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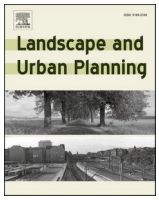

Important places in landscape – investigating the determinants of perceived landscape value in the suburban area of Wrocław, Poland

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HIGHLIGHTS

- We assess landscape values with subjectivist and expert approaches.
- Results from subjectivist and expert assessments often differ.
- Citizens assigned highest environmental value to suburban landscapes.
- Results from the expert assessment emphasize forests and river valleys.
- Landscape planning should upscale efforts to consider citizens' values.

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ABSTRACT

Landscape planning studies usually consider landscape values through expert assessments of landscape aesthetic quality. Combining such expert assessments with people's perceptions as derived from citizen-based approaches is advisable, but scientific knowledge gaps exist regarding explanatory variables of perceived landscape values. This study aims to investigate determinants of landscape value as perceived by citizens. The suburban area of Wroclaw, Poland serves as an illustrative case study. Our research design consists of a three-step approach: (i) eliciting citizens' landscape value types using a Public Participatory GIS survey, (ii) formally assessing indicators of landscape aesthetic quality, (iii) comparing physical environmental characteristics and accessibility for both types of areas with spatial-statistical methods. The survey results (n = 468) include 364 important landscape places attributed to environmental, cultural, aesthetic/scenic or personal reasons. Agricultural landscapes were appreciated highest due to associated perceived environmental and aesthetic values. The expert assessment of landscape aesthetic quality was implemented by GIS-based analyses of naturalness, diversity and uniqueness indicators. It's results showed that landscape aesthetic quality is distributed mainly across forested areas and river valleys. In general, elicited value types and landscape aesthetic quality indicators illustrated only weak relationships, with the exception of perceived environmental value and landscape naturalness. We conclude that citizens' perceived landscape values often do not correspond with places identified in expert assessments. Landscape planning and management should therefore consider amending its portfolio of evaluation approaches to better capture values relevant for people.

1. Introduction

Assessments of values associated with landscapes provide important insights to inform landscape policy and decision-making (Hermes et al., 2018). Landscape values, understood in this context as nonmonetary values providing information about human needs and desires (Zube, 1987), have proven to be one of the most important factors affecting citizens' well-being (Florida et al., 2011; Kyttä et al., 2013). Thus, many

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policies today require the consideration of landscape values in decision-making, as suggested by the European Landscape Convention (ELC) and the Polish Landscape Act.

Numerous methods for assessing landscape values have emerged in the last three decades (Solecka, 2018). Two basic approaches can be distinguished: expert and subjectivist approach (Lothian, 1999; Tveit et al., 2006). Expert approaches, the first category, utilize general public preferences for certain landscape features, derived from basic research concerning the general perception of landscape and visual amenities, expert knowledge, and statements in the law (Dramstad et al., 2006; Martínez Pastur et al., 2016). This type of assessment refers to intersubjective values, which are not objectively proven but agreed upon by most people and they refer to a core of basic common landscape preferences that can be deduced from the literature (Hermes et al., 2018). Existing expert assessments often refer to landscape aesthetic quality (LAQ), understood as the pleasure that people gain from the aesthetic appreciation of landscapes (Reid et al., 2005). High LAQ can have a positive influence on people's satisfaction (Hadavi et al., 2018), enhance mood (Kaplan, 2001) and enhance the quality of life (Falihin et al., 2016; Kerebel et al., 2019). Exemplary applications of LAQ-like assessments include Ozkan and Ozdemir (2015), Frank et al. (2012, 2013), and Hermes et al. (2018).

The second category, subjectivist approaches, attempts to elicit local users' perceptions and preferences concerning landscapes in a given area. We understand landscape perception as the function of the interaction of people and landscape (Zube, Sell & Taylor, 1982); accordingly, it also includes people's perception of landscapes and the values that people assign to them. Diverse subjectivist assessment methods have recently been proposed (Conrad et al., 2019; Solecka, 2018), including interviews, questionnaires, or ratings of pictures (Arriaza et al., 2004; Beza, 2010; Bulut & Yilmaz, 2008; Cañas et al., 2009; Pflüger et al., 2010; Tveit, 2009), social media content analyses (Van Berkel et al., 2018; Langemeyer et al., 2018; Tieskens et al., 2018; Richards & Tunçer, 2018) or public participatory GIS (PPGIS) (Brown & Raymond, 2007; Kahila-Tani et al., 2016; Kyttä et al., 2013).

Recent studies have shown differences in subjectivist assessments not only between experts and laypeople (Conrad et al., 2019; Riechers et al., 2017; Vouligny et al., 2009) but also between laypeople living in different landscape types (Soliva & Hunziker, 2009). While experts and laypeople tend to have similar opinions on cultural landscape value (Vouligny et al., 2009) and cultural ecosystem services such as recreation (Rabe et al., 2018), their opinions may differ in terms of ordinary landscapes such as intense agricultural landscapes (Vouligny et al., 2009) and landscapes requiring protection (Conrad et al., 2019). Sociocultural valuation depends on the values of an individual or a group of people as well as the larger social context, e.g., values for the community (altruistic values) or values for future generations (bequest values) (Scholte et al., 2015).

Researchers agree that combining both approaches is advisable (Kerebel et al., 2019; Rabe et al., 2018; Wartmann et al., 2021). Rabe et al. (2018) used a model for recreation suitability that integrates users' preferences into an expert-based modeling process, and Kerebel et al. (2019) applied a Bayesian model to weigh indicators and assess landscape aesthetics. However, these studies focus more on the potential integration of the approaches than on finding some general explanatory variables for the landscape values perceived by citizens. Wartmann et al. (2021), by exception, focus on factors influencing visual landscape quality perceived by people; however, these are mainly variables concerning personal background information (e.g., length of residence in the region). While an increasing number of studies compare results from either subjectivist or expert approaches, very few studies provide insights into potential reasons why those differences exist.

This study aims to investigate the determinants of subjectivist landscape assessment and compare those with results from a expert approach. Our research questions are:

1. What values did citizens associate with areas of high importance?
2. What physical environmental characteristics describe areas of high-quality landscapes assessed with subjectivist and expert approaches?
3. To what degree can a expert approach capture the diverse value perceptions of local people, and how can both approaches be integrated?

To answer these questions, we use the PPGIS survey-based method to assess the subjectivist approach and conduct LAQ assessment based on the expert approach developed by Hermes et al. (2018). Our case study area comprises the suburban area of Wrocław, Poland, a landscape of primarily agricultural land interspersed with small forests and protected areas with high urbanization pressure and rapid landscape change. Our case study will provide insights for landscape policy and planning in peri-urban areas that aim to incorporate spatial and functional aspects regarding landscape values and places that are important for citizens.

2. Methods

2.1. Case study area and landscape policy context

The case study area consists of ten suburban municipalities surrounding the city of Wrocław located in the Lower Silesia region in Southwest Poland (Fig. 1). This area has been marked by rapid growth in residential areas in the past (Solecka et al., 2017) and in planning documents (Świąder et al., 2020).

2.2. Subjectivist approach

We use a subjectivist approach to assess the perceived landscape quality (PLQ). We collected PPGIS data using a web-based platform that combines geographical data with a traditional questionnaire. The PPGIS questionnaire was distributed among the inhabitants of the case study area using random household sampling (leaflets and traditional post) and crowdsourced sampling (social media, websites of the municipalities) between June and October 2019. Before running the questionnaire, it was tested in different age groups to ensure that it was usable and equally accessible for everyone. To ease usability, only point information could be marked on the map following Gottwald et al. (2016).

