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Article

Perception of urban trees by Polish tree professionals vs non-professionals

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Abstract: Sustainable urban forests require tree acceptance and support. Two groups of respondents: professionals working in urban green areas and individuals with no professional connection with trees revealed their attitudes towards trees by assessing statements in a survey questionnaire. Tree benefits were perceived as much more important than the annoyance. However, 6% of the non-professionals found only negative aspects of trees, proving to be arboriphobes. No arboriphobes and no "tree sceptics" were among the professionals. Around 40% of the respondents in the two groups found the number of trees in the surrounding areas too low. The nuisance caused by trees was seen as more disturbing by younger and lower educated professionals. Women tended to assess trees as more attractive and as having a stronger influence on social relations than men. Men dominated the "tree indifferent" group. The attractiveness of trees and their impact on social relations were related to the place of residence and the level of education among the non-professionals. The level of education of the non-professionals was also connected to being clustered into one of the four abovementioned groups of respondents. A majority of medium and big city dwellers as well as a minority of villagers were in the "tree liking" cluster.

Keywords: tree professionals; tree non-professionals; attitudes towards trees; perception of trees; sustainable urban development; social survey

1. Introduction

To protect urban forest means preserving and enhancing the livability of the city. Sustainable urban forests require a healthy tree and site condition, community-wide tree acceptance and support, but a comprehensive management approach as well [1]. Tree professionals should consider how the forest can best meet people's needs [2]. There is considerable and growing literature suggesting that air-pollution mitigation, energy savings, avoidance of runoff, and other benefits are associated with trees. The benefits can be estimated, and the monetary value of ecosystem services is the most important and most effective argument supporting tree management. For example, a benefit-cost ratio of 2.83 indicates that the value of projected benefits is nearly three times the value of projected costs [3]. On the other hand, it is known, also among professionals, that different values and attitudes can cause social conflict between the need to protect urban trees or to cut them down [4,5,6]. Kirkpatrick [5]points out that trees are not necessarily accepted by all people. People are known to vary considerably in their appreciation of urban forests and green spaces, with attitudes ranging from worship to fear [7,8]. This means that professionals need to deal with public pressure to cut trees down, especially when they are in conflict with development, or block out sunlight or the view. People also fear that trees might damage property or cars, and should be cut down for sanitary or just personal reasons [9,10]. Hence, it seems very important that the professionals take an objective look at the role of trees in the city, free of prejudice and bias. This problem is also important

in Poland, where the landscape architect or arborist profession does not have enough formal and legal support and therefore tree protection often depends on their individual decisions. Poland is developing dynamically, similarly to other former socialist members of the EU in central and eastern Europe and because of the high rate of overcrowding, which assesses the proportion of people living in overcrowded dwellings [11], Poland is undergoing a construction boom. The removal of trees in Polish cities results to a large extent from construction processes and the regulations do not contain guidance on technical procedure. Hence, tree protection on construction sites depends on the commitment of professionals and their understanding of the role of trees in the city. Unfortunately, in the design process, a lack of consistent application of tools allowing sustainable management of green areas can be observed. More and more often, architects create urban and historic green spaces without proper tree protection, which adversely affects their composition and functions. To a certain extent, tree professionals are responsible for the successful management and protection of urban forests and must deal with different kinds of constraints. Keeping existing trees in the construction and management process needs the concise environmental and social benefits of tree preservation to be successfully communicated to architects and developers [12]. Therefore, it is important to know how professionals perceive the various benefits and harms associated with trees, which can be summarized as (increasing) attractiveness, (improving) social relations, (causing) nuisance, (being a source of) contamination and damage, (causing) danger. To assess professionals' understanding of the role of urban forests, it is interesting to compare their attitudes towards trees with the attitudes of a representative group of non-professionals.

Attractiveness

City residents often express a positive view of street trees, like improvements in the aesthetic environment (sights, sounds, smells) [2]. High importance is assigned by residents to aesthetic and practical attributes, including beautification, the provision of shade, and increased property values [13].

Social relations

Social benefits associated with trees are well known. For example, a large existing tree adds chic and value to properties, which in the case of new projects makes them more readily acceptable by the community, which is especially important for retailers [12]. Psychological benefits associated with physical activity undertaken in urban forests include a sense of community and safety, increased enjoyment of everyday life, a stronger feeling of connection between people and their environment [14] and reduced rates of crime, relief from stress (which can lead to improved physical health), enhanced feelings and moods [2,15,16,17]. Social contact is known to have a positive effect on mood and stress levels and urban forest is a desirable environment in which to undertake it [18].

Nuisance, contamination and damage

The positive aspects of surrounding trees are associated with negative ones, however. The cost and inconvenience of urban forests can include nuisance caused by animals, insects and disease (i.e., Lyme disease or allergies), and displeasure with the messiness and clutter [2]. These reasons are a common excuse and cause of felling trees in Poland, especially since the beginning of 2017, when the Polish Act on Environmental Protection liberalized the regulations. Moreover, it is relatively common to find information on trees in conflict with the underground and aboveground infrastructure [19,20,21,22,23,24]. One of the reasons for the damage comes from the fact that tree roots grow throughout the whole life of the tree and can exert pressure on adjacent soil and nearby infrastructure surfaces [25,26]. This root pressure can lead to, among other things, the lifting of sidewalks [21,27,25] and the widening of pipe cracks [28,29]. The consequent replacement of hardscape elements can cause significant mechanical injury and loss of stability, especially in instances where existing structural roots are severed near the trunk during construction [30].

Danger

Trees can also cause a sense of danger connected with falling trees or limbs [2]. The darkness caused by trees can also lead to a fear of crime [2]. Therefore, the intensity of an urban forest could be considered as a factor in perceptions of safety [31,32].

