et al. 2008; Iacono et al. 2010).

In our study the above variables, calculated using network distances, represent the benefits derived from visiting green spaces, such as physical activity, social relationships or psychological restoration (i.e. active benefits), the availability of which may potentially influence real estate prices. To take into account benefits derived from the proximity of green space alone (i.e. passive benefits), such as air quality, microclimate improvement, or noise reduction, we included three additional environmental variables – the number of users who marked positive, negative or "lack of greenery" markings in a buffer around the real estate. We tested several ranges of both Euclidean buffers and street network service areas, and determined that the 300 m Euclidean buffer best fit the model according to AIC criterion. With these, we provide an approximation of different ecosystem services.

5.4 Results

The stepwise regression reduced the number of variables from 52 to 31 (including the constant) (Table 3). As expected, the structural attributes of the apartments (as measured with the z-values) were the most influential. The architectural period dummy variables show that apartments in buildings erected before 1990 were on average cheaper than the new ones, and those in buildings built between 1881 and 1918 were the cheapest. Not all the story dummy variables were significant, which justifies our decision not to include this information in the linear form. The locational variables were also of high statistical significance: location in each of the three peripheral districts (except for Polesie) was on average worth less than in the central one. From a comprehensive set of potentially influential locational amenities, only six were found significant in the final model, although the direction of their impact was rather unexpected (which will be discussed in the following section). More than half of the environmental variables "survived" the stepwise regression, which suggests that environmental characteristics have an influence on apartment buyers' choices. Every additional percent of increase in the distance to the Lagiewniki Forest decreases the apartment price by 177 PLN per square meter, whereas a corresponding increase in distance to a forest of no net preference decreases the square meter price by 96 PLN. The parks influenced the property prices to smaller extent: a 1% increase in the distance to the nearest park of high perceived value was associated with a decrease of the apartment price by 26 PLN. There were also two categories of green spaces which were seen as disamenities: cemeteries – decreasing the apartment price by 109 PLN with every 1% decrease in distance there to; and parks with low perceived value were associated with a corresponding decrease of 62 PLN. The results support the hypothesis of many previous studies that different types of green space impact the real estate prices in different ways and to different extents. The z-value also confirmed the need to take into account the spatial autocorrelation of the dependent variable.

Table 3. Ordinary Least Squares regression results
(* – significant at 10% level, ** – significant at 5%, *** – significant at 1%; z-values in parentheses)

Variable name	Coefficient
Lagged dependent variable	0.33*** (0.06)
Const	4069.60*** (6.95)
AGE_1881_1918	-1237.10*** (-11.72)
AGE_1919_1939	-1051.80*** (-10.67)
AGE_1944_1970	-670.24*** (-10.54)
AGE_1971_1989	-565.99*** (-9.51)
AGE_1990_2010	155.44*** (5.09)
STORY1	-171.35*** (-9.13)
STORY2	-34.42** (-2.06)
STORY6	135.48*** (4.36)
STORY7	75.19* (1.89)
STORY8	97.74** (2.17)
STORY10	-88.51* (-1.92)
BUFFER300_LACK	-9.30*** (-2.81)
BUFFER300_NEGATIVE	16.08*** (3.74)
LN(DIST_CEMETERY)	109.38*** (4.65)
LN(DIST_LAGIEWNIKI)	-176.73*** (-4.39)
LN(DIST_FOREST_NO_PREF)	-95.59*** (-3.64)
LN(DIST_PARK_HIGH)	-25.81** (-2.31)
LN(DIST_PARK_LOW)	62.30** (2.31)
LN(DIST_INFORM_NEG/LACK)	-33.23** (-2.36)

GORNA	-135.67*** (-3.61)
BALUTY	-135.46*** (-3.11)
WIDZEW	-189.90*** (-4.65)
SOLARIS	1519.30*** (6.43)
LN(DIST_MIDDLE_SCHOOL)	44.56*** (3.39)
LN(DIST_HIGH_SCHOOL)	-26.00* (-1.93)
LN(DIST_UNIVERSITY)	-60.49*** (-3.62)
LN(DIST_PLAY_FIELD)	31.61** (2.20)
LN(DIST_SHOPPING_CENTRE)	82.06*** (3.09)
DIST_INDUSTRY	-25.99* (-1.86)
Lambda	0.25
N	9346
Standard Deviation	595.48

5.5 Discussion of the results

The perceived value of urban green spaces derived from softGIS was significant in the hedonic pricing model, thus indicating that there is no reason to reject the hypothesis that "areas identified as valuable in the softGIS survey will also positively affect apartment sale prices in a hedonic pricing study." The direction and magnitude of their influence were in most cases consistent with our expectations: green spaces attract apartment buyers in general, but green spaces of high perceived value also had a higher value in hedonic pricing. The Lagiewniki Forest, which was valued highly in the softGIS study, had the greatest positive impact on real estate prices, significantly better than forests of no net preference. Also, parks of high perceived value exerted a positive influence on apartment prices. Conversely, a property close to a park of low perceived value also had a lower value in hedonic pricing, which is in line with our hypothesis that a green space of low perceived value may serve as a disamenity: not only discouraging visitation, but also negatively affecting the surroundings. Unsurprisingly, cemeteries were also considered as disamenities, a conclusion that has been drawn in previous studies (Tse and Love 2000; Anderson and West 2006).

