Annals of Warsaw University of Life Sciences – SGGW
Horticulture and Landscape Architecture No 35, 2014: 25–38
(Ann. Warsaw Univ. Life Sci. – SGGW, Horticult. Landsc. Architect. 35, 2014)

Avenue trees – esthetic preferences and safety

EDYTA ROSŁON-SZERYŃSKA*, DOROTA WOJTYNA
Department of Landscape Architecture, Warsaw University of Life Sciences – SGGW

Abstract: *Avenue trees – esthetic preferences and safety.* In the planning of avenue trees, various criteria are taken into account, including esthetics and safety. Although the safety aspect is much debated, there is little research into the actual perception of trees as potentially hazardous. The aim of this paper is to answer the following question: are trees with potentially hazardous features intuitively rejected? It is hoped to understand what kind of criteria are considered in the assessment of trees' attractiveness, and whether one can speak of intuitive recognition of the risk posed by trees with impaired static properties. A survey was carried out among a group of 110 respondents, of whom 10% had professional experience with avenue trees. The questionnaire took the form of a graphical presentation consisting of three parts: (a) 18 sets of black-and-white silhouette models of single trees standing by the road; (b) 3 visualizations of trees in an avenue setting; and (c) 3 real photographs in full color with different roadside arrangements (presence of large trees, small trees, and low vegetation). The first 21 sets contrasted stable trees with trees of impaired stability. The results showed that trees with structural defects and potentially hazardous features (tall trees with widespread, asymmetrical crowns and ill-formed forks) were considered more attractive. The only hazardous features considered unattractive were unnatural lean and high slenderness.

Key words: avenue trees, safety, esthetic preferences, hazard tree, tree assessment

INTRODUCTION

Many criteria are taken into consideration when planning avenue trees; especially important are the aspects of safety and esthetics. As regards safety, opinions are divided, for some see road trees as an advantage and others as a disadvantage. Most research on the safety issue concerns the features of trees that influence their stability and can lead to accidents; there has been little or no research into the perception of trees as potentially hazardous. When considering the function of avenue trees, many factors are taken into account, including safety and esthetics among others. The basic function of a road of any kind is to enable its users to arrive quickly and safely at their destination. The trees should in no way endanger road users or hinder their journey. More and more publications are appearing which discuss rules governing the proper choice of tree species in correlation with the condition of a given road or street [Borowski and Latocha 2006], and there are also many publications advising on the arrangement of forestation so that it optically improves the traffic, warns about dangers, prevents dazzle and driver weariness, and protects from storms [Reda and Hrynkiewicz-Sudnik 1999, Oleksyn 2007, Szczepanowska 2010]. Guidance is also given with regard to safety measures, including the avoidance of trees prone to failure, with widespread crowns [Haber 2001] or with

*e-mail: edyta_roslon_szerynska@sggw.pl

structural defects which impair their stability [Coder 2000, Rosłon-Szeryńska and Sikorski 2011].

In planning and arranging the areas around roads and streets, esthetics are equally important. Much research shows that in their choice of trees, people consider the safety aspect in correlation with tree species that are well-known to them and are associated with their family home. There are a few evolutionary esthetic approaches, such as those of Orians [1980] or Sommer and Summit [1996], according to which society prefers a landscape of savannah and trees with widespread crowns typical of *Acacia* species. On the other hand, Schroeder [2006] claims that residents prefer smaller and slower-growing trees, while according to Williams's [2002] survey respondents prefer medium-sized trees with widespread crowns.

Researchers only occasionally consider the question that will be addressed here: are people aware of the dangers connected with trees' stability, or do they intuitively prefer trees with beneficial structural features and shape which decrease the risk of breakage and failure? Rosłon-Szeryńska and Sikorski [2011] researched the issue of trees' safety and exposure in forestations.

The aim of this paper is to investigate social preferences towards trees in correspondence with features responsible for their stability. It is hoped to understand what kind of criteria are considered in the assessment of trees' attractiveness, and whether one can speak of intuitive recognition of the risk posed by trees with impaired static properties.