The respondents were asked to mark important places in the landscape with a colored pin (Fig. 2) and to evaluate their respective importance for environmental, cultural, aesthetic/scenic or personal reasons using a six-level Likert scale. Respondents also indicated how often they visited these places (ranging from more than once a week to less than once a year). Further questions related to background information included age and gender. The data were validated based on the location of the home point within the case study area and responses to the landscape evaluation questions.

The selection of landscape values was motivated by Polish legislation and the definition of priority landscapes. According to the Polish Landscape Act (Act of 24 April 2015 amending certain laws in connection with the strengthening of landscape protection tools), priority landscapes are particularly valuable to society because of natural, cultural, historical, architectural, urban, rural or aesthetic/scenic values and, as such, require preservation or rules and conditions for development. We consider cultural landscape values as including historical, architectural, urban and rural values as they all refer to cultural heritage (Brown & Raymond, 2007). Although the values originate from the legal definition, they are also widely used in the scientific literature in different contexts. The authors often refer to more than one type of landscape value (Brown & Brabyn, 2012; Frank et al., 2012; Smith & Theberge, 1986; Sowińska-Świerkosz & Chmielewski, 2016).

2.2.1. Spatial clustering of PLQ

To identify areas important for citizens, we created areal clusters from the places marked as most important by citizens. We used the spatial clustering method described by Laatikainen et al. (2017) to investigate the

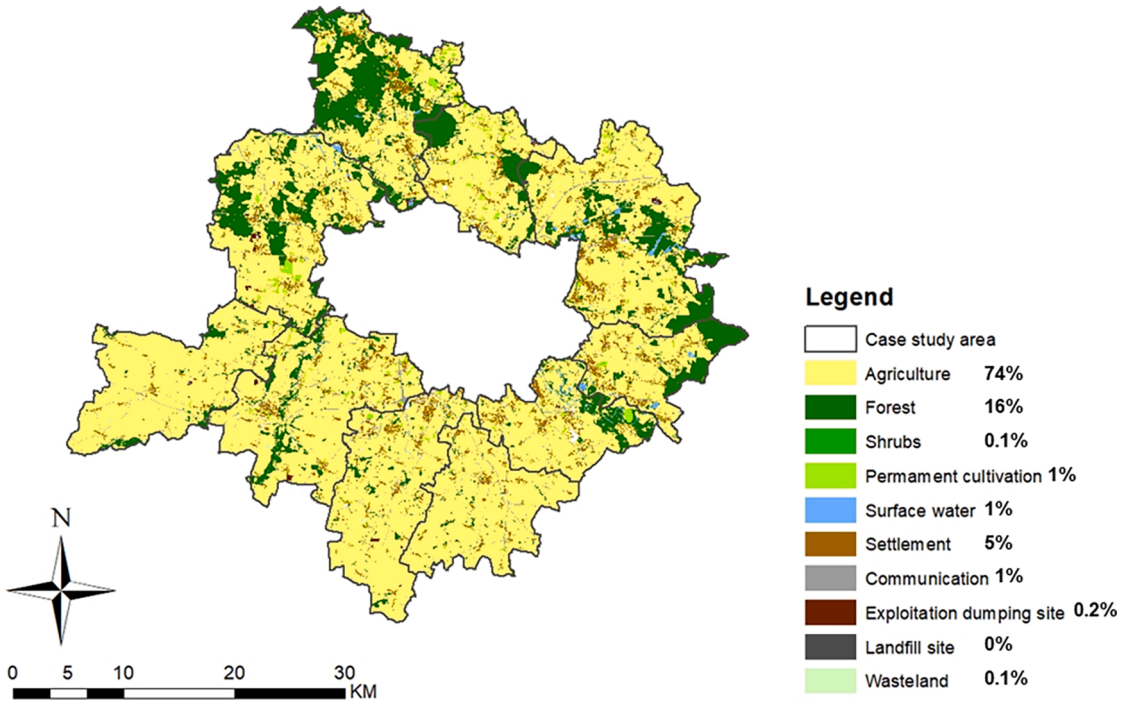

Fig. 1. View map showing peri-urban area around the city of Wrocław with land uses and their share in % (1 - Kostomłoty, 2 - Miękinia, 3 – Oborniki Śląskie, 4 – Wisznia Mała, 5 – Długołęka, 6 – Czernica, 7 – Siechnice, 8 – Żórawina, 9 – Kobierzyce, and 10 – Kąty Wrocławskie).

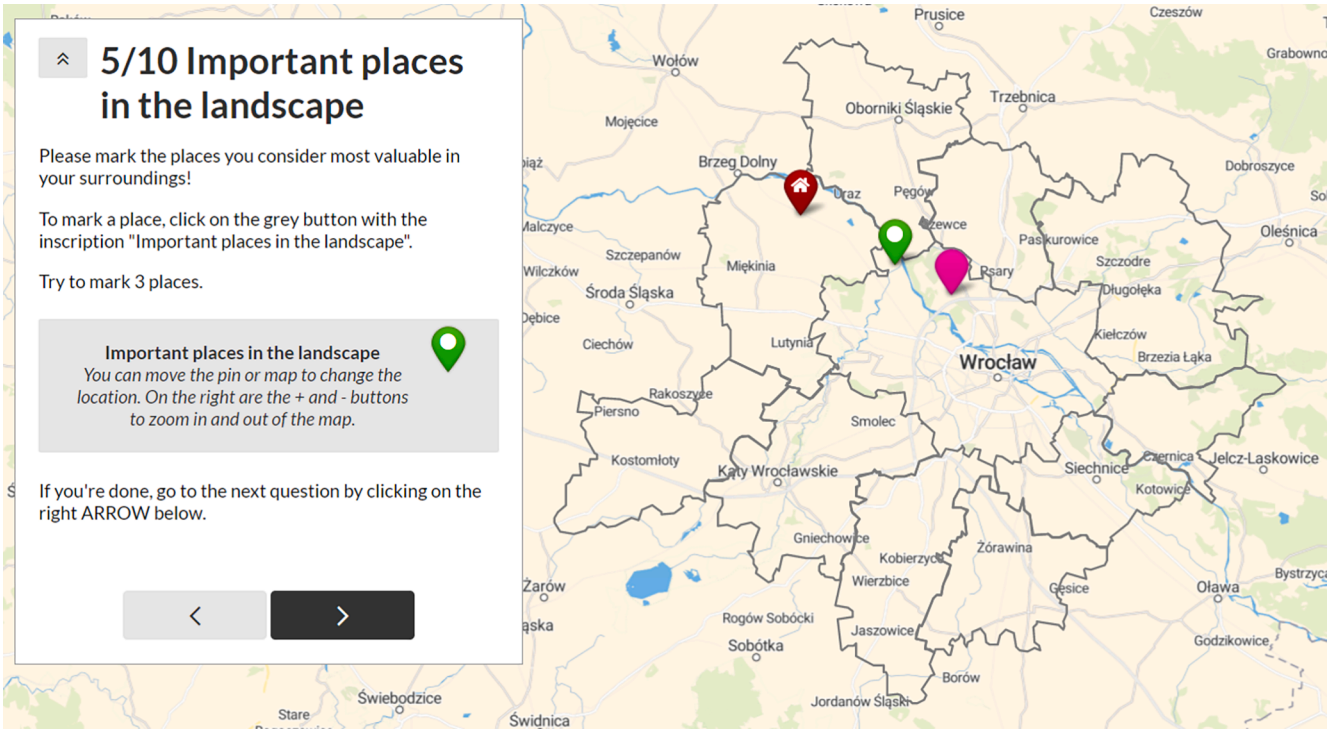

Fig. 2. The online interface of the survey where respondents marked on a map the places in the landscape they consider important (translated version, original in Polish).

areas with the highest PLQ. Using nearest neighbor analysis, a corresponding distance band of the mean distance of the mapped points was calculated, and the points were aggregated into polygons based on the identified distance band of 669 m. Finally, we intersected the clustered points to polygons to create the final dataset for the analysis. For each cluster of PLQs, we calculated mean environmental, cultural, aesthetic and personal values.