Aim of the study

Our study was performed among two groups of respondents: the professionals, specialists working or planning to work in future on urban green areas; and non-professionals, respondents having no professional connection with trees. We asked both groups about the various benefits and harms associated with trees. The aim of the study was to compare the attitudes of professionals and non-professionals towards urban trees. The comparison was performed in two ways. Firstly, we examined the average attitudes towards the examined tree - related benefits and harms in both groups of respondents. Next, the differences in the respondents' attitudes were used to divide both professionals and non-professionals into clusters in order to try to identify such groups as arboriphobes or tree enthusiasts. The main goal of this clustering was to estimate and compare the shares of professionals and non-professionals in the identified groups. We believe that if professionals are to withstand public pressure to cut trees down, their group should include no arboriphobes and rather include many tree enthusiasts, free from fears and prejudices. On the other hand, it is the professionals who should objectively recognize both the benefits and harms associated with urban trees.

2. Materials and Methods

Professionals

Active tree specialists working in the field of planning and construction of building projects as well as possible future specialists were recruited in the years 2015–2016 during the project Roads for Nature on tree diagnostic training in the LIFE project (Project LIFE 11 INF / EN / 467 Roads for Nature - campaign promoting Poland`s trees in rural landscapes, as habitats and ecological corridors). The training was designed for current and future design professionals, construction employees and tree decision-makers such as public officials. Participants in the meeting were e-mailed an information letter asking them to fill out the questionnaire, with a link to the survey. Six hundred emails were sent out, for which complete answers were sent back from 198 persons, giving a 21% response rate. Twelve answers were removed from the study because the respondents had experience neither in education concerning tree protection nor in building projects. A further two answers were discarded because the respondents gave the same answers to all the survey questions. Finally, 184 answers to the questionnaire were analysed.

Table 1. Socio-demographic characteristics of 184 professionals whose answers to questionnaire were analysed.

Sex	Female	75%	**Place of residence**	Village	21%
	Male	25%		City below 50K citizens	20%
Age	Below 30	47%		City 50-200K citizens	9%
	30-45	38%		City over 200K citizens	51%
	Over 45	15%	**Place of work**	Village	8%
				City below 50K citizens	18%
Profession	Student	31%		City 50-200K citizens	10%
	Official	37%		City over 200K citizens	64%
	work contractor	15%	**Work experience**	Less than 1 year	15%
	Designer	17%		1-3 years	30%
Education	Secondary	29%		4-10 years	33%
	Higher	71%		Over 10 years	22%

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The professionals were mainly women, aged under 45 years, with higher education, living in cities with more than 200,000 residents. The dominance of women follows from the specificity of the profession - more women study landscape architecture and other 'green' studies and more work subsequently as specialists in comparison to the number of men.

The professionals were divided into four categories: students, officials, work contractors and designers. Their detailed sociodemographic characteristics are presented in **Table 1**.

Non-professionals

A quota sample of Polish citizens (n=514) took part in a survey conducted by IMAS International Institute in April 2015. All the survey data collection was done via personal paper-and pencil interviewing (PAPI). Qualitative methodology was used; answers to closed questions were listed. As four respondents returned empty questionnaires the number of surveys analysed was 510. The detailed sociodemographic characteristics of the non-professionals are presented in **Table 2**.

Table 2. Socio-demographic characteristics of 510 non-professionals whose answers to questionnaire were analysed.

Sex	Female	52%	**Education**	basic/primary	37%
				secondary and post-secondary	49%
	Male	48%		higher	14%
Age	Below 30	26%	**Place of residence**	Village	40%
	30-45	27%		City below 50K citizens	24%
	Over 45	46%		City 50-200K citizens	16%
				City over 200K citizens	19%

Questionnaire

The questionnaires used in the study for both groups of respondents were based on the modified version used in the research conducted by Schroeder et al. [33]. In the case of the professionals, it consisted of 29 statements regarding the benefits and harms associated with urban trees. The respondents expressed their opinion on each of the statements with answers given on a 5-point Likert scale anchored by "I fully disagree" and "I fully agree". The statements are presented in detail in Table 3. Additionally, the professionals were asked to assess the number of trees in their current place of residence on a 5-point scale anchored by "too few trees" and "a lot of trees". The survey for non-professionals was shortened to 24 statements. Each respondent selected those statements with which she/he agreed the most. Additionally, the non-professionals could choose the statement: "there are too few trees in cities".

Statistical Data Analysis

The Agglomerative Hierarchical Clustering (AHC) with Kendall distance and Ward agglomeration method was used to cluster the survey questions into sets forming the latent variables, based on the professionals' answers. The internal consistency within each set of questions was measured with Cronbach's alpha. For each professional, the values of the latent variables were computed as her/his mean answers to the questions corresponding to each of the variables. The importance of the latent variables for non-professionals was estimated by the number of statements belonging to each of the latent variables that they selected. Further analysis of the survey was based on the latent variables. The same clustering method with the Euclidian distance was further applied to cluster the respondents, separately professionals and non-professionals, based on the latent variables.

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The Kruskal–Wallis one-way analysis of variance test was used to compare the median responses to the latent variables among professionals categorized according to each of their sociodemographic characteristics and according to the clusters. In the case of statistically significant differences among the median responses in different categories of respondents, the homogeneous groups of categories were established using the Tukey's Honestly Significant Difference (HSD) multiple comparison procedure.

Contingency tables were created in order to investigate the relations between the numbers of selected statements associated with the latent variables defined in the study and the socio-demographic features of the non-professionals, as well as the dependence of the clusters of professionals and non-professionals on their sociodemographic characteristics. The dependence was examined for each of the characteristics with Fisher's exact test [34]. Fisher's exact test was chosen instead of the frequently used chi-square independence test because of the small size of the sample in the study. In the case of significant relations, we applied the approach adopted by Zeiles et al. [34] in order to bring out the pattern of these relations. The cells in the contingency table responsible for the departure from independence of the examined variables were identified as those for which the Pearson residual exceeded 1.0, 1.5 and 2.0.