MATERIAL AND METHODS

The survey was carried out among a group of 110 people, of whom 90% were chosen randomly. The remaining 10% were chosen among people with knowledge of the principles of the planting of avenue trees (even though the actual percentage of such people in the general population would be slightly lower), in order to investigate whether this group would assess the attractiveness of trees with awareness of safety, or would rather evaluate the two aspects separately. For the purpose of the survey, an anonymous questionnaire was made available online in the form of a graphic presentation. The presentation consisted of three parts, each with three types of graphics to be evaluated, presenting: (a) black-and-white silhouette models of single trees standing by the road; (b) visualization of trees in an avenue setting; and (c) real photographs showing three ways of arranging the side of the road (presence of large trees, small trees, and low vegetation). The models used in the first two parts were prepared in Adobe Photoshop [Wojtyna 2012] on the basis of models of hazard trees likely to break or fail, according to the WID method of Rosłon-Szeryńska [2006, 2012]. The trees were not meant to represent any specific species, in order to avoid choices influenced by sentiment for well-known trees, e.g. from childhood; additionally, a uniform background was used to minimize the influence of other factors. The sets presenting particular features/defects were randomly placed in the questionnaire, one per page, and the trees with correct stability were randomly placed on the right or left side of the page. In each case,

respondents were asked to pick a tree/avenue which seemed the most attractive to them. The response was meant to be quick and intuitive. The respondents had no knowledge that the survey was connected with the issue of safety.

The first part of the presentation included 18 sets of single trees with opposite features. In each case a tree with no crown defects was placed together with a tree presenting a high chance of breakage or failure. The following features were chosen for the evaluation, on the basis of a thorough analysis of critical literature concerning this subject [Rosłon-Szeryńska 2006]:

- height – measured from the bottom of the trunk to the peak of the crown. A height of 8 m was assumed safe, while a height of above 20 m exposes the tree to twice as much pressure from the wind [Sinn 1983, Niklas and Spatz 2000] – Figure 1;
- slenderness – the ratio of H to D, where H stands for height and D stands for the trunk's diameter measured at a height of 1.3 m from the base of the trunk. Safe trees have a slenderness value lower than 20, whereas for hazardous trees it is higher than 50 [Sinn 2000] – Figure 2;
- crown's force resistance – based on Coder [2000], hazardous trees have a cylinder-shaped crown (force resistance parameter ≥ 0.625) while safe trees have a cone (0.333) or neiloid (≤ 0.250) shaped crown (Fig. 3);
- lean – measured by the degree of inclination from the vertical. According to the scale of Zajączkowski [1991], a natural lean cannot exceed 45º (Fig. 4), and an unnatural lean should not be higher than 10º (Fig. 5);
- crown shape – the classification of Coder [2000] was used, according to which safe trees are arrow-shaped with a clear central leader and branches bending at an angle of not more than 40–45º; moreover branches and boughs should not be more than half the thickness of the leader (Fig. 6).

Certain features which have a significant influence on tree stability (wood decay, damaged roots, cracks in the trunk) were omitted, for the reason that they are difficult to present graphically and assess on the basis of photographs.

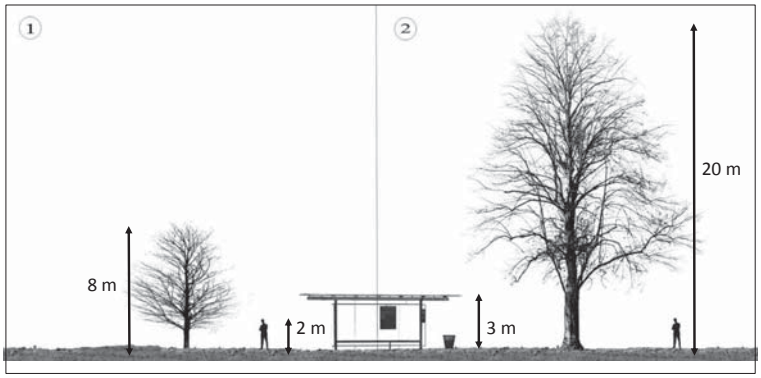

FIGURE 1. Example of a set with trees varying in height. Tree without foliage with safe height (1) and hazardous height (2). The slenderness criterion remains the same for both trees

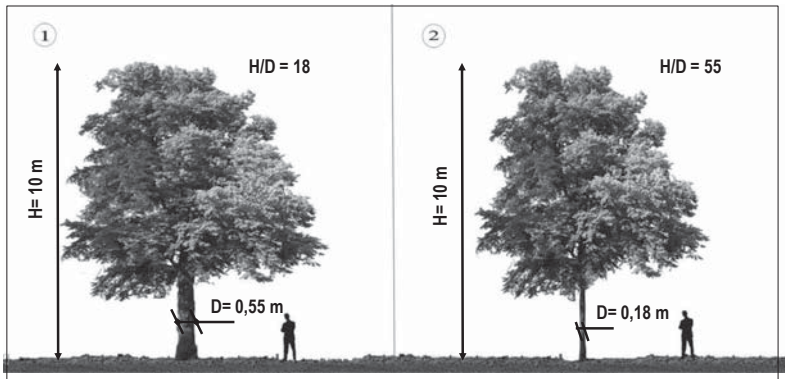

FIGURE 2. Example of a set with trees varying in slenderness, in correspondence to tree statics: within the safe range (1), and hazardous (2). The remaining features (height, crown shape) are the same