Nevertheless, the model included some exceptions to the hypothesised relationships. The other forests of high perceived value (other than Lagiewniki) turned out to be insignificant (whereas forests of no net preference in the softGIS study turned out to significantly increase property prices). The same applied to parks of no net preference, which were the only parks not exerting any impact on apartment prices. These green spaces might be characterised by lower accessibility or poorer infrastructure than the other green spaces recognised in the softGIS study. In addition, the negative impact of parks of low perceived value; the insignificance of those of no net preference; and the positive impact of those of high perceived value might suggest that parks need to be valued very high or very low in non-monetary terms to have their value reflected in housing prices. However, we have to remember that these inconsistencies might simply be caused by the fact that there is a difference between the choice of place of residence and the choice of a recreational destination. These decisions are based on different criteria and the number of these criteria is considerably larger in the case of real estate transactions. As noted by Langemeyer et al. (2015), there might be significant differences in the perception of some ecosystem services generated by an urban green space captured with different valuation techniques.

The seemingly surprising positive effect of negatively-perceived informal green spaces (mostly overlapping with places lacking greenery), as well as the insignificance of the positively-perceived informal green spaces needs to be explained. Firstly, the places which were pointed out as lacking greenery or where greenery was neglected, are actually better known to the public than the well-perceived informal green spaces. In many cases, these are central and representative places in Lodz, and the higher prices in these locations result from their importance from the point of view of tradition and culture, e.g. the Freedom Square or the Dabrowski Square. Indeed, the fact that they lack well-maintained greenery was reflected in public discussions on urban development in Lodz in recent years. Secondly, both datasets used in the study were based on different samples. SoftGIS users were not necessarily exposed to the experience of buying apartments and they did not necessarily look at the broader context of the locations they indicated (a consideration which we might expect from real estate buyers). We can assume that the charming informal green spaces are likely to be found mainly in the proximity of living places (hence after the actual real estate transaction), not vice versa. However, the insignificance of attractive informal green spaces recognised in the softGIS study is an important result, which is related to the differences in what we can capture via the use of different valuation methods (we explore this in the second part of this discussion).

When it comes to the number of positively-perceiving or negatively-perceiving users and those marking lack of greenery in a 300 m buffer, the conclusions are ambiguous. On the one hand, the lack of greenery is associated with a negative sign, while neglected or badly-designed green spaces (but still green spaces) increase the price of property, which is in line with our initial assumptions. This may have to do with the fact that in the case of passive benefits the quantity of green space might be more influential than its perceived value. On the other hand, the number of users who positively evaluated green spaces within the 300 m radius from a particular piece of real estate turned out to be insignificant, a finding that we cannot explain convincingly.

Finally, our model based on the softGIS-driven division of green spaces fits better than the one with green spaces grouped according to their functional category and acreage, followed in the baseline study (see the previous chapter). This conclusion is supported by the Voung and Clarke tests, which allow for comparison of non-nested models. This suggests that there are good reasons not to reject our second hypothesis, i.e. that softGIS results constitute a useful contribution to a hedonic pricing study. This led us to consider an even more complex integration of valuation approaches and value dimensions – one that involves monetary valuation and an already integrated concept of biocultural value – as explained in the following chapter.

6 INTEGRATING MONETARY AND BIOCULTURAL VALUE DIMENSIONS

6.1 Introduction

In the third study, we used hedonic pricing method to check whether green spaces representing the highest biocultural value have a stronger impact on property prices than those the biocultural value of which is lower (Czembrowski et al. 2016b). In this way, we attempt to integrate the monetary and non-monetary (biocultural) dimensions of value of urban green spaces, taking into account that the biocultural dimension already integrates the biological and cultural dimensions of value. We hypothesise that the biocultural value of green spaces is reflected in the prices of the properties located nearby.

