

THE EFFECTIVENESS OF THE VISUAL METHOD OF HAZARD TREE ASSESSMENT (WID METHOD) IN THE MANAGEMENT OF URBAN TREES

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This article aims at assessing the effectiveness of the WID method, developed in 2006 by Rosłon-Szeryńska, in the monitoring of urban trees. Although, the method has found its application in experts research, its development continues with verification of the established criteria. The performance aspects of the method verified so far are: the time consumed for an assessment and the repeatability of the results in varying seasons. A survey was conducted on 125 trees, growing by the Rozbrat street in Warsaw. The sample underwent two evaluations with the interval of 6 months (January, July). The attained data was put through a comparative analysis, investigating differences in the intensity of the analyzed tree characteristics, the hazard tree risk score and the time required for an assessment in winter and summer. On the basis of the results, effectiveness and repeatability of the WID method were determined. High consistency marked the score of the likelihood of breakage in the base of the trunk (96%) and in the fork (83%). Significant differences were observed in the evaluation of the likelihood of breakage in the crown (Chi2 = 0.001). The risk of an accident caused by hazard tree score was consistent throughout both surveys (from 49% for windthrows to almost 100% for breakage in the base of the trunk). Discrepancies in the results were caused by the lack or existence of foliage, the seasonal appearance of tree fungus and insects, and the snow cover in the root zone. The research was compared with the results of an inspection by the trees administrator, which declared three times more trees to be removed than the WID method would allow.

Keywords: hazard tree, visual method, tree risk, tree assessment, urban trees

Introduction

Regular tree condition and hazard assessments are essential in preventing threats caused by tree failure and breakages. Tree risk assessment is a broad area of expertise which combines many disciplines. There is a large body of scientific literature about biomechanics, impact of the wind, soils, wood decay, and other topics that relate to tree risk assessment. Several internal defect detection technologies have been adapted for arboriculture and used to evaluate the risk of tree failure, for example:

- a static load test (pull test) (Wessolly and Erb, 1998),
- a single-path stress wave equipment (Fakopp Microsecond Timer),
- an acoustic tomography (Picus Sonic Tomograph),
- a resistance microdrill (IML Resistograph) and other.

There are major gaps in research which are directly applicable to professional practice. There is no single piece of equipment which could provide a complete assessment.

Commonly, in routine assessments of urban tree the visual methods are applied. The first methods of urban tree assessments were developed in the 70's in Germany and the USA (Paine, 1973). The time consumed for a single tree assessment with visual method can vary greatly

(5 to 60 minutes) and depends on the specific method (Rosłon-Szeryńska, 2006). The methods so far developed can be placed in a threefold classification:

- 1. The methods of assessment of the tree stability, based on the laws of biomechanics (Mattheck and Breloer, 1994; Wessolly and Erb, 1998 and others).
- 2. The methods based on qualitative assessment of the exterior symptoms and structural defects which lead to tree failure (Siewniak and Kusche, 1996 and others).
- 3. The methods of risk assessment, including safety of people and property protection, popular in the USA (Robbins, 1986; Ellisson, 2005 and others).

Though many methods have been developed, and some, like the VTA- method (Visual Tree Assessment), have gained international renown, it is still believed that there is not one ideal method which would consider all the possible occurrences of tree damage.

The visual method of hazard tree assessment 'WID' by Rosłon-Szerynska (2006), was developed in Poland on the basis of a critical analysis of the European and American research between 1951 and 2005, as well as a close study of 261 cases of windfalls and windthrows in Masovia. Likewise the American methods, the WID method focuses on risk assessment. In the development of the method elements of the fault tree analysis (FTA) and event tree analysis (ETA) were used, which aim at

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identifying specific relations between the causes and a combination of events which can result in creating a hazard situation and contribute to the damaging process itself. Due to the complex nature of the source of hazard, an additional logical modeling technique was established based on the compiled cases of tree damage and the concurrent symptoms/structural defects, tree shapes, as well as the characteristics of the habitat which contribute to windfalls and windthrows (Rosłon-Szeryńska, 2009, 2012). Up till 2014, the WID method has been used to evaluate over 1500 trees growing in the urban areas. The disadvantage of the method is the lack of time-efficiency in its application, therefore it is planned to develop programs which will support the summary of the data. The aim of this article is to assess the effectiveness of WID method in routine control of urban trees.