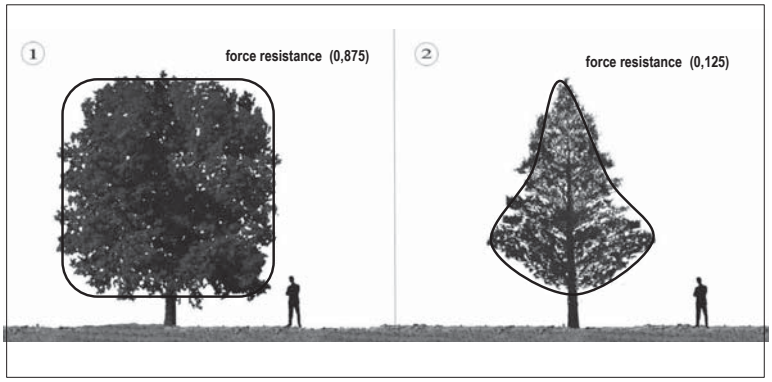

FIGURE 3. Example of a set with trees presenting high wind force resistance (1) and low wind force resistance (2). Both examples include trees with foliage, for the reason that force resistance is much lower without. The height of the trees is 10 m, and the slenderness value is 22

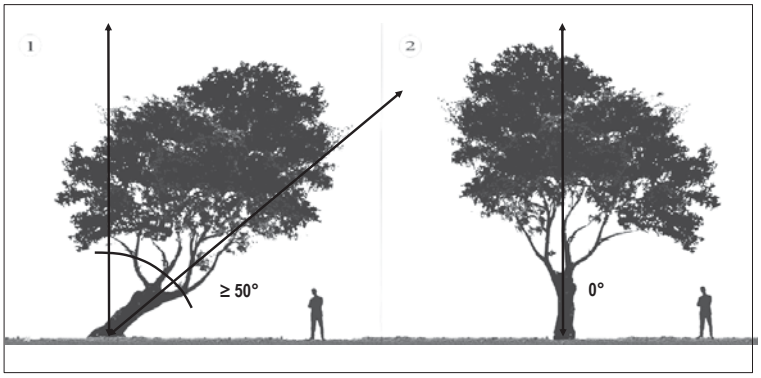

FIGURE 4. Example of a set with two asymmetrical trees, one straight (2) and one with a critical lean of 50º indicating a likely failure (1). The height of both trees is 10 m, and the slenderness value is 18

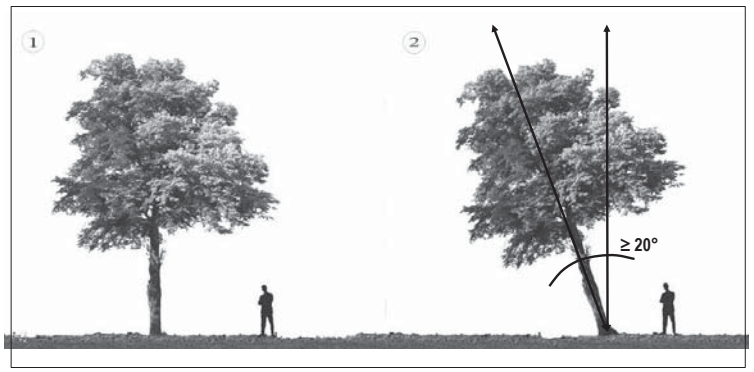

FIGURE 5. Example of a set with a well-shaped tree (1), contrasted with a tree with unnatural lean of 20º (2). The height of both trees is 10 m, and the slenderness value is 22

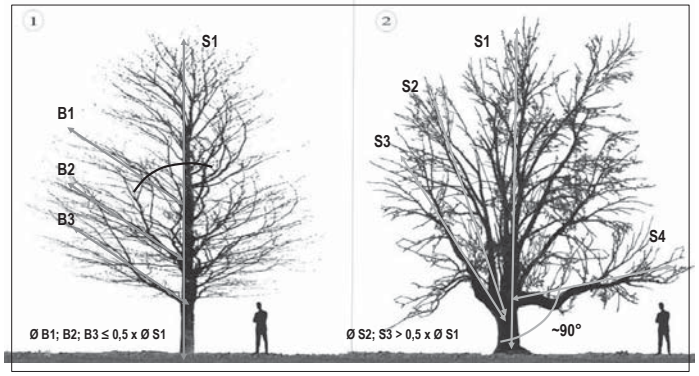

FIGURE 6. Example of a set with trees without foliage and with crowns of varying build. One of the trees is well-shaped (1), whereas the other has too thick branches, competing leaders and ill-formed forks (2). The height of both trees is 10 m, and the slenderness value remains within the safe range (20 and 18)

The models show trees varying in one feature (i.e. height), or in several connected features (i.e. defects of the crown shape, high force resistance and height) (Figs 7–8). In order to increase the reliability of the results, two or three sets of trees were prepared for each case (for each feature and group of features).