In this study, we focus on the city centre because we want the analysed properties to be close to the "Green Circle of Tradition and Culture" (GCTC), which was designated in Lodz to underline the special biological and cultural value of certain areas in the city, hence it represents biocultural value (Elands et al. 2015). The concept of the GCTC was introduced to protect natural and cultural heritage of the city, and is included in the spatial planning documents and various tourism development strategies for the city (Kaczmarek et al. 2006; Wysmyk-Lamprecht et al. 2007). The reason for focusing on the city centre was that the impact of green spaces tends to diminish with the growing distance (Kong et al. 2007). We are only interested in the impacts that green spaces from the GCTC exert on property prices as we assume that postindustrial areas or other culturally important locations have limited impact on property prices (they are omnipresent in the city).

The focus on the city centre allows also for exploration of another aspect of monetary valuation of green spaces – the variation of estimates within different price segments. We expect that these price segments can be characterised by different rules of pricing (Kostov 2009; Liao and Wang 2012). To do this, apart from estimating a spatially autoregressive model (SAR), we performed spatial quantile regression (SQAR) (for a presentation of the econometric analysis followed in this study, see section 3.1). Due to the environmental focus of this study, we explore only the variation of influence of green spaces on apartment sale prices within the different price ranges.

6.2 Biocultural value

In this study we referred to concept of biocultural diversity understood as an effect of manifold social processes that took place in the past and shaped the present day ecosystem (Elands et al. 2015). This understanding of biocultural diversity goes beyond the traditional one which linked to various biodiversity conservation practices of indigenous peoples (Cocks 2006; Elands et al. 2015). The GCTC is an irregular ring around the city centre and consists of green spaces as well as postindustrial areas and other historically important locations. Indeed, the GCTC is the effect of the cultural diversity which was a trademark of Lodz in the 19th century and which shaped the character of the city (Elands et al. 2015). However, even within the bioculturally diverse GCTC one can differentiate areas of higher and lower biocultural value. In the case of two complexes of green spaces historical human interventions have been particularly important from the point of view of their present biodiversity, and on these grounds they can be separated from the rest of green spaces belonging to the GCTC.

The history of Lodz is essential from the perspective of our study: most of the present GCTC was founded or built during the Industrial Revolution and resulted from mutual work of different cultures. Some of the green spaces still have trees that formed the ancient forest of Lodz and were incorporated into private properties of the rich manufacturers, especially Helenow Park and Zrodliska II Park (Olaczek 2010; Olaczek and Bonisławski 2008). Both of these belong to the two green space complexes of particularly high biocultural value which we treat separately from the rest of the GCTC for comparative reasons. The former, the so-called Lodka River Gardens (LRG), consists of three parks and two palaces with their gardens. The second complex – the Priest's Mill – is formed by Zrodliska I and II Parks, green squares adjacent to the parks, and the reservoir on the Jasien river mentioned in the opening paragraph. Most of these green spaces date back to mid-19th century, whereas most of the rest of the GCTC was founded in the beginning of the 20th century.

Apart from the two green space complexes extraordinarily important from the biocultural perspective, we separated two cemeteries from the original GCTC. The reason for this was that previous hedonic pricing studies indicated that cemeteries are often considered as disamenities (Tse and Love 2000) or – at best – are insignificant in explaining the property prices (Saphores and Li 2012), contrary to other types of green spaces. All the green spaces used in the study are shown in Figure 5.