All analyses were performed in the R program version 3.2.5 [36] with the use of RStudio version 0.99.896 [37].

3. Results

3.1 Latent variables based on professionals' answers

The 29 statements used in the survey were divided via AHC clustering into five sets based on the professionals' answers. Each set of statements could be associated with a latent variable, related to a different general benefit or harm associated with trees. The resulting variables can be described as: "Attractiveness", "Social relations", "Nuisance", "Contamination and damage", and "Danger" (see Table 3). The computed Cronbach's alpha values for the latent variables were 0.78, 0.80, 0.71, 0.91 and 0.82, respectively. Values of alpha exceeding 0.7 show high reliability of the latent variables. The two first variables have a positive and a further three negative connotations. The mean ± standard deviation (median) answers of the professionals to the latent variables are: 4.78±0.30 (4.90), 3.98±0.78 (4.00), 2.72±0.95 (2.67), 2.32±0.95 (2.33) and 2.24±0.80 (2.20).

Table 3. Statements regarding benefits and harms associated with urban trees used in the study survey.

Statement	Latent	Non-professionals
"Trees are pleasant to look at"	Attractiveness = „Trees are attractive and improve attractiveness of their surroundings"	No
"Trees are attractive when bloom "		No
"Trees beautifully change color in the autumn"		No
"Trees bring closer the world of nature"		No
"Trees improve aesthetics of the house and surroundings"		Yes
"Trees provide shade"		No
"Trees purify the air pollution"		Yes
„Trees provide privacy"		Yes
"Trees protect buildings from heat in summer"		Yes
"Trees hide the unpleasant views (such as e.g. an ugly wall with graffiti)"		Yes
"A positive effect on the feeling of social ties (e.g. with the neighbors)"	"Trees improve social ties"	No
"Trees strengthen the sense of ties with home and family"		Yes

"In areas with trees drivers retain their greater caution and reduces speed"	Nuisance = „Trees cause nuisance"	Yes
"Trees are a source of spiritual and emotional values"		Yes
"Trees increase the value of the property on which they grow"		Yes
"Trees produce resins, liquids, etc. which contaminate the area around"		Yes
"Trees are causing allergies"		Yes
"Trees attract unwanted by people insects"		Yes
"Trees are causing economic damage by the roots destructive for pavements"	Contamination and damage = „Trees are source of contamination and damage"	Yes
"Trees interfere when their branches grow low from the trunk"		Yes
"Trees litter around with the seeds, dry branches"		Yes **
"Trees litter the area around, by falling their flowers"		Yes **
"Trees litter the area around by falling their leaves in the autumn"		Yes **
"Trees litter the area around when their the leaves fall down throughout the summer"		Yes **
"Trees are a threat to the security of people because of the brittle branches "	Danger = „Trees cause danger"	Yes
"Trees reduce visibility and therefore sense of security"		No
"Trees restrict the view from windows of apartments and houses "		Yes
"Trees restrict access of light (shade the area)"		Yes
"Trees should be removed from playgrounds or along roads, as they constitute a threat to users "		Yes

** Four statements were summarized in one statement: "Trees litter the area around"

The Kendall tau correlation coefficients of the latent variables are presented in **Table 4**. According to the results, two groups of variables can be distinguished. First, the "Attractiveness" of trees is positively correlated with "Social relations". Second, "Nuisance", "Contamination and damage", and "Danger" are related to each other. Negative correlations among the variables from the two groups are observed, though not all of them are statistically significant. The factor with significant, negative correlation to both "Attractiveness" and "Social relations" is "Danger".

Table 4. Kendall correlation of latent variables defined in the study. Kendall tau values and corresponding p-values given.

	Social relations	**Nuisance**	**Contamination and damage**	**Danger**
Attractiveness	0.47 (<0.001)	-0.03 (0.64)	-0.12 (0.033)	-0.21 (<0.001)
Social relations		-0.04 (0.50)	-0.07 (0.19)	-0.22 (<0.001)
Nuisance			0.39 (<0.001)	0.26 (<0.001)
Contamination and damage				0.47 (<0.001)

The attitude of the respondents to these positive and negative groups of variables may be the key to their division. The main factor responsible for the possible differences among the professionals may be the balance between their attitudes towards the positive and negative groups of variables.

3.2 Non-professionals' choice of latent variables

The importance of the latent variables for non-professionals was estimated by the number of statements belonging to each of the latent variables that they chose. Because the numbers of statements belonging to each variable were not equal (5 for "Attractiveness", 4 for "Social relations" and "Danger", and 3 for "Nuisance" and "Contamination and damage"), the numbers of statements chosen were divided by the numbers of statements in each variable. The overall results were 227.2, 107.0, 91.3, 69.7, and 86.2 for "Attractiveness", "Social relations", "Nuisance", "Contamination and damage" and "Danger", respectively, and the average shares of statements chosen by the respondents were: 0.47, 0.22, 0.18, 0.14 and 0.14, respectively. The numbers of respondents who chose at least one statement associated with a given latent variable were: 460, 267, 189, 154 and 250.

3.3 Assessment of the number of trees

Of the professional respondents, 16% and 26% assessed that the number of trees in their place of residence is "too low" or "rather too low"; according to 26% of the professionals the number of trees is "just right"; 22% and 10% assessed that there are "rather a lot of trees" and "a lot of trees", respectively. 38% of non-professionals chose the statement "there are too few trees in the cities".