The results of the survey are verified in the second part of the questionnaire, which contrasts trees in an avenue setting that have no structural defects with trees that have a large number of defects (are too tall, too slender, ill-shaped with high force resistance of the crown). The features foregrounded in this case are height, crown shape, and structural defects of the boughs. The first two sets present trees of varying height (20 and 8 m). The third set presents trees of the same height, where well-structured trees are contrasted with trees with ill-formed silhouettes (competing leaders and horizontal boughs that are too thick) – Figure 9.

The final part of the questionnaire aimed to the separate the issues of safety

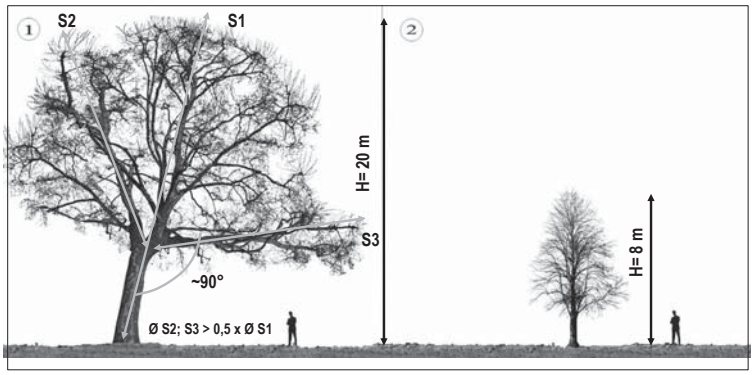

FIGURE 7. Example of a set with a tree of seemingly stable silhouette (2) and a tree likely to break (1) due to extensive height, ill-structured forks, competing leaders and hazardous lean

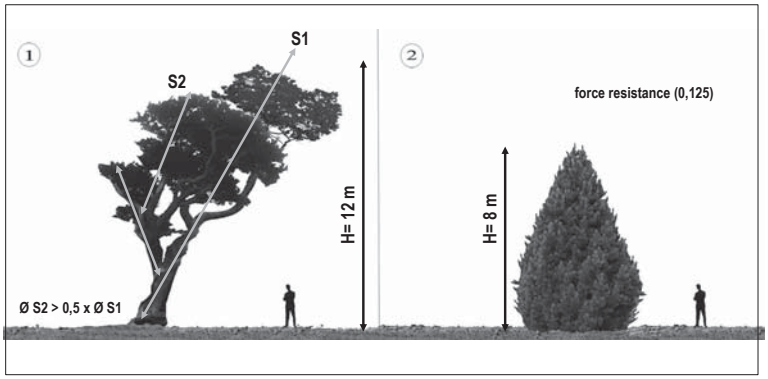

FIGURE 8. Example of a set with an evergreen with a safe, cone-shaped silhouette (2) and an asymmetrical, leaning tree with ill-formed forks and competing leaders (1)

FIGURE 9. Set with trees of the same height and varying crown structure, with (1) aerodynamic and (2) defective structure (D. Wojtyna)

and attractiveness. Three photographs of roads with large trees, small trees or low vegetation growing alongside were presented together, in order to assess how the sense of road esthetics changes depending on the adjacent trees or lack thereof, and how this relates to the feeling of safety (Figs 10–12). The photographs presented below represent existing roads of a similar quality, without center lines, shoulder or sidewalks. It was assumed that all photographs present a visually attractive reality. Respondents were tasked

FIGURE 10. Road with large trees that are structurally defective and situated close to the edge of the road

FIGURE 11. Road with small trees that show a tendency to develop ill-formed forks, but are situated a safe distance from the road

FIGURE 12. Road with open view, devoid of forestation

with grading the photographs based on their attractiveness and safety. A three--point scale was used, where one stood for attractive or safe, and three for unattractive or unsafe, where both criteria were evaluated separately.