2.3. Expert approach

As an expert approach, we used LAQ based on Hermes et al. (2018), focusing on visual landscape attractiveness, and we aligned it to the local level. This method is based on literature analysis, including cultural ecosystem services studies and landscape planning assessments as approaches to assessing landscape character and relevant studies from

the fields on environmental psychology and health research (Hermes et al., 2018), e.g., widely used methods by Frank et al. (2013) and Walz and Stein (2014). The selection of indicators is based on investigative determinants of LAQ, including a comprehensive overview of visual concepts and the indicators commonly used to operationalize the concepts, as reviewed by Tveit et al. (2006). A detailed explanation of the LAQ assessment is given in Appendix 1.

2.4. Investigating the determinants of perceived landscape value

We further calculated a mean LAQ value for each PLQ cluster area to investigate whether formally assessed high-quality landscapes are associated with areas important to citizens. The PLQ values were also normalized to allow for the comparison of corresponding normalized values to LAQ values. We performed correlation analyses to assess the spatial associations between LAQ measures and PLQ.

In addition, we calculated the share of different land use types within each cluster to analyze the physical environment of PLQ landscapes. To compare these to the expert approach, we also calculated the land use types for the highest LAQ quartile. To further assess how accessibility is related to landscape values, we used national topographic data, including roads (database of topographic objects from General Center for Geodetic and Cartographic Documentation). We buffered each road segment with a buffer of 100 m to include the direct surroundings of the roads. We calculated the share of road areas within PLQ clusters and the highest LAQ quartile.

Moreover, we performed an agglomerative hierarchical cluster analysis on the PLQ clusters to determine if specific environmental, aesthetic, cultural and personal experience value profiles exist that characterize the areas of importance for citizens. Agglomerative hierarchical cluster analysis has also been used elsewhere in landscape research (McGarigal et al., 2009; Nungesser, 2011). Hierarchical cluster analysis is an exploratory analysis method to reveal natural groupings within a dataset that would not otherwise be apparent (Aldenderfer & Blashfield, 1984). Thus, hierarchical cluster analysis using the unweighted pair group method with squared nearest neighbor as the distance measure was found to be a convenient statistical method to classify the spatially determined PLQ areal clusters based on their (dis) similarities in environmental, cultural, aesthetic/scenic and personal values. We also used a one-way analysis of variance (ANOVA) to determine whether there were statistically significant differences between the mean formal LAQ value and the PLQ cluster groups. We analyzed these to better understand if contradictions exist in subjectivist and expert approaches, and if so, of what nature. Finally, we also analyzed written comments attached to important places to fully understand the personal value of each cluster. All geospatial analyses were performed with ArcGIS 10.7.1, and statistical analyses were performed with IMB SPSS Statistics 26.

3. Results

3.1. Subjectivist approach

A total of 468 people responded to the survey. We decided to merge the respondent data from two different methods of sampling (random household sampling and crowdsourced sampling), as their combination helps to achieve better representativeness (for detailed sociodemographic structure and duration of living in the case study area, please see Appendix 2). After data validation, we selected 344 respondents who marked 364 important places in the landscape for environmental, cultural, aesthetic/scenic or personal reasons (Table 1).

The results show that 21% of places indicated as important are visited more than once a week, 18% once a week, 20% once a month, 20% once every few months, 5% once a year, and 2% less often than once a year. Approximately 12% of respondents did not indicate how often they visited their important places.

3.1.1. Spatial clustering of PLQ

To understand how the specific perceived landscape values characterize areas of high importance to citizens, we analyzed those values within clusters of PLQ. With the use of the described spatial clustering method, we identified 28 spatial clusters that included important places mapped by 163 citizens within the case study area (Fig. 3). All 28 clusters scored relatively high in aesthetic and environmental values. The mean environmental value of all the clusters was 4.47 on a scale from 1 to 6, whereas the mean scores for cultural, aesthetic and personal values were 3.27, 4.98 and 3.96, respectively. Moreover, the mean scores of the cultural and personal values, in particular, varied between different PLQ clusters.

The size of PLQ clusters varies between 0.001 and 0.69 km^2 and includes between 3 and 25 points. To further investigate the characteristics of the PLQ clusters, we performed agglomerative hierarchical cluster analysis. After identifying the spatial clusters, we aimed to analyze and recognize whether there were cluster groups with similar PLQ profiles. Furthermore, as some of the original 28 spatial clusters included a very small number of points inside them, putting potentially similar PLQ clusters together was found appropriate for further analysis. Hierarchical clustering was also performed to understand if there were specific PLQ clusters that had similar perceived landscape value characteristics. The hierarchical cluster analysis looked at the mean values of environmental, cultural, aesthetic/scenic and personal values of each of the 28 PLQ clusters and began with each object in a separate cluster. At each step, the two clusters that were most similar to each other were combined and formed a single new cluster based on the average-linkage-between-groups method. While deciding on the number of cluster groups formed as a result of the hierarchical cluster analysis, we examined both the agglomeration schedule and the dendrogram to determine an inconsistent increase in the dissimilarity measure (Fig. 4). With a clear inconsistent increase in the dissimilarity measure between approximately 10 and 15 along the horizontal axis, having analyzed the results of the dendrogram, which suggested a five-cluster solution, we decided on a six-cluster solution, as we wanted to be able to separate Clusters 4 and 5 from each other. This was decided because the mean environmental value was the lowest for Cluster 5 compared to any other cluster group (Fig. 4). As the environmental value was relatively high in most of the 28 PLQ clusters, we considered it essential to maintain one cluster with a distinctively lower environmental value in the final analysis.

Hierarchical clustering returned six groups of PLQ clusters that tended to have similar profiles based on the perceived landscape values (Fig. 4). The original PLQ Clusters 1, 2, 4, 6, 7, 15, 17, 20 and 27 were grouped as cluster Group 1 (total of 85 original points); PLQ Clusters 3,

Table 1
Descriptive statistics of the environmental, cultural, aesthetic/scenic and personal values concerning important places of 364 respondents.