3.4 Arboriphobes

The lowest answer to the latent variable "Attractiveness" among the examined professionals was 3.6, indicating that there were no arboriphobes in this group of respondents. On the other hand, 29 non-professionals (6%) chose none of the statements associated with tree attractiveness. The average respondent in this group chose 0% of statements related to "Attractiveness", 0% to "Social Relations", 28% (approximately 1 statement out of 3) to "Nuisance", 34% (approximately 1 statement out of 3) to "Contamination and Damage" and 90% (between 4 and 5 statements out of 5) to "Danger", respectively, proving that this group contains arboriphobes.

3.5 Professionals' answers vs social characteristics

The results of the comparison of the median answers to the latent variables defined in the study and for the assessment of the number of trees in the place of residence for various socio-demographic groups of professionals are presented in **Table 5**. Tests show a weak dependence of the answers on the socio-demographic group membership. There was no difference between the examined professions in their attitude towards the five benefits and harms caused by trees. Significantly different median answers were observed between female and male respondents for "Attractiveness" and "Social relations", both of which were scored higher by women. The "Nuisance" caused by trees was assessed differently by respondents of different age, education and from different places of residence. The nuisance caused by trees, such as allergies or attraction of insects, is on average seen as more disturbing by younger and lower educated respondents living in the largest cities. The differences in the perception of the "Danger" associated with trees were related to the work experience. Professionals with increasing seniority rate "Danger" higher. Finally, the assessment of the number of trees in the place of residence significantly differs only among respondents living in different places of residence, as the residents of villages and the largest cities gave the highest and lowest scores for the number of surrounding trees, respectively.

Table 5. Results of the Kruskal-Wallis test followed with the Tukey HSD procedure for the differences between median answers to the latent variables defined in the study and for the assessment of the number of trees in the place of residence in various socio-demographic categories of professionals at significance level α=0.05. In the case of significant differences the mean answers to the latent variables in each socio-demographic category given and homogenous groups of categories denoted with letters.

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Sex	Female	Attractiveness	4.83 a	Social	4.08 a
	Male		4.61 b	relations	3.70 b
Age	Below 30	Nuisance	2.93 a		
	30-45		2.59 ab		
	Over 45		2.36 b		
Education	Secondary	Nuisance	2.93 a		
	Higher		2.63 b		
Place of	Village	Nuisance	2.48 b	Number of	3.34 a
residence	City below 50K citizens		2.63 ab	trees	2.81 ab
	City 50-200K citizens		2.35 ab		2.38 ab
	City over 200K citizens		2.91 a		2.70 b
Work	Less than 1 year	Danger	2.00 b		
experience	1-3 years		2.15 ab		
	4-10 years		2.24 ab		
	Over 10 years		2.53 a		

3.6 Non-professionals' answers vs social characteristics

The relations between the non-professionals' choice of latent variables and their gender, age, education and place of residence were examined. To simplify the description of the results, the numbers of chosen statements belonging to each of the latent variables were coded in the following way: low = 0 or 1, medium = 2 or 3 and high = 4 or 5 statements in the case of 5 statements; low = 0 or 1, medium = 2 and high = 3 or 4 statements in the case of 4 statements; low = 0 or 1, medium = 2 and high = 3 statements in the case of 4 statements.

There was no relation between the age and gender of the non-professionals and their attitudes toward various tree benefits and harms. As presented in **Table 6**, significant relations were observed for some of the latent variables and place of residence or education. Education seems to influence non-professionals' opinion on both the benefits of trees: attractiveness and improvement of social relations. An increase of the education level increases the percentage of respondents choosing a high number of statements related to the "Attractiveness" and "Social relations" and decreases the percentage of respondents choosing a low number of such statements. Only the opinion on "Contamination and damage" caused by trees is not influenced by the place of residence. In comparison to others, inhabitants of the largest cities seem to select more statements related to "Attractiveness" and a lower number of statements related to "Social relations", "Nuisance" and "Danger". The residents of small cities, with below 50,000 inhabitants, show the least interest in the attractiveness of trees. Finally, in the case of "Danger", the residents of medium size cities, with 51,000–200,000 inhabitants, more often select medium and high numbers of statements related to danger associated with trees. **Table 7** presents the significant relations between the selection of the "there are too few trees in the cities" statement and the socio-demographic categories of the non-professionals. The results show that the assessment of the number of urban trees varies among respondents of different age and education: the older respondents least often and the respondents with higher education most often were of the opinion that the number of trees in cities is not enough.

Table 6. Results of the Fisher test for the dependence between numbers of the selected statements associated with the latent variables defined in the study and various socio-demographic categories of non-professionals. Non-significant differences (p-value >0.1) denoted by ns. The cells in the contingency table responsible for the departure from independence of the examined variables were identified as those for which the Pearson residual exceeded 1.0 (*), 1.5 (**) and 2.0 (***).

		Attractiveness			Social relations			Nuisance			Danger		
		Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
Place of residence	Village	37%	40%	23%	74%	15%	**11%***	82%	**14%***	**4%***	85%	9%	5%
	City: <50K	**51%***	**29%****	20%	80%	12%	8%	89%	11%	**1%****	89%	6%	5%
	City: 51-200K	35%	43%	23%	79%	13%	8%	86%	10%	5%	**76%***	**13%****	**11%***
	City: >200K	**28%***	**46%***	25%	**88%***	11%	**1%****	92%	8%	**0%****	95%	**5%***	**0%*****
	p-value	0.034			0.048			0.087			0.0048		
Education	Primary	42%	43%	**15%*****	85%	**10%***	**5%***	Ns			Ns		
	Secondary	38%	38%	24%	77%	15%	8%						
	Higher	**31%***	32%	**38%*****	69%	17%	**14%****						
	p-value	0.0050			0.051								

Table 7. Results of the Fisher test for the dependence between selecting of the "there are too few trees in the cities" statement and various socio-demographic categories of non-professionals. Only the significant (p-value<0.1) results presented. The cells in the contingency table responsible for the departure from independence of the examined variables were identified as those for which the Pearson residual exceeded 1.0 (*), 1.5 (**) and 2.0 (***).