RESULTS AND DISCUSSION

The results concerning esthetic preferences in relation to tree height showed that the majority of respondents prefer tall trees (76–81%). Similar results were obtained in the group of respondents with professional experience/knowledge of avenue trees (70%). With the sets where height was one of several varying features, 65 to 75% of respondents chose taller trees. The trend continued in the second part of the survey (with trees in an avenue setting), with the majority of respondents choosing taller trees (72 and 85%). It should be noted that the presence or absence of tree foliage had some influence on the assessment. In the sets of trees varying only in height there were 10% fewer tall trees chosen if they had no foliage, whereas in the sets

presenting more than one varying feature (tree silhouette or asymmetric shape of the crown) the number of tall trees was 20% lower (Fig. 13). The results of the third part of the survey also confirmed the aforementioned preference.

As far as slenderness was concerned, the majority of respondents preferred trees within the safe range (H/D $\leq$ 20). Only 13% found highly slender trees attractive. Trees with a dangerously thin trunk relative to the mass of the crown and tree height were always rejected. Also trees with an unnatural lean of 20° were not favored by respondents, as 90% chose vertical trees. However, this preference changed in the case of trees with a natural lean, where respondents slightly more often (56%) chose trees with a high lean rather than vertical ones (Fig. 14).

The results concerning esthetic preferences regarding trees with varying crown surface showed that trees with a widespread and dense crown (and thus with high wind force resistance) are considered more attractive. This preference was not highly dominant for the first set, where a cylindrical crown (preferred by 56%) was contrasted with a cone-shaped crown. However, the trend was clearly visible in the case of the second set, presenting a tree with a widespread

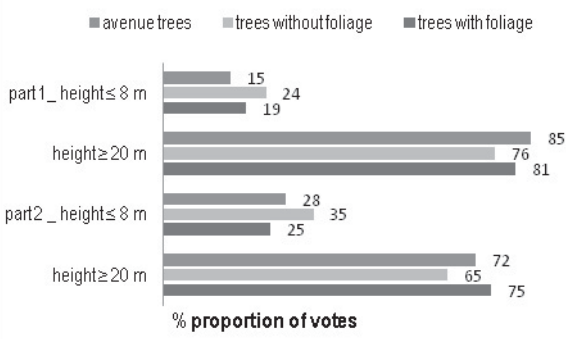

FIGURE 13. Preference results for trees in an avenue setting varying in height: part 1 – simple sets varying in one feature (height); part 2 – complex sets varying in several features (height, crown shape and force resistance, and tree silhouette)

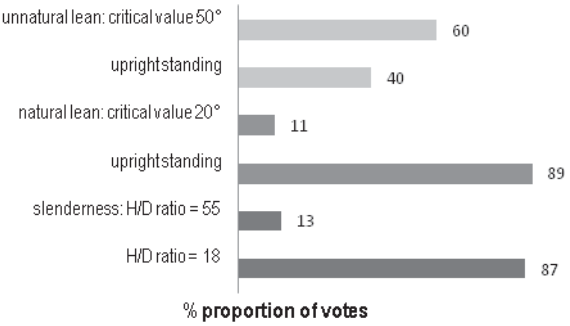

FIGURE 14. Preference results in relation to trees' lean (natural and unnatural) and slenderness (% of votes)

crown (preferred by 71%) and a tree with a neiloid-shaped crown. Finally, in the third set, which presented trees varying in two features (crown force resistance and ill-formed shape of the boughs), the preference for defective trees was most visible (77% preferred trees with defects) – Figure 15.

The assessment of tree crowns varying in shape showed similar tendencies. Crowns with defects that could indicate a hazard were found by respondents to be more attractive. There was a clear tendency to choose trees with picturesque, widespread crowns and ill-formed boughs with many leaders and forked branches. The assessment of the same tree presented in different locations (single tree – part 1; avenue setting – part 2) differed only by one response. As few as 23.5% of respondents preferred trees with a stable build. When trees with and without foliage are compared, more respondents chose well-structured trees if no foliage was present (36%). It is important to note, however, that within that group most of the respondents had previous knowledge of dendrology. Among the respondents with specialist knowledge of trees, 87% chose safe trees (Fig. 16).