	Environmental value	Cultural value	Aesthetic value	Personal experiences or memories
Mean	4.88	3.29	4.91	3.95
Median	5	3.5	5	4
Std. Deviation	1.17	1.52	1.17	1.54
Minimum	1	1	1	1
Maximum	6	6	6	6

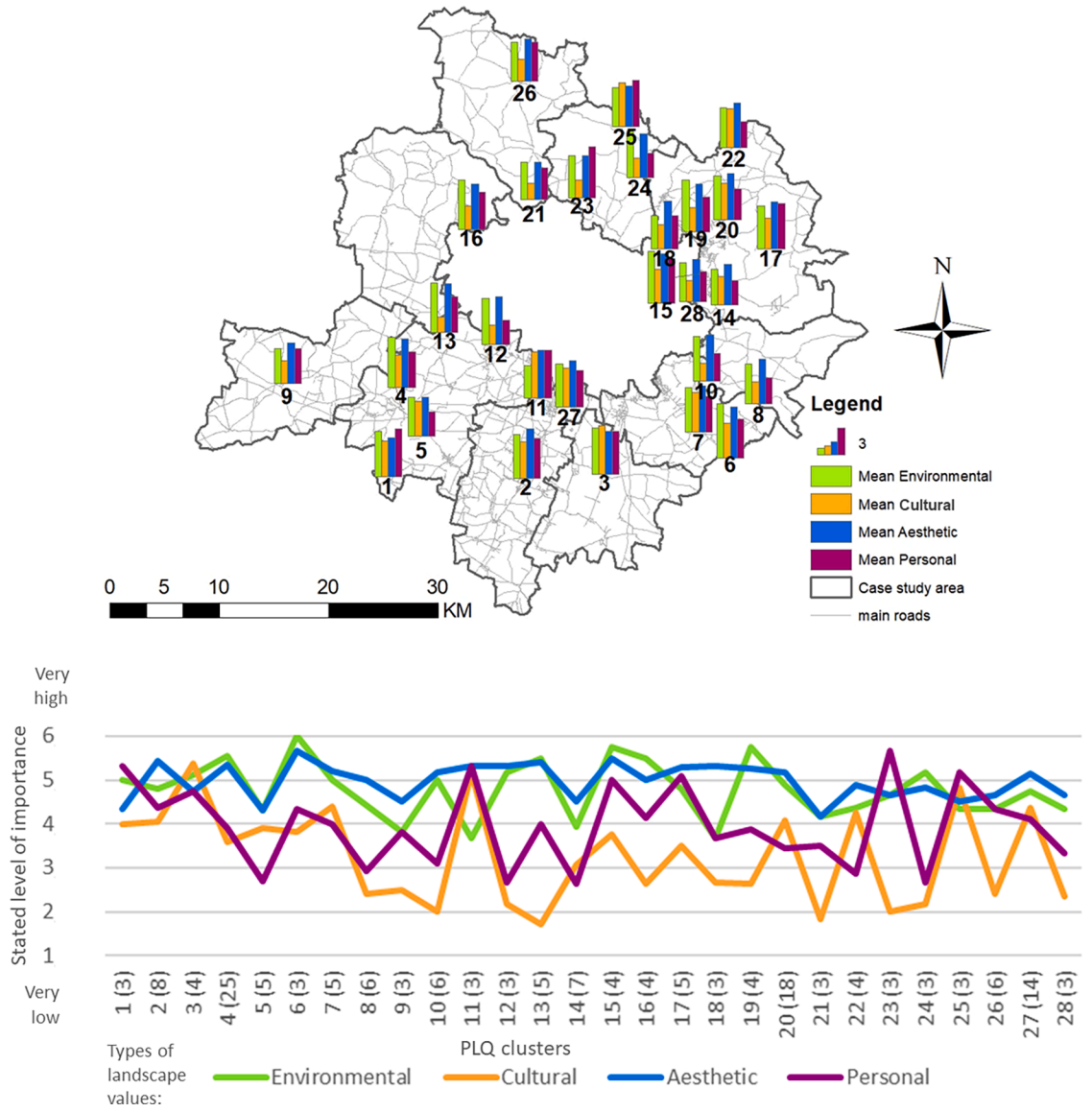

Fig. 3. Case study area with mean environmental, cultural, aesthetic and personal values for 28 PLQ clusters pictured in relation to main roads. The chart presents the stated level of importance ranging from 1 (very low) to 6 (very high). The number of points falling inside each cluster is included in brackets.

11 and 25 as cluster Group 2 (10 points); PLQ Clusters 5, 14 and 22 as cluster Group 3 (16 points); PLQ Clusters 8, 10, 12, 13, 16, 19, 24 and 28 as cluster Group 4 (34 points); PLQ Clusters 9, 18, 21 and 26 as cluster Group 5 (15 points); and, finally, PLQ Cluster 23 as a single separate cluster Group 6 (3 points) (Fig. 5).

The newly formed cluster Groups 1 and 4 score the highest in environmental and aesthetic quality. In cluster Group 1, the mean scores of cultural and personal values are also fairly high, whereas in Group 4, these qualities are clearly lower. Group 2 scores high in all four categories but higher in cultural and personal than in environmental and aesthetic values. Groups 3 and 5 both score slightly lower in environmental and aesthetic values than Groups 1 and 4 but, similarly to Group 4, rather low in cultural and personal values. Cluster Group 5 scores the lowest for environmental value but much higher in terms of personal values than cluster Group 3. Group 6 represents only one single PLQ cluster (23), which, compared to all other groups, scores relatively high on personal values and low in cultural values. Because cluster Group 6 includes only one original PLQ cluster with just 3 points falling into it, we excluded it from further analysis.

The analysis of variance showed that the five remaining cluster groups had statistically significant differences in the mean scores of three out of four different perceived landscape values (Table 2). Post hoc analyses were conducted using Tukey's post hoc test. The mean perceived environmental value in cluster Group 1 ($M = 5.17$, $SD = 0.47$) differed significantly at $p < .05$ compared to cluster Group 3 ($M = 4.2$, $SD = 0.24$) and cluster Group 5 ($M = 4.00$, $SD = 0.3$). Additionally, the mean perceived environmental values were significantly different between cluster Group 5 and cluster Group 4 ($M = 5.10$, $SD = 0.51$). The mean perceived cultural value in cluster Group 2 ($M = 5.13$, $SD = 0.27$) differed significantly at $p < .05$ from the mean values of all other cluster groups (Table 2). The mean perceived cultural value was significantly different at $p < .001$ in cluster Group 1 compared to 4 and 5 and in cluster Group 3 compared to 4 and 5. The mean personal value in cluster Group 1 ($M = 4.40$, $SD = 0.62$) differed significantly at $p < .05$ compared to cluster Group 3 ($M = 2.74$, $SD = 0.14$) and Group 4 ($M = 3.33$, $SD = 0.6$). The mean perceived personal value was significantly different at $p < .001$ in cluster Group 2 compared to Clusters 3, 4 and 5. No significant differences in aesthetic values between different cluster groups were found.

The remaining five cluster groups were also further analyzed to examine their spatial distribution in the study area and the physical environment characteristics, similar to high LAQ areas. By visual