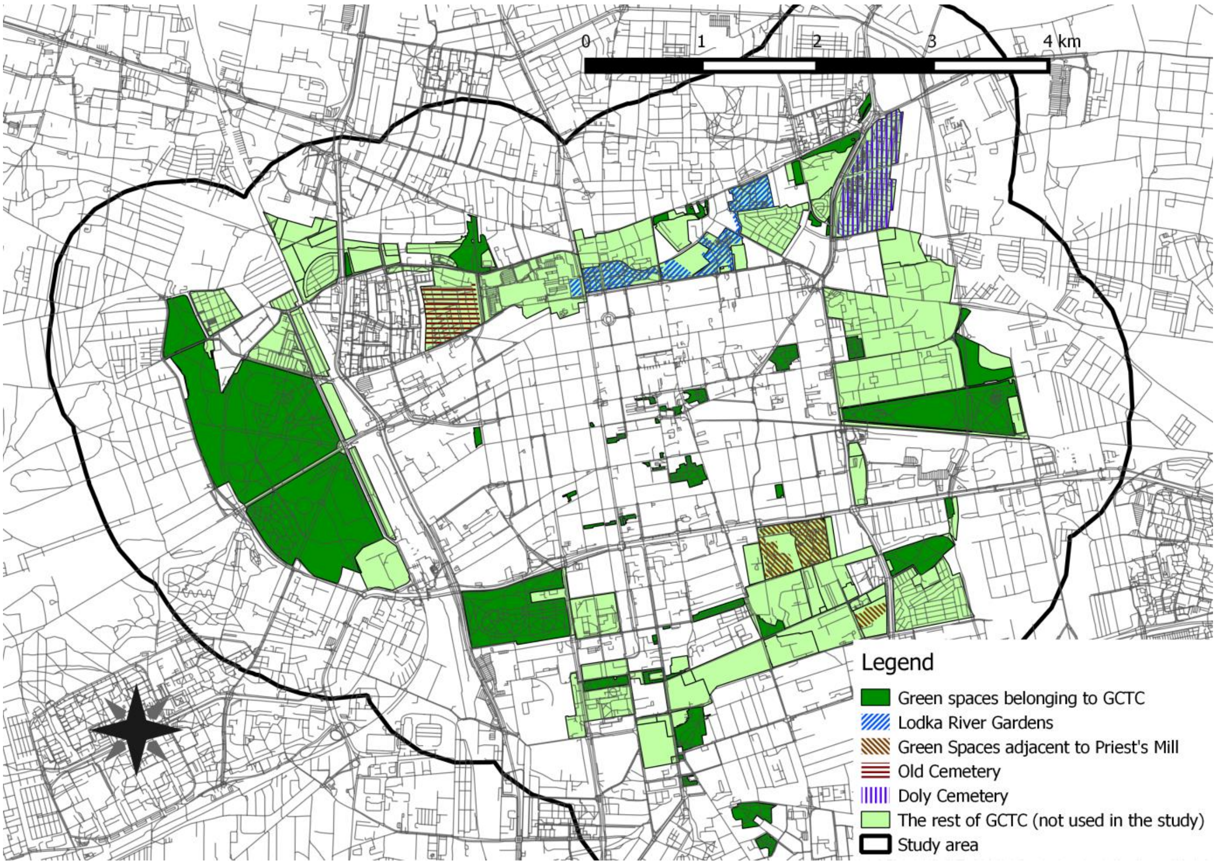

Figure 5. Green Circle of Tradition and Culture

6.3 Variables

In this study, environmental attributes were mainly represented by distances to the nearest entrances to green spaces. As a *novum* to the hedonic pricing studies, we introduced a new categorisation of green spaces based on their biocultural value (as described in the previous section). In order to capture also the general ambient condition, we included the percentage of greenery in the 500 m buffer. To control for the expected positive impact of other green spaces (not belonging to the GCTC), we also calculated the distances to those green spaces with a view to insert them into the model. However, due to the strong negative correlation with the distance to city centre, we had to transform these distances into dummy variables, indicating only the exceptional closeness to a non-GCTC green space. After a series of estimations, the threshold of this "exceptional closeness" was calculated at 59 meters as a highest distance for which the impact of a non-GCTC green space was still significant. For similar reasons, we had to remove the distance to the Doly Cemetery (strong correlation with distance to the LRG).

6.4 Results

The results for SQAR seem to be in general consistent with the ordinary SAR estimates. However, they reveal some heterogeneity of estimates across different price ranges especially for the attributes that turned out insignificant in the SAR model. In this section we interpret the results of SAR regression as the average results for the whole sample, unless otherwise noted. The results from both SAR and SQAR are presented in Table 4. Note that the listed results reflect only the direct impacts of the attributes on the apartments' sale prices. The statistical significance of ρ proves that there are also indirect impacts (Won Kim et al. 2003) but due to the spatial heterogeneity (understood as a difference of average house prices between districts) we find it risky to measure their magnitude basing only on ρ estimates.

Estimates of both SAR and SQAR models showed that green spaces of the highest biocultural value not only do not exert stronger impact on property prices compared to other green spaces, but they do not have a positive influence at all. The LRG turned out to have no statistically significant impact, while the green spaces adjacent to the Priest's Mill complex were seen as disamenities – the increase in distance to the nearest of the Priest's Mill green spaces by 1% was associated with an increase of the sale price by 50 PLN per m^2. This result comes from the SAR estimation but SQAR results are consistent with it, also indicating that these green spaces are seen as disamenities. The estimates for the consecutive quantiles are respectively: 78.98 PLN, 97.35 PLN, 119.37 PLN, 75.29 PLN, 68.40 PLN; the estimate for the quantile 0.95 was not statistically significant.

The distance to the nearest other green space belonging to the GCTC was assigned with statistically significant negative coefficient, which means that the growth of the distance to the green space of this category significantly decreases the price of the property. The 1% increase of the distance translated into decrease of the sale price by 92.16 PLN per m^2. The parameters in consecutive price segments were respectively: -21.70 PLN, -53.49 PLN, -81.29 PLN, -118.34 PLN, -120.61 PLN, -90.86 PLN, however the first estimate (for the quantile 0.05) was not statistically significant. The Old Cemetery turned out to be perceived as a disamenity by real estate buyers: the 1% increase in distance to it increased the apartment price by 37.20 PLN.