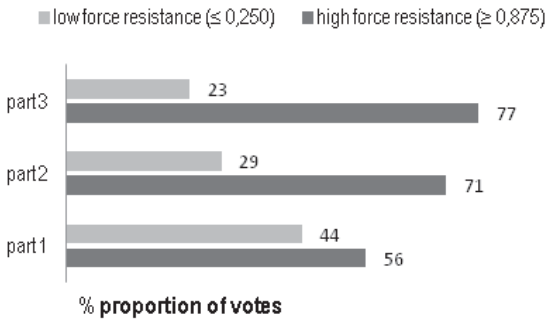

FIGURE 15. Preference results for trees in an avenue setting in relation to crown build (high or low force resistance)

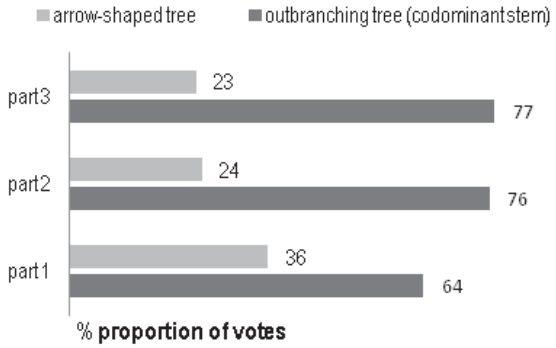

FIGURE 16. Preference results in relation to crown shape. Part 1 – set with trees without foliage present, a outbranching tree contrasted with an arrow-shaped tree (one dominant stem); part 2 – trees with foliage present, well-formed contrasted with structurally defective trees; part 3 – trees from part 2 in an avenue setting

Depending on the set, a large number of respondents preferred highly defective trees; even among the group that had professional experience with avenue trees the choice tended towards large trees with multiple features that could indicate risk of failure. The results were similar for the sets presenting conifers. The vast majority preferred larger trees with asymmetrical crown, leaning silhouette and competing leaders. Oval- and cone-shaped silhouettes of small trees were not attractive (Fig. 17).

The last part of the survey concerned the varying structure of vegetation on the side of the road (trees of safe or hazardous height, or absence of trees). The results show that the assessment of attractiveness is inversely proportional to the safety of the evaluated trees. The photograph presenting a road with large trees was considered highly attractive by 70.9% of respondents (mean score 2.13); however it also received the lowest score in terms of subjective feeling of safety (mean score 1.45). Exactly the opposite result was obtained for the photograph of a street with no surrounding trees, which received the highest score in terms of safety (mean score 1.95), and lowest in terms of attractiveness (mean score 145). The last photograph, presenting a road with small trees, received quite a high score for attractiveness, with 63 respondents (mean score 1.65) considering it a very attractive scenario (Fig. 18). Only 7.3% of respondents assessed the road as hazardous, which is a similar result to that for the road with no trees present (6.4%). The results were slightly differ-

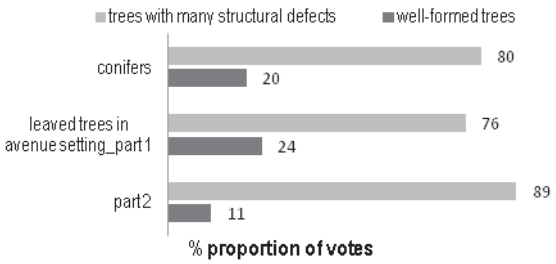

FIGURE 17. Preference results for conifers and for trees in an avenue setting: trees with several structural defects contrasted with well-formed trees

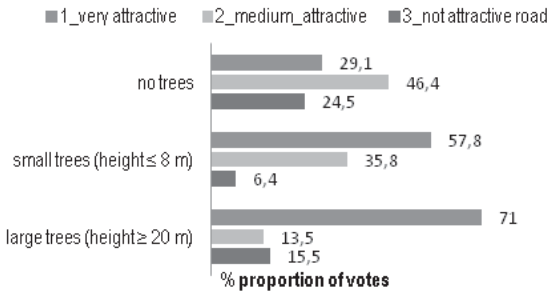

FIGURE 18. Mean score of responses assessing the attractiveness and the safety of roads with varying configurations of plants at the roadside

ent among respondents who had previous experience with avenue trees. Only one of these respondents assessed the road with large trees as hazardous, and 40% regarded it as very hazardous. Nobody graded the roads with small trees or no trees as hazardous.

Figure 19 shows the number of respondents whose assessment of attractiveness in correlation with the five selected tree features was consistent with tree safety. The distribution of the data from the survey was analyzed, and the esthetic preferences of respondents were investigated in correlation with five criteria of tree hazard assessment (slenderness, height, forks and sweeps, leaning, and crown shape).

Significant differences were noted in the numbers of respondents within each of and between the five groups (Chi^2 = 82.55, p = 0.00). Therefore, safe trees were not always rated as attractive. The most consistent correspondence between attractiveness and safety is visible in the assessment of trees with varying slenderness. A great majority of respondents recognized as attractive the trees with favorable (low) H/D. On the other hand, the assessment of trees with varying tree crown resistance parameters shows large discrepancies between tree attractiveness and safety. Most of the respondents found attractive the trees with a (high-valued) crown resistance factor indicating risk of breakage or windthrow.