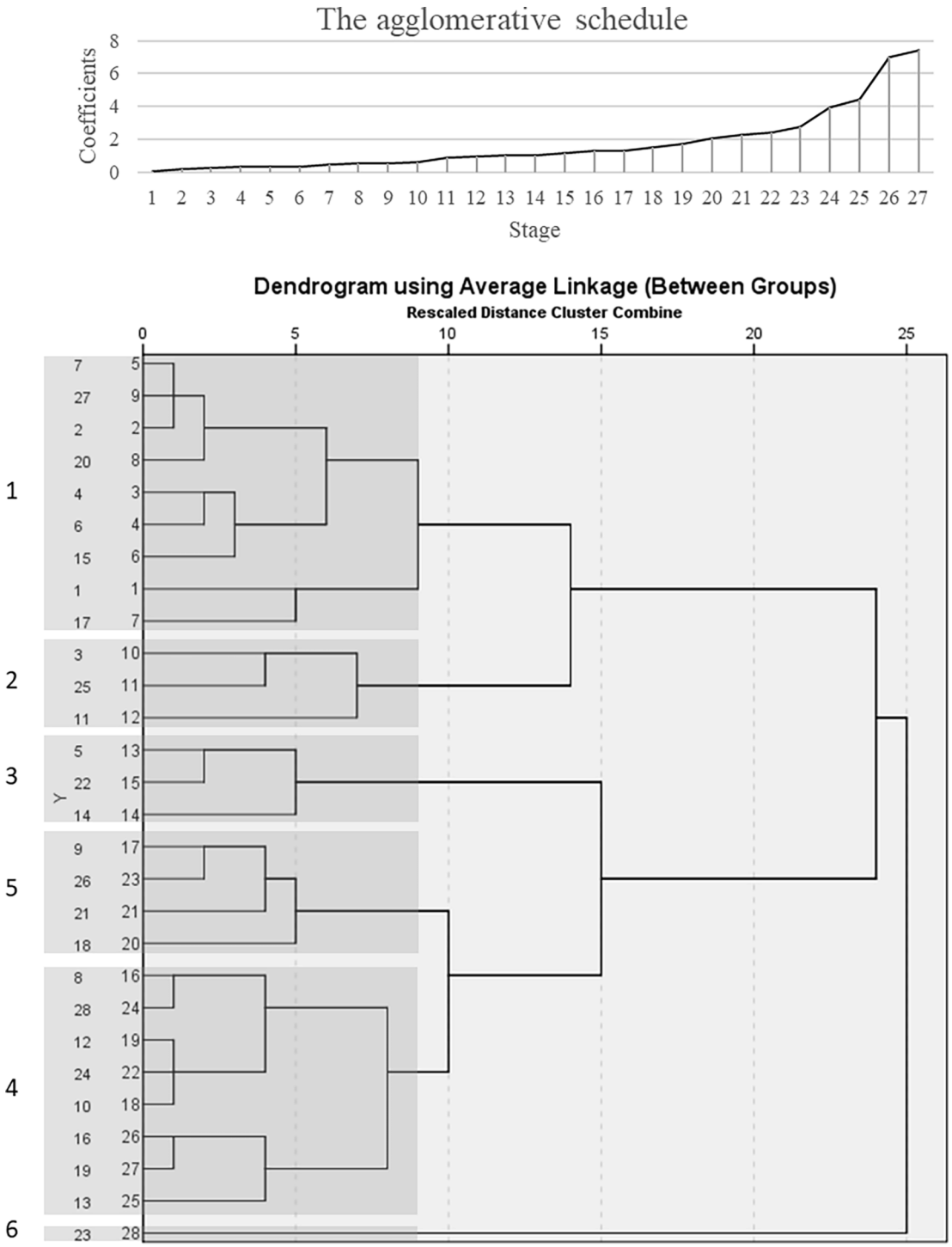

Fig. 4. The agglomerative schedule and the dendrogram showing the 28 PLQ clusters obtained with the average linkage (between groups) method. The gray boxes show the final six-cluster solution.

inspection, it is evident that particular cluster groups are spatially mixed around the study area, yet some of the groups follow somewhat similar spatial distributions. Cluster group one is located in the southern and eastern parts of the case study area. Clusters are located relatively close to the city or nearby main roads. Cluster Group 2 is located in the north and south. Cluster Group 3 is distributed evenly, and only one cluster is located near the main road. Cluster Group 4 is located around the city of Wrocław and is well connected. In cluster Group 5, the distance from the city differs between clusters; however, they are all located near main roads in the northern and eastern parts of the case study area.

3.1.2. The physical environmental characteristics of PLQ cluster groups

To investigate which physical environmental characteristics describe the PLQ cluster groups, we analyzed them in terms of land use. We found that there were no statistically significant differences in the physical environmental characteristics between the five different PLQ cluster groups. While there were some differences in the amount of settlement (17%, 66%, 33%, 0%, and 44%), industry (11%, 0%, 0%, 0%, and 0%), mine (0%, 0%, 0%, 0%, and 24%), green space (0% for all), agriculture (11%, 32%, 63%, 19%, and 25%), forest (52%, 2%, 4%, 63%, and 7%) and water (9%, 0%, 0%, 19%, and 0%) land covers, none showed

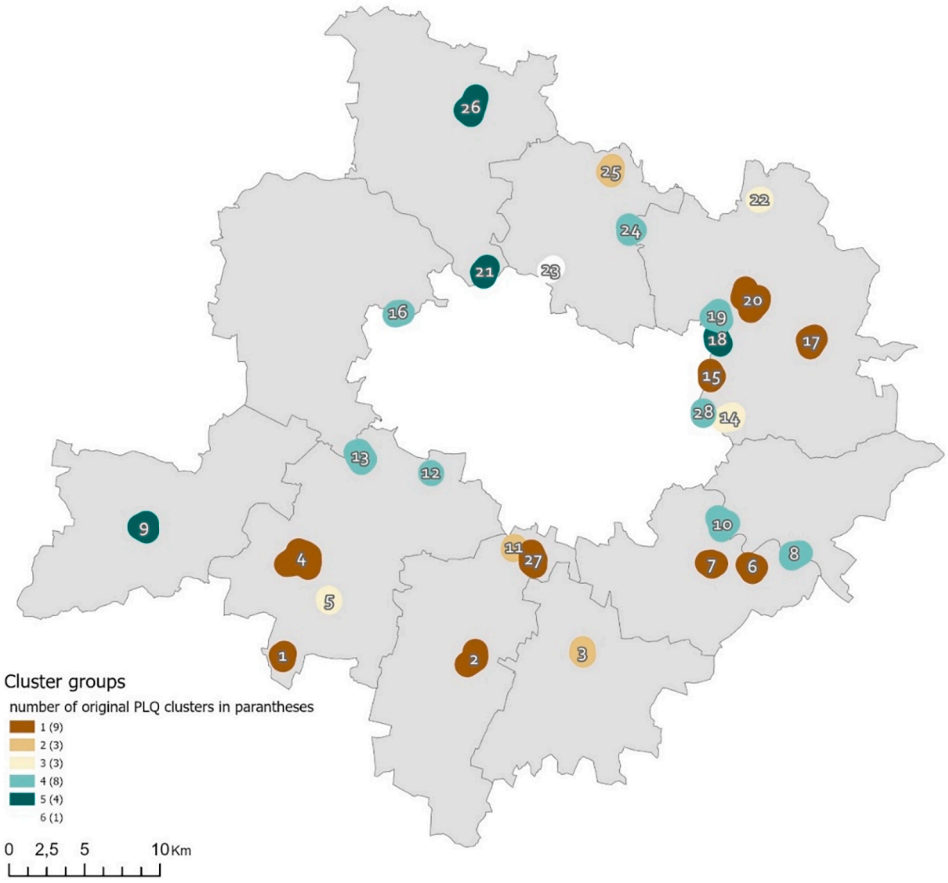

Fig. 5. Spatial distribution of the five different PLQ cluster groups determined by agglomerative hierarchical cluster analysis.

Table 2
The mean environmental, cultural, aesthetic/scenic and personal values in each of the six different PLQ cluster groups.