Table 4. The SQAR estimates for given quantiles and the SAR estimates for whole sample results (* – significant at 10% level, ** – significant at 5%, *** – significant at 1%)

	Quantile 0.05		Quantile 0.15		Quantile 0.25		Quantile 0.5		Quantile 0.75		Quantile 0.95		SAR	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
Const	164.43		1958.9	**	2281.14	***	2772.64	***	3110.53	**	7272.9	*	2790.76	***
ln(LIV_AREA)	125.89	*	16.88		-39.73		-59.85	*	-94.39	**	-137.61		6.66	
AGE_1850_1880	-585.41	***	-428.39	***	-398.66	***	-308.87	***	-175.77	**	273.88		-281.38	***
AGE_1881_1918	-1996.78	***	-1985.42	***	-1940.82	***	-1827.05	***	-1484.69	***	-967.09	***	-1620.27	***
AGE_1919_1939	-1868.31	***	-1673.47	***	-1538.96	***	-1353.4	***	-1233.33	***	-800.86	***	-1326.57	***
AGE_1945_1970	-1134.23	***	-1092.99	***	-1170.14	***	-1101.31	***	-1008.45	***	-824.85	***	-1026.75	***
AGE_1971_1989	-1004.52	***	-998.82	***	-1047.86	***	-1011.77	***	-986.91	***	-798.66	***	-949.58	***
AGE_1990_2010	-589.22	***	-309.96	***	-299.23	***	-133.7	***	20.58		364.75	**	-98.2	**
STORY_1	-209.09	**	-241.25	***	-255.37	***	-205.34	***	-177.6	***	-176.89	**	-207.81	***
STORY_2	-96.62		-19.15		-8.6		-22.78		-5.93		-12.23		-36.03	
STORY_4	86.55		21.95		24.64		28.57		48.94		-59.16		21.65	
STORY_5	178.79	*	106.98	***	116.64	***	67.35	**	86.62	**	65,00		100.17	***
STORY_6	281.27	**	187.32	***	172.16	***	151.39	***	219.33	***	211.19	**	226.48	***
STORY_7	231.29		203.04	***	146.06	***	145.16	***	181.67	***	230.13		180.1	***
STORY_8	181.45		125.61	*	74.75		29.9		21.74		756.09	***	129.45	*
STORY_9	101.91		17.67		106.12		45.41		13.99		16.53		45.59	
STORY_10	23.94		-36.12		19.7		-63.45		75.32		-123.22		-1.14	
STORY_11	204.58		44.26		73.36		46.08		70.29		-59.4		37.92	
STORY_12	100.53		67.71		-25.77		-91.73		123.95		-97.5		84.08	
STORY_13	-437.16	*	-954.9	***	-1134.46	***	475.9	*	1002.37	***	-106.7		95.5	
STORY_14	556.94	***	171.46		26.41		165.75		234.96		-605.23	**	147.22	
ln(DIST_RIVER_LODKA_GARDENS)	92.63		67.58	*	83.93	**	97.42	**	104.19	**	149.85		105.11	***
ln(DIST_PRIESTS_MILL)	73.62		-8.73		9.34		-61.91		-55.33		-206.92		-4.46	
ln(DIST_OLD_CEMETERY)	-5.31		76.05	**	69.43	*	29.97		14.13		11.03		28.03	
ln(DIST_REST_OF_GCTC)	-43.65		-10.95		-45.62	**	-45.16	**	-51.65	***	-48.05		-46.41	***
BIN_OTHER_GREEN_SPACE	310.37	*	321.53	***	325.49	***	251.48		407.08	*	653.4	**	296.59	***
PERCENT_GREEN	9.11	*	7.08	***	5.35	**	2.72		0.78		-4.92		3.27	*
ln(DIST_PRE-KINDERGARDEN)	-102.55	**	-61.73	***	-44.38	**	-6.4		-40.45		-9.77		-46.9	**
ln(DIST_KINDERGARDEN)	6.92		31.23		31.37		33.44	**	32.06	**	48.51	*	25.61	*
ln(DIST_ELEMENTARY_SCHOOL)	-58.58		-14.49		-35.35	*	-26.55		-14.85		6.23		-33.11	*
ln(DIST_MIDDLE_SCHOOL)	34.22		34.41		6.35		35.15	*	52.9	***	137.75	***	52.29	***
ln(DIST_HIGH_SCHOOL)	58.4		13.85		33.34	*	20.47		-15.57		-69.38		-0.24	
ln(DIST_UNIVERSITY)	-119.93	***	-138.68	***	-75.16	***	-24.78		16.72		-15.55		-55.16	**
ln(DIST_PLAYING_FIELD)	59.68		24.18		17.85		33.03	*	20.5		9.93		28.86	
ln(DIST_SWIMMING_POOL)	24.31		89.22	**	105.34	***	100.53	***	79.1	*	2.63		65.16	**
ln(DIST_CITY_CENTER)	386.34	***	97.22		47.2		11.13		18.71		-116.56		91.24	*
ln(DIST_TRANSPORT_HUB)	48.41		63.95	*	91.57	***	89.25	***	18.92		-181.15		18.51	
ln(DIST_SHOPPING_CENTER)	-127.92		-39.93		-22.95		1.53		98.25		33.65		-37.04	
QUARTER	-50.07	***	-46.74	***	-49.61	***	-56.24	***	-57.12	***	-66.72	***	-53.39	***
(fixed effects for 26 adm. units)	(…)	(…)	(…)	(…)	(…)	(…)	(…)	(…)	(…)	(…)	(…)	(…)	(…)	(…)
RHO	0.31	**	0.23	***	0.17	***	0.16	***	0.2	**	0.28	**	0.22	***