	"There are too few trees in the cities"			**"There are too few trees in the cities"**	
Age	Not selected	Selected	Education	Not selected	selected
Below 30	57%	43%	basic/primary	66%	34%
30-45	56%	44%	secondary and post-secondary	62%	38%
Over 45	**67%***	**33%***	Higher	**50%***	**50%****
p-value	0.041		p-value	0.065	

The small number of arboriphobes did not allow for testing the significance of the differences between their socio-demographic characteristics and the characteristics of the examined quota sample. The majority of the 29 arboriphobes among the non-professionals lived in villages (45%) and cities with below 50,000 citizens (48%). The division of arboriphobes by gender and age was similar to the division in the quota sample: 48% female and 52% male, 24% below 30 years, 31% between 30 and 45 years and 45% over 45 years of age. There was a higher share of arboriphobes with secondary/post-secondary education than in the quota sample (59%) and a lower share of

arboriphobes with higher education (7%). Finally, only the minority (21%) of arboriphobes were of the opinion that the number of trees in cities is too low.

3.7 Clustering of professionals

As no significant differences between the answers to the five latent variables were observed according to the socio-demographic characteristics of the respondents, the answers to the latent variables were used to divide the respondents into clusters. Four clusters of respondents containing 30 (16%), 56 (30%), 76 (41%) and 22 (12%) persons respectively were extracted. The results of the Kruskal–Wallis test followed with the Tukey HSD procedure for the differences between the median answers to the latent variables defined in the study in various clusters are presented in **Table 8**. The dependence between membership in a given cluster and membership in a given socio-demographic group for each socio-demographic characteristic was assessed with Fisher's exact test for independence. The results of the statistically significant dependencies: gender, place of work and assessment of the number of trees in the place of residence, are presented in **Table 9**. To simplify the description of the results, the answers considering the number of trees were combined, leading to three answers: "too low" ("rather too low" and "too low"), "just right" and "a lot of trees" ("rather a lot of trees" and "a lot of trees").

Table 8. Results of the Kruskal-Wallis test followed with the Tukey HSD procedure for the differences between median answers to the latent variables defined in the study in various clusters of respondents at significance level α=0.5. In the case of significant differences the mean answers to the latent variables in each cluster given and homogenous groups of clusters denoted with letters.

	Attractiveness	**Social relations**	**Nuisance**	**Contamination and damage**	**Danger**
Cluster 1	4.78 a	4.00 ab	4.06 a	3.52 a	3.15 a
Cluster 2	4.89 a	4.40 a	2.96 b	2.52 b	2.02 b
Cluster 3	4.82 a	4.00 b	2.04 c	1.55 c	1.83 b
Cluster 4	4.35 b	2.85 c	2.61 b	2.86 ab	2.96 a

Table 9. Results of the Fisher test for the dependence between socio-demographic characteristics and clusters of professionals. Only the significant (p-value<0.1) results presented. The cells in the contingency table responsible for the departure from independence of the examined variables were identified as those for which the Pearson residual exceeded 1.0 (*), 1.5 (**) and 2.0 (***).

		Cluster 1	**Cluster 2**	**Cluster 3**	**Cluster 4**
Sex	Female	80%	**84%***	74%	**50%*****
p-value=0.022	Male	20%	16%	26%	**50%***
Place of work	Village	3%	**0%*****	**13%****	**14%***
p-value=0.026	City: <50K	17%	20%	16%	23%
	City: 51-200K	**0%*****	14%	11%	14%
	City: >200K	**80%***	66%	61%	50%
Assessment of the number of trees	Too low	**30%***	50%	46%	**27%***
in the place of residence	Just right	30%	**21%***	**20%***	**55%*****
p-value=0.044	A lot of trees	40%	29%	34%	**18%***

Firstly, it can be noticed that though there was a difference in the scores for tree "Attractiveness", in all clusters this variable was highly rated. According to the results, the clusters can be divided into two groups. Clusters 1 to 3, all with very high scores for "Attractiveness", contained professionals who additionally rated the influence of urban trees on social relations highly

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and differed mostly in their recognition of tree-related harms. Cluster 4 was of professionals who rated tree attractiveness highly, but significantly lower in comparison to other clusters. The clusters can be characterized in the following way:

- Cluster 1: The respondents recognizing "Attractiveness" and the positive effect of trees on "Social relations" with high scores for all three tree-related harms. In comparison to clusters 2 and 3, respondents in cluster 1 least often assessed the number of trees in their place of residence as too low. This group could be named "Tree accepting". This group contains a high percentage of respondents working in the largest cities and low share of professionals working in villages.
- Cluster 2: The respondents recognizing "Attractiveness" and the positive effect of trees on "Social relations" with medium scores for all three tree-related harms. This group contains a high percentage of respondents who think that there are too few trees in their place of residence. This group could be named "Tree liking". Cluster 2 contains the highest percentage of women. No respondents working in villages were found in this group.
- Cluster 3: The respondents recognizing "Attractiveness" and the positive effect of trees on "Social relations" with low scores for all three tree-related harms. Like cluster 2, this group contains a high percentage of respondents who think that there are too few trees in their place of residence. This group could be named "Tree enthusiasts". In comparison to clusters 1 and 2, a high share of respondents working in villages were found in this group.
- Cluster 4: The respondents recognizing tree "Attractiveness" with similar, medium scores for all other benefits and harms related to trees. This group contains respondents who seem to have no thought-out opinion about the role of urban trees or whose attitude towards trees is indifferent. This group could be named "Tree indifferent". Cluster 4 consists of respondents with an excess of men in comparison to the respondents examined in the survey. This group has a high share of respondents working in villages and smaller cities.