	Cluster Group	No of original PLQ clusters	Mean	Std. Deviation
Mean perceived environmental value	1	9	5.17	0.47
	2	3	4.38	0.73
	3	3	4.20	0.24
	4	8	5.10	0.51
	5	4	4.00	0.30
	Total	27	4.78	0.66
Mean perceived cultural value	1	9	3.95	0.32
	2	3	5.13	0.27
	3	3	3.74	0.61
	4	8	2.25	0.32
	5	4	2.35	0.36
	Total	27	3.32	1.06
Mean perceived aesthetic value	1	9	5.23	0.38
	2	3	4.86	0.43
	3	3	4.56	0.29
	4	8	5.08	0.25
	5	4	4.67	0.49
	Total	27	4.99	0.42
Mean value of personal experiences or memories	1	9	4.40	0.62
	2	3	5.08	0.30
	3	3	2.74	0.12
	4	8	3.33	0.60
	5	4	3.83	0.36
	Total	27	3.89	0.86

statistically significant differences between cluster Groups 1, 2, 3, 4, and 5.

3.2. Expert approach

The LAQ was evaluated with the use of three indicators: diversity, naturalness and uniqueness. High landscape quality areas are located in the north, east and southwest parts of the case study area in the forested areas and river valleys (Fig. 6). Municipalities with low LAQ values are characterized by agricultural land use with a low share of other land uses, as well as by the lack of rivers and forests. Uniqueness provoking elements (e.g., cultural monuments) are still present, yet the overall score is relatively low. These municipalities are located in the southern and western parts of the case study area. The highest score is related to the rivers and their direct surroundings.

Landscapes marked by high diversity are located in the southeast, southwest and north of the indicated area (Fig. 6a), due to the mixed land use of forests, pastures, meadows and rivers located in these areas. In the northern part, it is mostly forest, and in the southeast and southwest, high landscape diversity is the result of the presence of rivers. Landscape naturalness was distributed similarly to landscape diversity (Fig. 6b). Forests, shrubs and water have the highest degree of naturalness. Landscape uniqueness is distributed differently in the case study area (Fig. 6c). The location of uniqueness provoking elements such as cultural and natural heritage objects is distributed evenly. The presence of rivers is visible mainly in the southern and southeastern parts of the case study area.

3.2.1. Physical environment of high-quality landscapes

To investigate which physical environmental characteristics characterize high LAQ quartiles, we analyzed them in terms of land use. The highest LAQ quartiles included all cells with values of 0.245 or higher (scale 0 to 1). The total area of these cells was 34.1 km^2 (above 2% of the total study area 1423,30 km^2). The highest LAQ quartile was highly

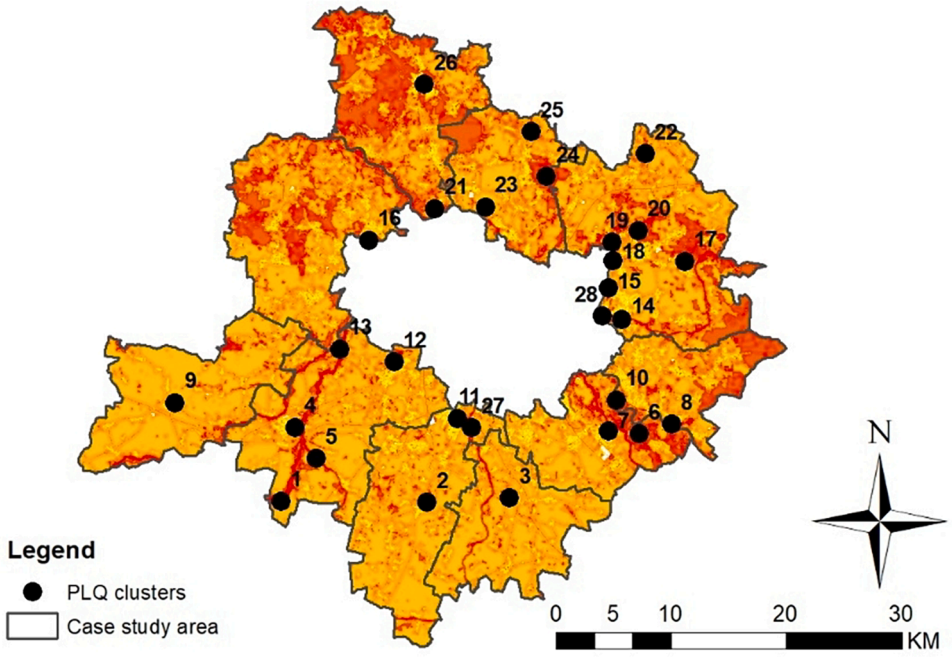

Fig. 6. Formal landscape aesthetic quality (LAQ) and spatial distribution of Perceived Landscape Quality (PLQ) clusters.

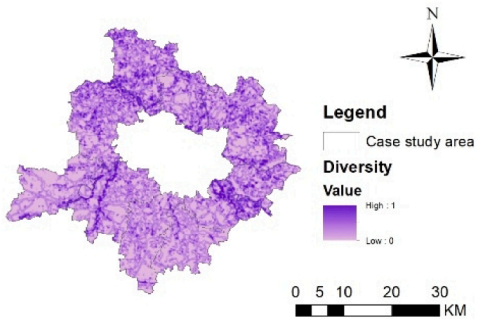

Fig. 6a. Landscape diversity across the case study area.

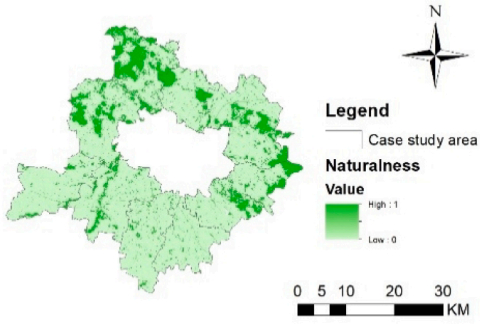

Fig. 6b. Landscape naturalness across the case study area.

dominated by forest areas, which covered 58%. Thirty-three percent of the area was covered by agricultural land, 3% by grassland, 2% by water, and 2% by settlements, while the remaining 2% was covered by green spaces and industrial and mining lands. From the visual inspection, we can additionally see that the highest scores appear in river valleys.

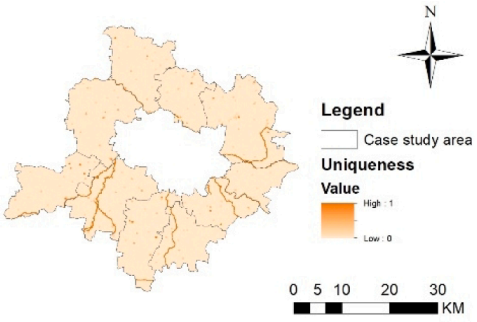

Fig. 6c. Landscape uniqueness across the case study area.

3.3. Investigation of the determinants of perceived landscape quality

We calculated mean formal LAQ values for each PLQ cluster area to investigate whether formally assessed high-quality landscapes are associated with areas important to citizens. The PLQ values were also normalized to allow the comparison of corresponding normalized values for LAQ values. We performed correlation analyses to assess the spatial associations between formal LAQ measures and perceived landscape value (Fig. 6). Environmental values ($r(28) = 0.476$, $p = .011$) were the only PLQ values that showed statistical significance associated with the total formal LAQ values when we analyzed all 28 different PLQ clusters separately (Table 3). Interestingly, the perceived cultural ($r(28) = -0.29$, $p = .088$) and personal ($r(28) = -0.20$, $p = .032$) values showed a negative association with LAQ, yet the findings were not statistically significant.