As expected, the exceptional proximity to the green spaces not belonging to the GCTC had a positive influence on property prices – the apartments located not further than 59 meters from green spaces of this type were on average more expensive by 269 PLN per m^2 than others. However, note that this dummy variable takes the value 1 only for 60 observations – thus it is designed rather to recognise the outliers located extraordinarily close to green spaces than to provide the comparative estimate of marginal willingness to pay for green spaces other than the GCTC. Also, the percentage of greenery in the neighbourhood of the building (approximated by 500 m buffer) was assigned with a positive coefficient – for the whole sample every increase by 1 percentage point in the share of green spaces in the buffer translated into an increase of a price of a square meter by 7.31 PLN.

The surprising results for green spaces adjacent to the Priest's Mill complex and the LRG inspired us to conduct additional estimations. We decided to check if there are any green spaces that exert a positive impact on apartment prices when considered separate from the rest of the GCTC. The alternative was that the positive effect is reserved only to the entirety of green spaces and is perceptible only when the distance is relatively short (as in the case of green spaces not belonging to the GCTC). To do that, we extracted from the GCTC four other parks, the three largest from the outer ring of the GCTC: Pilsudski, Poniatowski, May 3rd parks, and the largest park from the inside of it – Sienkiewicz Park. We selected the largest parks as the point of reference because many previous hedonic pricing studies indicated that large green spaces have larger impact on property prices than the smaller ones (Brander and Koetse 2011; Larson and Perrings 2013; Melichar and Kaprová 2013; Tajima 2003). Then we estimated four sets of regressions (SAR and SQAR), analogous to those referred to above. In each case, the GCTC was divided into two variables: the selected park and the rest of the GCTC. The results of these regressions are presented in Table 5 (see the attachment); for the sake of clarity we presented only the estimates for the abovementioned sets of two variables.

The results show that Pilsudski Park has stronger impact on property prices than the rest of the GCTC in all price segments and for the whole sample. Similarly, Poniatowski Park tends to slightly outdo the rest of the GCTC taken together in influencing the property prices, although the effect is not as evident as in the case of Pilsudski Park. The lack of statistical significance in the last price segment might suggest that there are few expensive apartments located in the proximity of that park. May 3rd Park influences the property prices to a smaller extent than the rest of the GCTC and Sienkiewicz Park seems not to have any significant impact (this lack of significance might be the result of the elimination from the sample the new building "Solaris" with extraordinarily expensive apartments which is adjacent to the park).

Table 5. Results for green spaces from regressions focused on other parks (* – significant at 10% level, ** – significant at 5%, *** – significant at 1%)

	Quantile 0.05		Quantile 0.15		Quantile 0.25		Quantile 0.5		Quantile 0.75		Quantile 0.95		SAR	
	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.	Coef.	Sig.
ln(DIST_PILSUDSKI)	-249.76	*	-179.99	***	-142.47	***	-143.42	***	-126.63	***	-128.74		-146.95	***
ln(DIST_REST_OF_GCTC_1)	-37.61		-15.71		-26.5		-43.67	**	-81.66	***	-103.68	**	-53.18	***
ln(DIST_SIENKIEWICZ)	-133.94	***	-68.42	*	-40.16		-78.04		-78.08		-619.86	***	-56.96	
ln(DIST_REST_OF_GCTC_2)	-26.86		-15.92		-34.33	**	-58.06	***	-92.32	***	-100.49	**	-56.3	***
ln(DIST_MAY_3RD)	-61.51		-118.42	*	-127.98	**	-16.09		-5.01		74.82		-50.64	
ln(DIST_REST_OF_GCTC_3)	-33.28		-17.07		-38.3	**	-61.22	***	-93.74	***	-99.97	**	-56.96	***
ln(DIST_PONIATOWSKI)	-56.56		-45.88		-52.22		-16.04		-17.14		-4.41		-62.67	
ln(DIST_REST_OF_GCTC_4)	-39.23		-14.73		-32.39	**	-57.24	***	-92.07	***	-116.23	**	-53.68	***