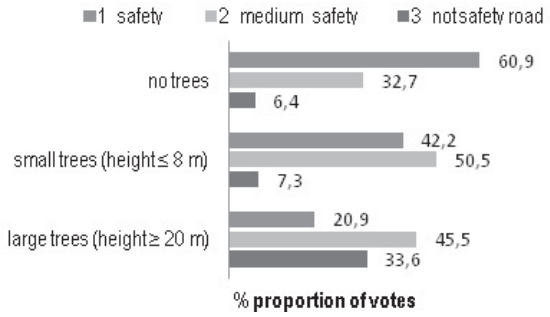

FIGURE 19. Tree assessment score distribution for five safety features of trees in correlation with attractiveness (Chi^2 = 82.55; p = 0.000)

FIGURE 20. Tree assessment score distribution for three safety features of trees in correlation with attractiveness (Chi^2 = 1.701; p = 0.427)

Figure 20 shows the number of respondents whose assessment of attractiveness in correlation with the three selected tree features was consistent with tree safety. There are no statistically significant differences in the group numbers. The safety of trees according to the selected features is significant ($Chi^2 = 1.701$, $p = 0.427$). The assessment of trees in correlation with tree height, lean and crown defects produced similar numbers in each group. In this case 29–38% chose the safe trees.

It was concluded that a majority of respondents consider trees with structural defects or features indicating potential hazard to be more attractive; this corresponds to the results obtained by Orians [1980], who concluded that people prefer trees which can be easily climbed on – leaning, with irregular, pendulous crowns. Similar results have also been presented by Sommer and Summit [1996, 1997], who claim that there is a preference for trees with round and spread crowns rather than cone- or arrow-shaped ones. On the other hand, research by Williams [2002] shows a strong tendency to choose trees of medium size, which is in disagreement with this and other research indicating a clear preference for tall trees.

CONCLUSIONS

It has been shown that both people with professional knowledge and experience regarding trees, and those who have no knowledge of dendrology, perceive structurally defective trees as more visually appealing. Trees with a crown resistance factor indicating risk of breakage or windthrow were found to be attractive by a majority of respondents. This trend is found in the case of assessment of both individual silhouettes and groups of avenue trees.

Nevertheless, one can note an intuitive rejection of trees with certain negative features relating to tree statics, such as unnatural lean and high slenderness. It is important to note that the presence or absence of foliage can alter assessments of trees' attractiveness somewhat. Preferences shift towards defective trees when foliage is present.

The assessment of roads with differing states of vegetation (small or large trees or without any trees) shows that roads with tall, large trees are considered most attractive, but also most hazardous. Only respondents with knowledge of dendrology do not identify tall trees as highly dangerous. The results show that the well-formedness of a tree's silhouette is not important for the assessment of attractiveness, and moreover there is no correlation between the perception of safety and attractiveness.

Although this form of research does not give the most reliable results, as trees can be perceived differently in direct contact, it still provides an overview of the way in which people perceive trees and which features are the most desirable. There are quite clear tendencies to choose trees that are picturesque, large, and with widespread crowns, rather than well-shaped, straight and safe trees. The height of trees is very significant for their assessment, with a clear preference for tall trees.

The results of the survey confirm that although the issue of safety is important in spatial planning, it should not be the sole factor determining the planting of trees. Other important factors should not

be overlooked, including the environmental, esthetic and health-related values of trees.

REFERENCES

BOROWSKI J., LATOCHA P. (2006). Dobór drzew i krzewów do warunków przyulicznych Warszawy i miast centralnej Polski. Rocznik Dendrologiczny 54: 83–93.

CODER K.D. (2000). Tree Biomechanics series. University of Georgia School of Forest Resources. Extension Publications FOR 00-13 to 32.

HABER Z. (2001). Kształtowanie terenów zieleni z elementami ekologii. Wydawnictwo Akademii Rolniczej im. Augusta Cieszkowskiego, Poznań.

NIKLAS K.J., SPATZ H.C. (2000). Wind-induced stresses in cherry trees: Evidence against the hypothesis of constant stress levels. Trees: Structure and Function 14(4): 230–237.

OLEKSYN H. (2007). Kompozycje roślinne w kształtowaniu terenów zieleni. Wydawnictwo Akademii Rolniczej, Poznań.

ORIANS G.H. (1980). Habitat selection: general theory and applications. In: The Evolution of Human Social Behavior. J.S. Lockard (Ed.). Elsevier North Holland Inc., New York.

REDA P., HRYNKIEWICZ-SUDNIK J. (1999). Drzewa alejowe. Materiały z konferencji naukowej, 28-29 maj 1999 r. VIII Targi Zieleni Miejskiej i Ogrodnictwa. Wyd. TARAGRA'99.