When we analyzed the 28 PLQ clusters in relation to the separate formal assessment values, we found that perceived environmental value was statistically significantly associated with the LAQ naturalness values ($r(28) = 0.587$, $p = .001$) (Table 3). Perceived cultural value was statistically significantly negatively associated with the LAQ diversity value ($r(28) = -0.374$, $p = .05$). Other PLQ values did not show statistically significant associations with particular LAQ values.

One-way ANOVA showed that the differences in LAQ values were

Table 3
Correlations between perceived and formally assessed landscape values in the 28 PLQ clusters.

	1	2	3	4	5	6	7	8
1. Formal assessment (LAQ)	1							
2. LAQ Diversity	0.733**	1						
3. LAQ Naturalness	0.872**	0.446*	1					
4. LAQ uniqueness	0.326	0.074	−0.011	1				
5. Perceived environmental value	0.476*	0.223	0.587**	−0.069	1			
6. Perceived cultural value	−0.292	−0.374*	−0.259	0.130	−0.029	1		
7. Perceived aesthetic value	0.122	0.044	0.240	−0.221	0.512**	0.105	1	
8. Personal experiences or memories	−0.195	−0.305	−0.089	−0.039	0.126	0.395*	0.112	1

statistically significant between the cluster groups ($F(4, 22) = 3.86$, $p = .016$). The mean LAQ values were 0.38 (SD = 0.13) for cluster Group 1, 0.19 (SD = 0.04) for Group 2, 0.34 (SD = 0.04) for Group 3, 0.44 (SD = 0.11) for Group 4, and 0.22 for Group 5 (SD = 0.16). We conducted post hoc analyses using the Tukey post hoc criterion to further investigate where the differences between the groups lie. The Tukey post hoc criterion indicated that the LAQ value was significantly lower in cluster Groups 2 and 5 than in cluster Group 4. Cluster Group 5 is located near roads, on agricultural land and away from rivers and cultural heritage objects. Because of those factors, this cluster group scored low on the LAQ. Cluster Group 2 scores high in all perceived values, yet personal and cultural values do not correlate with LAQ. Cluster Group 2 is located on agricultural land, which is not evaluated high in the formal assessment. Cluster Group 4 scores high both in formal assessment and perceived environmental value and has significant forest coverage, which is evaluated high in the formal assessment. We found no significant associations of the separate LAQ values (diversity, naturalness and uniqueness) of the PLQ cluster groups.

Accessibility analysis showed that within PLQ clusters, the areas related to roads cover 28% of the total area, and within the highest value LAQ areas, they cover 9%. However, a significant difference in size between those two areas should be noted. The highest value LAQ areas cover 274,69 km^2, and PLQ clusters cover 2,78 km^2. Larger areas are crossed by roads due to the location of the road network across the region, and the location of smaller areas within the buffer of 100 m of main roads is noncoincidental (Fig. 3).

Our analysis of written comments revealed that important places in cluster group one which scores high in personal values are described as great places for relaxation, places with outstanding cultural and business potential, a wonderful play area for kids, a beautiful castle, and a great place to walk your dog; they remind people of their childhood environment, enable swimming in the river in the summer and picking mushrooms in the forest, and people are involved in planning in these areas. Perceived personal value is the second highest in cluster Group 2. In this group, all comments are related to the park described as beautiful and unique, with beautiful old trees, snowdrops and many birds. The score for personal values is lowest in cluster Group 3. Important places in this cluster group are described as great places for walking, grilling and sport. Personal values are relatively low in cluster Group 4. This cluster group is described as a place with great potential for rowing boats and family picnics. Finally, cluster Group 5 scores higher than Groups 3 and 4 in personal value and is described as a place with various kinds of trees, wild animals and a great place for walking, sport and barbecue.

4. Discussion

This paper investigated determinants of subjectivist landscape assessment from functional and spatial perspectives and compared those with results from an expert approach. We explored similarities and differences between both approaches at the rural–urban fringe.

4.1. Perception of peri-urban agricultural landscape

Areas of high importance for citizens differ in terms of types of dominant perceived values. Areas of high PLQ in suburban agricultural areas are generally evaluated as aesthetically and environmentally valuable. Our results are confirmed by Wartmann et al. (2021), who found that openness of view is positively related to visual quality ratings, which relates directly to the character of agricultural landscapes. Our finding also corresponds with the suggestion by Ode et al. (2008) to assess LAQ with reference to an indicator relating to the proportion of open land. Another reason for highly perceived aesthetic landscape value is the fact that agricultural landscapes illustrate the seasonal variation in crops and fields. This indicator contributes to the ephemeral value of the landscape (Ode et al., 2008) and the fascination factor within restorative environments (Kaplan & Kaplan, 1989).

We are aware that spatial discounting, understood here as uneven distribution of points, might influence our results. For instance, places near settlements might receive more points than places further away or places without tourist attractions and infrastructure. Furthermore, the respective place of residence may influence citizens' landscape preferences. For example, Soliva and Hunziker (2009) found that residents of mountainous regions more often prefer well-maintained cultural landscapes, while visitors from lowlands appreciate wild landscapes. This finding is in line with our results, where important places usually tend to cluster around respondents' homes. We assume that inhabitants of peri-urban areas (49% of them have lived in this area for less than 10 years and functionally depend on the city) also appreciate cultivated land and perceive it as a natural landscape, most likely in contrast to the nearby city. In this case, we included volunteered geographic information methods (crowdsourced sampling) to augment probability sampling (Brown et al., 2020).

Generally, lower scores and greater differences between areas of PLQ appear in cultural and personal values. Perceived cultural values might depend on the condition of cultural objects and how it affects the perception of cultural heritage. This topic requires further investigation and more information about the cultural objects themselves. However, a study of landscape values in suburban areas in the Czech Republic reveals that local people seek and value landscapes that offer regeneration and relaxation more than landscape elements with high cultural value (e.g., cultural monuments) (Šťastná et al., 2018). However, our study shows that if places with high cultural value also offer relaxation and regeneration, they might be recognized with the highest personal value. We conclude that landscapes perceived as personally valuable are often described by the respondents as places that include special buildings or venues with unique characters (such as a castle, a historical park or an aeroclub) that are designed for different users (e.g., a play area for kids) or for different activities (e.g., swimming, picking mushrooms). This corresponds with findings from Baumeister et al. (2020) that historic sites and sports infrastructure enhance the cultural ecosystem value of urban forests as perceived by people.

4.2. Implications for formal landscape assessment

We assessed the correlation between perceived and formally assessed landscape value to better understand similarities and differences between them. We observed that the use of formal assessment reflects only what people perceive as environmentally valuable. We expected that

perceived aesthetic value would correlate with formal assessment because the expert approach is focused on aesthetic quality and is based on aesthetic theories (Tveit, 2009); however, our data did not show any correlation. The survey framing might have conveyed an impression that the term landscape might be more closely associated with the natural environment than with cultural assets. The cultural value of landscapes could also be understood by citizens as traditional farm management regimes and not necessarily with cultural heritage objects. Enhanced, nuanced understandings could be gained by complementing our research with deliberative approaches (Scholte et al., 2015).

Moreover, we expected that perceived cultural value would correlate with landscape uniqueness, but no such correlation was found in this study. This might be because the theme "cultural value" is not necessarily associated with cultural heritage and perhaps the word "historical value" would have better reflected the uniqueness provoking elements with cultural character. The condition of cultural heritage buildings and monuments was not taken into account and might differ between buildings and influence their exposition and perception. The perception of cultural heritage objects might also depend on the high variation of those objects and their specific features.