6.5 Discussion of the results

The above results provide no support for the hypothesis that green spaces of the highest biocultural value exert a stronger impact on property prices than other green spaces. Additional regressions indicated that there is one green space in Lodz that alone has a strong positive impact on property prices, but that the green spaces of the highest biocultural value (the LRG and the Priest's Mill complex) do not. What seems to be a matter of preference for real estate buyers is mainly the area of the park (this conclusion is also supported by our baseline study (chapter 4). Although green spaces of the highest biocultural value contribute to some extent to the cultural identity of the city (Berbelska et al. 1998; Olaczek 2010; Olaczek and Bonisławski 2008), they are not essential for the real estate buyers. However, this finding does not mean that the concept of biocultural value is incompatible with the monetary valuation framework. We find it quite possible that the travel cost method or contingent valuation method might work better for estimating the value of this attribute of green space than does hedonic pricing (Brander and Koetse 2011). Indeed, the cultural benefits of urban green spaces most often valued with the use of hedonic pricing refer to recreation and aesthetic quality (Sander and Haight 2012).

The lack of significance of green spaces adjacent to the Priest's Mill complex might also be a result of that specific neighbourhood. It is a unique, post-industrial area that was in use until the early 1990s, and then began to fall into decay (Sowinska-Heim 2012). Such conditions might have successfully obscured the expected positive impact of green spaces. Only recently have more comprehensive urban revitalisation activities been initiated in this area, which have yet to be capable of bringing about the expected results (Ostajewska 2015). Meanwhile, the negative impact of the LRG may be associated with the fact that this part of the city has historically been rather neglected and poor, and the LRG constituted the southern border of the ghetto created during the Nazi Holocaust of the Jews (the second largest ghetto in WW2 German-occupied lands) (Olaczek 2010; Pelt 2015). The latter is commemorated in various information panels and is relatively widely remembered in the society.

The use of quantile regression allowed us to spot the growth of negative impact of LRG in the consecutive price segments. The reason for this might be the general negative result for LRG mentioned above – the buyers of relatively cheap apartments might be relatively less concerned with the bad connotations of the neighbourhood. The insignificant SQAR results for the rest of the selected green spaces prevent us from drawing conclusions from the quantile regression regarding their impacts on real estate prices. Only Pilsudski Park revealed significance in most of the price segments but its impact was contrary to our expectations: the estimates were decreasing in consecutive quantiles: more expensive apartments were associated with lower payments for closeness of the park. We suppose that the real estate market in Lodz might not be mature enough to reveal some dependencies between willingness to pay and total price of the real estate (the decision of property buyers are not sufficiently information-driven) in the case of the subtle differences that could be captured with the quantile regression or the number of observations is not large enough to capture such differences. This however requires further analysis in the broader context of the whole city.

In summary, this study aimed at incorporating the concept of biocultural value into the hedonic pricing framework. The green spaces with the highest biocultural value turned out to have a negative or insignificant impact on property prices in Lodz. The lack of impact of green spaces adjacent to the Priest's Mill complex and the negative impact of the LRG might result from their specific neighbourhoods. However, it seems plausible that the biocultural value of green spaces does not matter when it comes to buying an apartment. Instead, real estate buyers appreciate other aspects of green spaces, and green spaces in general seem to be perceived as important amenities.

7 DISCUSSION AND NEXT STEPS

The above three hedonic pricing studies indicated that the green spaces in Lodz are in general desired by the real estate buyers. Our results show that it is the perceived attractiveness, as captured by softGIS in the second study, rather than the biocultural value that real estate buyers are willing to pay for. The fact that biocultural value did not turn to be reflected in monetary terms may be related to the fact that it is not understood and perceived by the general population and hedonic pricing is too coarse to depict such influences – or that there were other factors that influenced apartment buyers (such as broader negative connotations of areas where the most bioculturally valuable green spaces are located). Most importantly, we have demonstrated the potential for integrating different valuation approaches and methods, and have described a general mechanism for how to operationalise integrated valuation in practice.

Furthermore, here and in another GREEN SURGE report (Kronenberg and Andersson 2016), we outline the broader framework into which integrated valuation attempts need to fit. This is to be held in contrast to other attempts to promote integrated valuation by simply assessing the value of different ecosystem services with the use of different methods at the same time, in an attempt to calculate a total value of an ecosystem (c.f. Bark et al. 2016). We see such attempts as parallel use of different methods, where one merely helps to interpret the results of the other, and none of the used methods is altered in any way. The 'real' integration requires that both methods are adjusted to provide a more meaningful and comprehensive (multi-dimensional) view of what is being valued or, at least, that one neatly fits within the other.