Material and methods

A number of performance aspects of the WID method was verified: the time consumed for an assessment and the results' repeatability in varying seasons. A survey was carried out on 125 trees, among which 69% were of the Fraxinus pennsylvanica kind, 28% of the Fraxinus excelsior, and 3% of Carpinus betulus 'Fastigiata' growing by the Rozbrat street in Warsaw. This sample underwent two evaluations with the interval of 6 months. The first survey was performed in the dormant season, between 8th and 11th January, with the air temperature varying between -13 and 0 ° C. The second survey was performed in the period of tree vegetation (8th-11th July, 15-26 °C). In both assessments a questionnaire was used which comprised the evaluation of the following areas: tree silhouette, canopy, base of the trunk, the trunk, the branch structure of the crown, and the crown. With the application of a qualitative scale it was aimed to measure the intensity of defect symptoms, and the intensity of characteristics of the tree and of its vicinity. The scale was prepared in accordance with the criterion of the likelihood of tree failure (F) and applied to each of the five potential hazard events: windthrow (F_{w}) , breakage in the base of the trunk ($F_{_B}$), breaking of the trunk ($F_{_T}$), breakage in the fork (F_{F}), breakage in the crown (F_{C}). The assessment of each separate event was based on 5-6 individual criteria concerned with the tree silhouette (height, slenderness, crown's force resistance, crown's asymmetry, lean), characteristics of the species, the habitat, damages and structural defects (decay, cracks, open cavities, v-shaped forks and other). The final score of risk of an accident caused by a hazard tree (R) was based on four parameters: the likelihood of tree failure (F), the likelihood of consequences of an event (C), the exposure to threat (E), and the possibility of avoiding the consequences of the event (A). The risk of an accident (RF) assessment scale was standardized from scope of 1–100 pt to 0–10 pt.

To finalize the evaluation, the results of WID assessment were compared with the an inspection carried out by the trees administrator (Department of Sanitation). The previous inspections of trees by Rozbrat street were conducted with the use of a subjective method of expert assessment similar to the one developed by Siewniak and Kusche (1996).

Results and discussion

In the surveyed sample defects were most often found in the tree trunk (bark tears, dead wood, cavities, discoloration and other symptoms of wood decay) and the crown (traces of cuts in the thick branches with symptoms of decay and cavities). The intensity of those defects seemed to vary with the seasons.

In the first survey (winter) the trunk was assessed to have 3% less damage than in the second one. Moreover, almost 50% less trees showed medium intensity defects (covering 25-50% of the trunk). In the second survey (summer) almost 11% of the trees were affected by conks, whereas in the winter there were only few traces of the fungus presence. During the second survey it was possible to carry out a detailed examination of decay symptoms, such as sap runs, discoloration, presence of ants and the wood dust which indicated presence of other insects. The variation in the results was also noted in the case of crown's force resistance. In the summer the percent of trees with a high crown shape parameter was considerably higher than in winter. There were also visible differences in the quantities of deadwood in the canopy. The summer survey presented actual amounts of deadwood spread, whereas the numbers in the winter survey were being over or understated, in fact, there were cases of providing different results for the same tree. An example can be provided by the tree nr 40, which initially was considered dead, but in the summer survey the deadwood appeared to spread only on 50–75% of the canopy. Tree groups with small and large quantities of deadwood presented most noticeable differences. The results of winter survey indicated that only 3% of trees have deadwood spreading on >50% crown's surface, whereas the results of the summer survey showed that as much as 13% of the trees belongs in that group.

The surveys also investigated the root system, which was evaluated through the analysis of the soil under the tree cover. Also in this case the rough winter weather conditions (snow) had a negative influence on the precision of the survey. The damage to the roots and cavities in the base of the trunk (often filled with snow and ice) seemed much more extensive than it was in reality. The snow cover, however, had its advantage in allowing for an accurate mapping of the district heating distribution lines, which was not possible in the summer survey. The parameters which were the most consistent





Figure 1 Tree assessment score distribution for RF_c parameter – the risk of an accident in correlation to breakage in the crown F_c [Chi2 = 0.001]

throughout two surveys were: slenderness and height, which are easy to measure.

Subsequently, the distribution structure of the data from both surveys was analyzed and compared using the parameters of the likelihood of tree failure (*F*) in correlation to five potential hazard events (breakage in the crown (F_c); breakage in the fork (F_F); windthrow (F_w), breakage in the base of the trunk (F_g), breaking of the trunk (F_τ)). Moreover, an assessment was made of potential risk of an accident caused by the damage to each of the five investigated areas (RF).

The scores for *F* and *RF* parameters in correlation to breakage in the crown (F_c) seem to vary, especially in the case of the former. In the investigated sample the trees with low and medium score of 0–3 pt are predominant. The structure of the sample in correspondence to the above mentioned factors has an asymmetrical rightward skewed distribution. Out of all trees 60% were classified as a group with medium risk of an accident, and 40% were assessed to have a low chance of breakage in the crown (0–1 pt). There were few instances of trees with score >5 pt, but not yet presenting extremely high levels of breakage risk (F_c) which would allow for their removal.

The risk of an accident (*RF*) is lower than the likelihood of an F_c event. The assessment of *RF* in winter indicated that almost 82% of trees pose low or medium risk, whereas



parameter – the likelihood of breakage in the crown [Chi2 = 0.710]

in the summer, only 52% were classified in those groups. The value of Chi2 for likelihood of crown breakage (F_c) is 0.710, which means that the score distribution for winter and summer surveys overlaps in 71% (fig. 1). Whereas the score of the risk of accident (RF_c) is inconsistent (Chi2 = 0.001), as a result of varying data for trees with full foliage and lack of foliage (fig. 2).