Vouligny et al. (2009) claim that experts' evaluations of landscapes are different from residents in terms of aligned values. Experts evaluate landscapes on a visual basis, while residents often assign higher values to local landscapes to which they have developed a sense of belonging. Our study confirms this result because we find no relation between perceived aesthetic, cultural and personal value and the LAQ. This also confirms the finding of Wartmann et al. (2021), whose study shows that the length of residency is positively related to visual quality ratings.

Both approaches also differ in terms of the physical environmental characteristics of high-quality landscapes. In the expert approach, the areas of high LAQ are mostly covered by forest and located in river valleys. Areas with the lowest LAQ for each indicator, as well as for the general result, are settlement and agricultural areas. This confirms the results of the national LAQ for Lithuania (Kalinauskas et al., 2021). However, no relation could be identified between PLQ and land cover. Finding no relation between PLQ and land use is worth mentioning because land cover is used as a proxy for cultural ecosystem services (Burkhard et al., 2012).

We observed that areas of PLQ were well connected to roads. Some of these areas resulted in low LAQ scores since a good connection to roads indicates lower formally assessed naturalness and lower diversity values. The authors assume that for people, the presence of roads is not perceived as negatively as it is in the formal assessment. Additionally, the study of Kalinauskas et al. (2021) underscores that a significant part of Lithuanian territory with the highest LAQ values has limited visibility and restricted access. To be of greater relevance for people, an expert approach might need to consider some aspects of the landscape beyond traditional measures, such as accessibility, and it should be included in the analysis while looking for potentially important places in the landscape. The importance of reachability and accessibility was also noted by Rabe et al. (2018) in the development of the model for the suitability of riverine zones for recreation as well as in the cross-country mapping of ecosystem service benefits in rural and peri-urban areas (Fagerholm et al., 2019) and in the study of landscape aesthetics capacity and flow in the province of Barcelona (Langemeyer et al., 2018).

4.3. Methodological challenges

While our study demonstrates the feasibility of the use of PPGIS tools to evaluate suburban landscapes, several critical challenges remain. We experienced a few limitations during the stage of distributing the survey and collecting the data that are worth mentioning. Because Poland does not require citizens to register their residences, it is often difficult to reach all residents by census data. Therefore, for practical reasons, it was impossible to use the random household sampling method as the only data gathering method. The response rate using the random household sampling method was very low, and without using crowdsourced sampling, it would not have been possible to conduct this study. The choice of sampling method, its costs and effectiveness should be considered in future studies, especially in countries where the use of PPGIS tools is not popular (for detailed information, please see Table 2 in Appendix 2). Background information was located on the last page of the survey. Therefore, the respondents probably became slightly tired from the mapping tasks and skipped the final questions (e.g., gender and age). Therefore, we were unable to draw conclusions about sex or age groups. While we choose to concentrate on areal units of analysis (clusters) for valid reasons related to focusing on the most important areas, this did reduce the number of data points in the analysis. Had we focused our analysis on separate place markings, we would certainly have had a larger amount of data to analyze but would have been faced with other challenges such as accuracy issues with point locations (Brown, 2012) and having to rely on arbitrary units of analysis with single point buffers (Hasanzadeh et al., 2018). Challenges related to the modifiable areal unit problem should also be recognized as a limitation related to using an areal approach with varying cluster sizes (Openshaw, 1981). Using a grid approach to identify landscape quality areas perceived as important by citizens would have improved the comparison between LAQ and PLQ approaches but might have hidden some spatial characteristics related to narrow and longitudinal point data clustering, e.g., along rivers (Laatikainen et al., 2017). The detailed results of this study are somewhat prone to the local characteristics of the case study area, but the PPGIS tools and the combination of expert and subjectivist approaches and the applied analyses used here are important for, and advance the field of landscape evaluation and research.

4.4. Implications for landscape policy and planning

The case study area is located in a rapidly developing suburban area, which constitutes an added value of this study. Landscape evaluation in changing multifunctional landscapes undergoing constant transformation and experiencing urbanization pressure requires complex tools and leaves gaps that should be explored in further studies. Our study showed that areas of high importance in the suburban setting where agricultural land cover predominates are generally evaluated as aesthetically and environmentally valuable. Following this finding, we suggest that new housing need not be located in environmentally valuable areas (e.g., near forests) to be perceived as environmentally valuable and to improve the quality of life of suburban dwellers. The rural character of suburban areas is vital for inhabitants, as it gives them a sense of living close to nature. Therefore, keeping both functions (agricultural and residential) in the suburban area in balance would be of the greatest possible value for people. In the context of the European Green Deal policy, high-quality agricultural production in peri-urban areas is expected to help reduce emissions through reduced transportation, job creation and improvements in the health and well-being of residents through improved diets.

Additionally, our study shows that PLQ does not relate to LAQ even though places of the highest personal value occasionally include cultural heritage buildings. Following this finding, we suggest that cultural heritage buildings in suburban areas could be improved and become areas of great importance for people if their functional aspects are considered in the revitalization and restoration process. Analysis of the location of areas of high PLQ could help to develop preferred locations for public spaces, which in the planning process produce platforms for community formation and the base for socially sustainable areas (Kasemets et al., 2019; Kajdanek, 2012), especially with local residents who have lived in the place for different periods of time. According to the latest studies, interaction with friends, family and community is strongly related to well-being and can help to improve the quality of life in peri-urban areas (Fagerholm et al., 2020). The spatial relation between home and important places will be analyzed in a separate paper and could reveal new findings about the activity spaces of suburban

dwellers and the spatial use of rural–urban fringes.

According to the ELC, local knowledge and perceptions need to be considered in land use management at the municipal level, and by law, residents need to be involved in the process. This study helps to identify determinants of highly perceived landscape value, which could improve the expert approach. The use of the PPGIS method provides the most detailed spatially explicit information about people's preferences and opinions, even though the application of the method is costly and time-consuming. Formal assessment is theory-based and often lacks context-sensitive and place-based approaches. Combining both approaches is possible; however, methods that enable this (e.g., the construction of Bayesian models) are time-consuming and require significant knowledge and technical competence (Kerebel et al., 2019). The authors hope that their study helps identify functional and spatial factors of places in landscapes that are important for people. We propose that considering accessibility in the formal assessment as well as our findings concerning the character of peri-urban landscapes and the use of areas related to cultural heritage will help to adjust landscape assessments to reflect people's preferences. We suggest the use of the PPGIS method, if possible, to ensure place-based specific insights and personalized community needs. Particularly, while capturing the value of ordinary landscapes from the planning perspective, a combination of subjectivist and expert approaches may be necessary (Vouligny et al., 2009). This approach can also be useful in planning landscapes that meet societal, functional and spatial challenges, such as the suburban areas in Poland, to help understand the needs of inhabitants and improve their quality of life.

5. Conclusions

We conclude that areas identified as being very important for people in the suburban area of Wrocław are associated with high perceived environmental and aesthetic landscape values. Suburban dwellers seem to appreciate the openness of views and agricultural landscape character that provide feelings of natural connectedness. Cultural and personal values have a relatively lower level of importance; however, the areas associated with personal values are often defined by unique elements (e.g., historical buildings), intergenerational recreation opportunities, and diverse activity possibilities. We do not identify relations between land cover and PLQ, in contrast to LAQ. Future landscape planning and management should aim at enhancing the integration of people's preferences in landscape assessments.

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Appendices 1 and 2. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.landurbplan.2021.104289.

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