3.8 Clustering of non-professionals

Clustering of non-professionals was performed after the exclusion of arboriphobes from the set of respondents examined. The division of non-professionals into clusters was based on the numbers of chosen statements concerning the five analysed benefits and harms related to trees and the results are presented in **Table 10**. Five clusters of respondents containing 64 (13%), 96 (19%), 40 (8%), 16 (3%) and 265 (52%) persons respectively were extracted. The relation between membership in a given cluster and membership in a given socio-demographic group for each socio-demographic characteristic was assessed with Fisher's exact test for independence. The results of the statistically significant dependencies, for education, place of residence and assessment of the number of trees in cities, are presented in **Table 11**.

The clusters can be characterized in the following way:

- Cluster 1: Respondents who consider trees to be moderately attractive but notice their positive impact on social relations as well as the nuisance related to trees. In comparison with clusters 2 and 3, the respondents in cluster 1 more often recognize the contamination and damage caused by trees. Only 30% of them think that the number of trees in the cities is too low. This group could be named "Tree accepting". This group contains a very high percentage of respondents from villages, and a low number of respondents with higher education.
- Cluster 2: Respondents who find trees highly attractive but choose very few statements related to other tree benefits and harms. These non-professionals seem to "just" like trees.

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About half of them think that the number of trees in the cities is too low. Hence it seems justified to call this group could "Tree liking". In comparison to other clusters, cluster 2 contains the average percentage of respondents with only primary education and a high share of persons with higher education. This group contains also the highest percentage of respondents from the largest cities.

- Cluster 3: Respondents who find trees highly attractive, with a high assessment of their impact on social relations. Nearly two-thirds of them think that the number of trees in the cities is too low. This group could be named "Tree enthusiasts". Cluster 3 is dominated by respondents with secondary education. Half of the members of this group live in villages.
- Cluster 4: Respondents who seem to find all the tree aspects examined in the study important. Similarly, all except one person in this group selected the "There are too few trees in the cities" statement. This cluster could be named "Tree experts". There are no citizens of the largest cities in this group and, like cluster 3, cluster 4 is dominated by respondents with secondary education.
- Cluster 5: Respondents who were not included into the group of arboriphobes but do not find trees attractive and do not find other benefits and harms related to trees. Similarly to cluster 1, only about 30% of them think that the number of trees in the cities is too low. This group could be named "Tree sceptics". Also, like cluster 1, cluster 5 contains a significantly larger percentage of respondents with only primary education. Among all the clusters, this group contains the lowest share of non-professionals with higher education. The respondents in cluster 5 do not stand out due to the place of residence.

Table 10. Average number of selected responses per person in each group of statements divided by the numbers of statements in each group.

	Attractiveness	**Social relations**	**Nuisance**	**Contamination and damage**	**Danger**
Cluster 1	0.50	0.47	0.38	0.23	0.16
Cluster 2	0.76	0.078	0.21	0.031	0.12
Cluster 3	0.89	0.61	0.20	0.058	0.16
Cluster 4	0.91	0.70	0.69	0.92	0.92
Cluster 5	0.28	0.13	0.096	0.12	0.088

Table 11. Results of the Fisher test for the dependence between socio-demographic characteristics and assessment of the number of trees in the cities and clusters of non-professionals (cluster 5 excluded from the last analysis). Only the significant (p-value<0.1) results presented. The cells in the contingency table responsible for the departure from independence of the examined variables were identified as those for which the Pearson residual exceeded 1.0 (*), 1.5 (**) and 2.0 (***).

		Cluster 1	**Cluster 2**	**Cluster 3**	**Cluster 4**	**Cluster 5**
Education	Primary	**44%***	**30%***	**20%****	**19%****	**42%***
p-value=0.012	Secondary	41%	48%	57%	62%	48%
	Higher	16%	**22%***	**22%***	19%	**10%****
Place of	Village	**56%*****	34%	**50%***	31%	37%

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residence	City: <50K	17%	22%	15%	31%	25%
p-value=0.049	City: 51-200K	14%	19%	12%	**38%****	17%
	City: >200K	**12%***	**25%***	22%	**0%*****	22%
"There are too few trees in the cities" p-value<0.001	Not selected	70%	**49%****	**35%*****	6%	**69%***
	selected	**30%***	**51%*****	**65%*****	94%	**31%****

4. Discussion

The results of the study show a similar general attitude from professionals and non-professionals towards the examined benefits and harms related to urban trees. For both groups of respondents the highest ranked are the benefits: "Attractiveness" followed by the impact of trees on "Social relations". Harms caused by trees seem to be less important. These results agree with the research of Schroeder et al. [33], which showed that the benefits of trees are much more important than the annoyance. Various authors have showed also that the highest ranked benefits were related to tree attractiveness: the ability of trees to shade and cool surroundings followed by trees' influence on helping people feel calmer [39]; attracting and providing biodiversity of wildlife [40,41]. This suggests that the aspects of contamination and inconvenience caused by trees have a lower impact on their perception of urban trees and could support conservation of the urban forest.

The negative perception of trees due to the damage that they cause could be further minimized by making the public aware that street trees can potentially reduce the extent of urban infrastructure damage by reducing the need for maintenance of asphalt roadways through shading [42,43] or reduce maintenance costs of underground infrastructure through their interception of rainfall [44].