ROSŁON-SZERYŃSKA E. (2006). Opracowanie metody oceny zagrożenia powodowanego przez drzewa o osłabionej statyce. Doctoral thesis, Warsaw University of Life Sciences – SGGW.

ROSŁON-SZERYŃSKA E., SIKORSKI P. (2011). Wybrane problemy zarządzania drzewostanem w parkach miejskich, cz. 2. Bezpieczeństwo a ekspozycja drzew. Zeszyty Problemowe Postępów Nauk Rolniczych 562: 197–205.

ROSŁON-SZERYŃSKA E. (2012). Ocena zagrożenia bezpieczeństwa ludzi i mienia przez drzewa o osłabionej statyce. Uprawa i ochrona drzew 27. Czasopismo Międzynarodowego Towarzystwa Uprawy i Ochrony Drzew, Kluczbork.

SCHROEDER H., FLANNIGAN J., COLES R. (2006). Residents' Attitudes Toward Street Trees in the UK and U.S. Communities. Arboriculture & Urban Forestry 32(5): 236–246.

SINN G. (1983). Standsichercheit von Baumen und Moglichkeiten der statischen Berechnung. Das Gartenamt 32/83. Arbeitsstelle für Baumstatik: AfB website: http://www.baumstatik.de/pages/frames/frame_baumstatik.html. Accessed 2004.

SINN T. (2000). Biostatische Baumkontrolle fachgerecht, schnell und sicher. T2. Hinweisende Symptome. Stadt und Grünn 7: 702–708.

SOMMER R., SUMMIT J. (1996). Cross-national ranking of tree shape. Ecological Psychology 8(4): 327–341.

SZCZEPANOWSKA H.B. (2010). Drzewa przydrożne a bezpieczeństwo ruchu. In: K. Worobiec, I. Liżewska (Eds). Aleje przydrożne: historia, znaczenie, zagrożenie, ochrona, Olsztyn: Borussia; Stowarzyszenie na rzecz Ochrony Krajobrazu Kulturowego Mazur "Sadyba".

WILLIAMS K. (2002). Exploring resident preferences for street trees in Melbourne, Australia. Journal of Arboriculture 28(4): 161–169.

ZAJĄCZKOWSKI J. (1991). Odporność lasu na szkodliwe działanie wiatru i śniegu. Wyd. Świat, Warszawa.

Streszczeniey: *Drzewa alejowe – preferencje estetyczne a bezpieczeństwo.* W kształtowaniu drzew alejowych stosuje się różne kryteria, wśród nich ważne znaczenie ma aspekt bezpieczeństwa i estetyki. Choć kwestia bezpieczeństwa budzi wiele kontrowersji, to jednak rzadko prowadzi się badania dotyczące postrzegania drzew potencjalnie niebezpiecznych. Celem niniejszego artykułu

jest odpowiedź na pytanie, czy drzewa posiadające cechy sprzyjające złamaniom są intuicyjnie odrzucane przez użytkowników. Jest to próba zbadania, czy społeczeństwo w ocenie atrakcyjności drzew kieruje się kryteriami związanymi z bezpieczeństwem i czy można mówić o instynktownym rozpoznaniu zagrożeń powodowanych przez drzewa o osłabionej statyce. Wykonano badanie sondażowe dotyczące preferencji estetycznych drzew w grupie 110 respondentów, wśród których 10% ankietowanych deklarowało doświadczenie zawodowe związane z drzewami przyulicznymi. Kwestionariusz został przygotowany w formie prezentacji z grafikami drzew i składał się z trzech części: (a) 18 zestawów czarno-białych sylwetek drzew pojedynczych przedstawionych w relacji wysokościowej do skali człowieka; (b) 3 wizualizacje alei drzew w odcieniach szarości; (c) 3 realne fotografie dróg z poboczem porośniętym przez duże drzewa, małe drzewa i rośliny zielne. W pierwszych 21 arkuszach zestawiano drzewa stabilnej sylwetce i osłabionej stabilności. Przeprowadzone badania wykazały, że za atrakcyjniejsze wizualnie uznaje się drzewa z wadami budowy. Preferowane są drzewa wysokie, z rozłożystą, stawiającą duży opór wiatrom koroną oraz z wadliwymi rozwidleniami. Jedyne cechy uznawane za nieatrakcyjne i jednocześnie wskazujące na ryzyko złamania to nienaturalne pochylenie i wysoki współczynnik smukłości drzewa. Niniejsze opracowanie jest przyczynkiem do szczegółowych badań w tym zakresie.