We see almost limitless possibilities for integration of different valuation methods, in which one method remains dominant (as in the two integrated valuation studies presented above, in which hedonic pricing remained the dominant framework). We can easily come up with ideas for next merges: hedonic pricing with biological value, softGIS with travel cost method, biocultural value with contingent valuation etc. The real limit to what is possible is the actual meaning of 'integration' – i.e. whether the integrated value dimensions are logically integrable or commensurable, and whether the methods are technically compatible (Kronenberg and Andersson 2016). Approaches that meet both these criteria will give measurable results and contribute to the general understanding of the role of urban green spaces. However, structurally adjusting both methods so that they provide a meaningful new method remains still remains a challenge.

We succeeded in integrating a monetary and a non-monetary valuation method twice. This allows us some insight into whether (or when) the non-monetary values are reflected also in monetary terms. In the case of general attractiveness and popularity of a green space (recognised with the softGIS) it turned out it is, while in the case of biocultural value it is not (at least not in our case study city and for how we captured biocultural value).

Some may argue that our examples are still monetary valuations, barely referring to the non-monetary concepts as the final output is still expressed in money. However, this would mean that the final result of integrated valuation is expected to be expressed in some combination of monetary and non-monetary units (such as "bioculturoeuros") and this seems impossible and pointless. Impossible because in fact we see very little potential of integration at the structural level, where two methods become an inseparable one. Pointless because even if such a merger would be feasible it is hard to imagine the interpretation of its results and their application. Therefore, if we consider integration as a tool for identifying linkages between different types of value – then we can conclude that there is a great potential for this, and our studies indicate the right direction.

Another important issue is to agree on the rationale for using, or striving for, integrated valuation. Stand-alone environment-focused hedonic pricing studies have been carried out all around the world since the 1970s, proving that in most cases "greenery sells". The general rule has already been established: that proximity to green spaces tends to increase property prices. What is the point of proving or denying this in yet another city? From a scientific point of view: practically none. From a political one: perhaps we can hope that such a study carried out in yet another city would be a good starting point for a local discussion of the value of green spaces, and that it would inculcate the understanding that not every parking place is actually worth cutting down another tree. Integrated valuation, on the other hand, satisfies both scientific and political purposes. It helps us understand relationships between different value dimensions (synergies and trade-offs), it provides new knowledge about different types of urban green spaces (or ecosystem services), and it provides information about the preferences of different stakeholders. In this sense, integrated valuation indicates new directions for our studies and activities by providing new information. It broadens the scope of our understanding and highlights the different value dimensions (and the sometime linkages between them), in many cases indicating that not all that has value can be expressed in monetary terms (again indicating trade-offs between different value dimensions). Thanks to our studies we know that people are willing to pay for the general attractiveness of green spaces but they are not willing to pay for its biocultural value (at least not when buying an apartment). However, if a green space is valuable from a biocultural point of view, and not necessarily from a monetary one, it does not mean that it is of no value or that it does not deserve protection. Quite the opposite. There are different value dimensions to consider, and integrated valuation should be able to highlight this. The societal value of UGI is not decided by people's willingness to pay for it, but by the extent to which it provides benefits to urban residents. The integration of methods allows to escape from encouraging the commodification of nature, for which it has been criticised (Gómez-Baggethun and Ruiz-Pérez 2011).

The ability of integrated valuation to depict trade-offs between different value dimensions provides a justification for making the extra effort required for taking this approach. One should not expect that different value dimensions are fully consistent and that the different methods used to capture them simply reflect the same preferences of urban inhabitants in different ways. They are not like different currencies that that just need an exchange rate. They reflect different value dimensions, hence they also refer to the different aspects or attributes of the valued goods and services - depending on which aspects are relevant from the perspective of a given value dimension. The main objective of integrated valuation is then to bring those different dimensions and aspects together, and to reveal the interactions between them (whether they are consistent or whether they exhibit trade-offs).

For the above reasons, work within GREEN SURGE will continue to explore options and opportunities for integrated valuation. We will keep hedonic pricing as the monetary component and try to connect it with other valuation approaches, including the sociotope, which is another kind of participatory mapping developed in Stockholm and depicting functionality and different uses (Ståhle, 2006), and with another monetary valuation method – choice experiment. We are happy to see that similar approaches have also been developed by others: in the Netherlands, Daams et al. (2016) have recently successfully combined hedonic pricing with value mapping survey data, finding that natural areas perceived as attractive do exert positive impacts on nearby property prices. Indeed, as indicated in our GREEN SURGE Milestone on integrated valuation (Kronenberg and Andersson 2016), it seems feasible to integrate hedonic pricing with most social valuation methods.

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