Still, in the case of non-professionals, the difference between the average number of statements selected concerning trees related to the variables "Social relations" versus "Nuisance", "Contamination and damage" and "Danger" seem to be smaller than the analogous difference between the average scores for these variables given by professionals. This may suggest that professionals are more attached to trees than average citizens. As was shown by Lohr et al. [39], respondents who strongly confirmed that trees were important to their quality of life perceived the benefits of trees as higher than those who did not strongly confirm this.

Similar percentages of professionals and non-professionals found the number of trees to be too low: 42% vs 38%. These numbers cannot be directly compared as professionals were asked about the number of trees in their place of residence and non-professionals could select the statement regarding too few trees in the cities. Still, as the share of questioned non-professionals from villages was only 21%, the results suggest small differences between the two groups of respondents in respect to the number of trees around them.

The main difference between the professionals and non-professionals examined lies in their division into groups with different relations to trees. No dependence on the represented profession was observed. All the professionals rated tree "Attractiveness" highly. Moreover, there was only one group, containing 12% of professionals, who did not recognize the influence of trees on "Social relations". As the average scores for each of the tree features apart from "Attractiveness" in this group were close to 3, corresponding to "I neither agree nor disagree with the statement" this group was denoted as "Tree indifferent". Additionally, most of the members of this group believed that the number of trees in their place of residence was just right. The division of the remaining professionals was due to different assessment of the harms related to trees. The three indicated groups of professionals were subjectively denoted as "Tree accepting", "Tree liking" and "Tree enthusiasts". These names result not only from the fact that members of the subsequent groups see

the harms related to trees as less and less important. The professionals contained in the first group indicated significantly least often that the number of surrounding trees is too low. Importantly, there were no groups of "tree sceptics" or arboriphobes among the professionals, while such groups were observed among the non-professionals. This again supports the conclusion that professionals are more attached to trees than average citizens, which, to some extent, could have been predicted, as practising this kind of profession is usually consistent with a "pro-nature" approach.

The division of non-professionals into groups with different relations to trees is more complicated, as non-professionals differ strongly in their assessment of tree "Attractiveness" and the impact of trees on "Social relations". Still, similarly to the professionals, three of the indicated groups of non-professionals were subjectively denoted as "Tree accepting", "Tree liking" and "Tree enthusiasts". The main difference between the groups of professionals and non-professionals in the groups denoted with the same name is that all of the former rated "Attractiveness" and "Social relations" very highly and, in the case of non-professionals, the number of selected statements related to tree "Attractiveness" and "Social relations" increases between the groups. The exception from this scheme is the group of non-professionals denoted as "Tree liking", where very few statements related to "Social relations" were selected. As members of this group also selected few statements related to tree harms, this group could also be interpreted as "Tree indifferent". The correctness of the naming of these groups is suggested by the increasing number of respondents selecting the "there are too few trees in the cities" statement. While only 30% of "Tree accepting" non-professionals selected the statement, the corresponding numbers of "Tree liking" and "Tree enthusiasts" increased to 51% and 65%, respectively. The following group of non-professionals, denoted as "Tree experts", consisted of non-professionals who found all of the statements describing tree benefits and harms important. This may result either from the high estimation of trees by these respondents, supported by the fact that 94% of them assessed that the number of trees in the cities is too low, or from the fact that these respondents want to prove themselves as experts in the field of ecology. The two remaining groups included the "Tree sceptics" and "arboriphobes". "Tree sceptics" did not find trees attractive and a minority (31%) thought that there are not enough trees in the cities. "Arboriphobes" selected none of the statements related to tree-related benefits and only a minority (21%) were of the opinion that the number of trees in cities is too low.

A variety of attitudes of urban residents towards trees was presented also in the studies by Kirkpatrick et al. [5,41]. In the study from 2012, respondents were divided into 7 groups ranging from arboriphobes, through indifferent residents, tree huggers, and aesthetes to practical tree lovers and native wildlife lovers. As the division of respondents was based on other questions than in the current study, their results cannot be directly compared. Most interestingly, in the study by Kirkpatrick et al. [41], 13% of respondents were identified as arboriphobes. Additionally, the study by Kirkpatrick et al. [5] found 0.4% of respondents who could not agree with anything positive about trees. The ratio of 6% of arboriphobes among residents identified in the current study falls within the range indicated by the above analysis. Kirkpatrick et al. [41] found also 7% of indifferent residents. We, on the one hand, found a comparable number of 12% of tree indifferent specialists, but on the other hand as many as 52% of tree sceptics among the non-professionals, which is a much higher rate. Finally, the study by Kirkpatrick et al. [5] found that 45% of residents could be called tree huggers and practical tree lovers, 16% aesthetes and 16% native wildlife lovers. This means that 77% of the questioned residents declared a positive attitude to urban trees. In the study by Oliveira Fernandes et al., [45], the ratio of the respondents self-reported as tree lovers reached 96%. That result is consistent with the results presented in the current study for the professionals, only 12% of whom were designated as tree indifferent, but is highly inconsistent with the results for the non-professionals, as only 43% of them were included in one of the groups of tree accepting, tree liking, tree enthusiasts or tree experts, a fact that can be explained by the too low level of their ecological education.