The score for *F* and *RF* parameters in correlation to breakage in the fork (F_p) also vary slightly. The first survey, covering the assessment of *F* parameter, indicated the predominance of trees with low and medium risk of an accident (1–4 pt). A couple percent of trees received >5 pt. Comparing the F_p and RF_p scores in varying seasons shows no statistically significant differences. The value of Chi2 for RF_p is 0.798, and for $F_p - 0.828$, which means that the data distribution of both surveys is close to identical, overlaps in 80% (fig. 3 and 4).

The scores for *F* and *RF* parameters in correlation to windthrows (F_{W}) show a right skewed distribution. The population of trees is predominated by low and medium risk groups. Result of the first survey show an 1.7 pt average risk of an accident caused by windthrow, whereas the average *RF* score of the second survey is at 1.34 pt. All of the analyzed criteria of tree assessment achieved higher scores in winter, indicating more hazard than in the summer. The comparative analysis of the data



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Figure 5 Tree assessment score distribution for RF_w parameter – the risk of an accident in correlation to windthrows [Chi2 = 0.493]

distribution for both seasons shows 50% consistency. The value of Chi2 for F_w is 0.496, and for RF_w – 0.493 (fig. 5 and 6).

The score for the *F* and R_F parameters in correlation to breakage in base of the trunk (F_B) remains close for both surveys. In the investigated sample there is a predominance of stable trees with very low risk of breakage (0–1 pt). Out of the whole sample 6% showed high risk of breakage, and 3% was extremely likely to fail (7.30–10 pt), and as such could be removed if the minimizing risk measures were unsuccessful. Comparing





the score distribution for winter and summer surveys shows a consistency of 95–99%. The value of Chi2 for FB is 0.959, and for $RF_{_B}$ – 0.996 (fig. 7 and 8).

The score for the *F* and R_F parameters in correlation to breaking of the trunk (F_{γ}) shows a slight discrepancy between the first and second survey. This is caused by the difference in severity of accident consequences, which corresponds to the weight of the part of the tree that can potentially cause the accident. Trees classified in the high and significant risk group make up 17% of the whole sample. Within that group 2% is of high risk and 1% of



parameter – the risk of an accident in correlation to breakage in the base of the trunk [Chi2 = 0.996]



Figure 8 Tree assessment score distribution for *F*_B parameter – the likelihood of breakage in the base of the trunk [Chi2 = 0.959]



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extremely high risk, thus their removal can be allowed if other measures of safety improvement fail. Comparing the score distribution of winter and summer seasons shows a consistency of 56–59%. The value of Chi2 for F_{τ} is 0.559, and for RF_{τ} – 0585 (fig. 9 and 10).

Finally, the time and results of the surveys were compared with an inspection carried out by the trees administrator. Inspectors of the Department of Sanitation merely assessed the trees with severe damages, and as a result of their evaluation 31 trees were declared to be removed. The avarage time spend on a single tree assessment was about 3 minutes. With the WID method it was assessed that removal of 8 out of the 31 trees could be avoided should other threat minimizing methods be used. The average time spend on a single tree assessment was about 10 minutes, to which the time spend on analyzing the data should be added.

Conclusion

Despite the minor differences in the data of winter and summer surveyes, the Chi-square test based on the score distribution proved high repeatability of the results: 49-100% for the *R* parameter (risk of an accident) and 50-96% for the *F* parameter (the likelihood of tree failure). The likelihood of breakage in the crown was the only exeption from the above (Chi2 = 0.001). High consitency of the results was observed especially in correlation to breakage at the base of the trunk (95–100%) and breakage in the fork (80–83%).

The tree characteristics consistent for both surveys were: slenderness and height of the tree, which are easy to assess. The over or understated results of the winter survey resulted from the presence of snow cover which interfered with accurate assessment of the tree trunks and the soil under the canopy. The snow cover had the advange of allowing a precise mapping of the district heating distribution lines. The summer survey enabled a more precise observation and analysis of wood decay symptoms, such as sap runs, discoloration, presence of ants and the wood dust which indicates the presence of other insects. The differences in results of the surveys were also apparent in the assessment of the quantity of deadwood and crown's force resistance, which are easily misjudged in the winter due to lack of foliage.

Worth mentioning is the lower score for risk of accidents caused by hazard trees (*RF*) in comparison to

the the likelihood of tree failure (*F*), which is a result of WID specific parameter – the possibility of minimizing risk of an accident (specific to WID method). This encourages the assessor to evaluate all possible measures of safety improvement and increases the chances of avoiding of the unnecessary removal.

The WID method by Rosłon-Szeryńska is extremely precise (more in the summer). It focuses on a particular event which is of the highest risk and hazard to safety of people and property. The method stands out among other developed so far as it allows to spot the risk sooner and subsequently save a larger number of trees. The inspections carried out with other methods, so far assessed three times more trees to be removed than the WID method would allow. The disadvantage of the method is the lack of time-efficiency in its application (due to comprehensive data processing), which is hoped to be improved with the help of computer programs.

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