From the point of view of tree protection, it seems very positive that the numbers of questioned professionals belonging to groups from "Tree accepting" (16%), through "Tree liking" (30%) to "Tree enthusiasts" (41%) increases, as it shows that, for the majority of professionals (71% contained

within the "Tree liking" and "Tree enthusiasts"), recognition of the positive effects of trees prevails over the perception of their negative features. Only the smallest group of about 12% of respondents comprised professionals who seem to be indifferent towards trees. The fact that, unlike non-professionals, the "Tree accepting", "Tree liking" and "Tree enthusiasts" groups of professionals were similar in their assessment of tree "Attractiveness" and "Social relations" may result from two factors: education and experience. The answers of a professional respondent may be less personal but more objective than that of a non-professional. The consequences of decisions made by professionals with a low level of knowledge and a high level of fear could be particularly devastating for urban forest and, for example, result in the removal of veteran, valuable trees deemed unjustifiably as causing risk. In general, as pointed out by Ames and Dewald [12], the most crucial element for tree protection is strong communication between the architect/forester and the constructor, fostered in an environment of respect and cooperation, and is based rather on progress than perfection. Maintaining community involvement is crucial for successful urban tree protection [46], but keeping a high level of professionals' education seems to be even more important for continuity in tree protection policy across generations.

Unfortunately, the number of "arboriphobes" (6%) and "tree sceptics" (52%) among the non-professionals is disturbing. Only small groups of respondents who seem to be concerned about the surrounding trees (8% of "Tree enthusiasts" and 3% of "Tree experts") were identified. This result is highly negative for urban forest protection and development, as the important aspect of humans' governance of trees is that it relies on the work of individual city residents and non-governmental groups. The non-governmental groups are able to affect street tree design, and self-monitoring of trees by urban residents can support the work of professionals [9]. On the contrary, a low level of urban tree tolerance can influence the decision-making process, causing more trees to be felled than is justified.

The low number of Polish respondents who have a positive attitude towards urban trees, and the high number of "arboriphobes" and "tree sceptics" may result from a low level of ecological education and result in an overestimation of tree-related risks. Kirkpatrick et al. [5] demonstrated that poor education results in a negative attitude toward trees and leads to their felling. As respondents with only primary education are over-represented in the group of "tree sceptics", and this group includes the lowest ratio of non-professionals with higher education, education regarding the profits resulting from urban forests and the real level of tree-related risks should be emphasized from primary school. All city residents should be made aware that all trees, and especially large trees, contribute to ecosystem services and can benefit human well-being, and that knowledge should be actively promoted (Shanahan et al., 2015) in the context of climate adaptation strategies, but also regarding individual feelings and emotions bound to the urban forest [47,48].

Some studies have shown that women are more "sensitive" than men in the way they perceive the surrounding landscape. In Kirkpatrick et al.'s study, women dominated the group of "tree huggers" who loved trees for everything and appreciated them for their spirituality value [41]. Another study demonstrates that women prefer wild, romantic gardens in comparison to men, who prefer them to be regular and well controlled [49,14,50,51]. In the current study, different assessments of tree features were observed only among the professionals. On average, women found trees slightly more attractive than men did, and women saw the role of trees more strongly as building good social interactions. Additionally, the group of "Tree indifferent" professionals contains an excess of men in comparison to the examined sample of respondents. Since it is women who dominate the group of professionals (in our study they constituted 75% of the sample), their "sensitive" attitude may have a particular influence on decisions towards tree removal or others, which could support the development of city green areas, and eventually the provision of ecosystem services.

In the case of non-professionals, "Attractiveness" and "Social relations" were related to the place of residence and education. The level of education was also positively correlated with the attitude to trees: lower educated respondents were in the "Tree accepting" cluster, higher in "Tree enthusiast", with "Tree liking" respondents in the middle. Interestingly, respondents in the "Tree

liking" cluster were dominated by residents of medium-sized and big cities. On the contrary, a minority of villagers participating in the study were assigned to this cluster.

"Nuisance" caused by trees, such as allergies or attraction of insects, is on average seen as more disturbing by younger and lower educated professionals (these two groups strongly overlap in the present study). This observation can be explained if we assume that younger people are more often victims of allergies, which are a disease of the modern world [52,53], and especially that, for them, managing allergies in the context of social relationships could be problematic [54]. In the case of non-professionals, "Nuisance" was related only to the place of residence: the statements related to this factor were slightly more often selected by residents of villages and least often by residents of large cities. It is worth noticing, however, that for some city dwellers, the nuisance caused by trees is not seen, since they do not live close to green areas.

In many studies, the increasing age of the respondents had a negative impact on their opinions towards the "danger" caused by trees [55,33,45]. In our study, work experience (to some extent connected with age) was the only variable influencing the perception of "danger" in the group of professionals: more experienced respondents were more likely to agree with that. This confirms the results of Koeser et al. [6], who found that professional risk assessment and recommended methods of risk mitigation are strongly influenced by experience, i.e., advanced professionals are concerned not only about the fact that a tree may fall but also about a target that the tree may fall over, and therefore rank the risk as higher than professionals and non-professionals do. However, in Kirkpatrick's study, the more educated respondents had significantly different opinions on this matter, perceiving a lower level of risk, which could be explained by their ability to evaluate the risks of trees and balance them with advantages [41]. Interestingly, in our study the most numerous group among the non-professionals stating that the danger caused by trees is low were residents of cities with more than 200,000 inhabitants. On the contrary, respondents living in cities with 51,000–200,000 residents were more likely to evaluate the danger as medium or high, which could be explained by higher public pressure.

5. Conclusion

In conclusion, similar general attitude from professionals and non-professionals towards the examined benefits and harms related to urban trees was observed. For both groups tree benefits were perceived as much more important than annoyance they may cause. The main difference between the professionals and non-professionals examined lied in their division into groups with different relations to trees. The group of professionals contained no arboriphobes but 41% of tree enthusiasts. On the contrary, the group of non-professionals contained 6% of arboriphobes and, what is most alarming, more than half of them were tree sceptics while less than 10% were enthusiastic about trees. The above may result from a low level of ecological education and result in an overestimation of tree-related risks. Hence, the major postulated step to increase the ratio of non-professionals accepting urban trees and understanding tree-related risks is to increase the level of ecological education, starting from primary school.

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