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The Tree Valuation Method as a Tool for Supporting Greenway Planning and Development. Case study: Section of Central Highway in Gliwice, Poland

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Introduction

Tree valuation is a tool determining proper and sustainable urban forest management. The valuation is also important for roads and highways planning, especially those functioning as greenways and greenbelts. In Poland, tree valuation is particularly important because of an intensive development of road network. In the last decade 2000 km of motorways and expressways and 1400 km of national roads were built. Rapid development, urban sprawl and auto-dependent housing in urban and suburban areas have been affecting the city of Gliwice. In general, urban development has taken precedence over land-use planning because natural capital and its ecosystem services in Poland are undervalued. The road network development is strictly related with tree logging and thus determines the need for tree value estimation, also during their partial damage during construction as a tool of proper urban forest management.

Background and Literature Review

Greenways play a significant role in an urban environment. For example, street trees, as a part of urban forest system, have positive influence on house rental rates or property value (Lavrene, Kimberly 2003); they also promote health improvement (Pokorny 1998). The first tree value regulations were introduced in the US in 1905-1910, and they concerned the fees for urban trees cutting based on low quality tree pricing. During the last century, tree value methods were developed and came into force in many countries all over the world (McPerson at all 1992, Dwayer at all 2000). The economic value of greenways is often estimated on the ecosystem services basis (Almack, Wilson 2010) – such a method was adapted as a tool of nation urban forest value calculation as well (Dwayer at all 2000). Tree value could be assessed by different trunk formula methods of tree appraisal, such as CTLA method (United States), Standard Tree Evaluation Method, STEM (New Zealand), Helliwell (Great Britain), Norma (Granada—Spain) or Burnley (Australia) and they give different values (Whtason 2002).

Most of trunk formula methods distinguish between older and younger trees estimation. Cutting younger trees gives possibilities of tree restoration through planting a tree of the same or similar size. In most tree value methods, the tree

size allowing the replacement of a new tree for the cut one is regulated by the trunk circuit. The dimension of circuit is different in different countries. In Denmark (the VATO3 method) it is 16/18 cm of the trunk circuit, in Germany (the Koch method) and in the US (CTLA/ISA) it can be 120 cm and more. The value of trees of these sizes is estimated on the basis of real replacement costs of an identical tree, including the costs if its planting, pruning in the certain period of time (depending on a method, the time varies from 1 to 5 years) (Szczepanowska 2007, Szczepanowska and Latos 2009). The real value of the tree could be assessed using cost- and benefit-based approaches adapted by the Council of Landscape and Tree Appraisers trunk formula method (McPerson 2007).

This paper addresses an important issue of tree value estimation: critical failure and partial failure estimation. During a number of road building investments in Poland, trees have suffered minor or major damages, which have led to the decreased wealth of municipalities. Some of the tree damages arise from the clash with the road and motorway infrastructure. However, many of them could have been avoided. The main reason for such a situation is negligence, visible at every stage of investment processes. It is often the result of investors' as well as regular builders' incompetence (Van der Wait 1986, Despot at al. 2003, Suchocka, Błaszczyk 2015), and is closely related to the lack of knowledge, money or simply disobeying recommendations and even law regulations. Threfore, it is necessary to use common tools enabling damage estimation and to allocate a certain amount of money for tree protection. One of such tools could be the Szczepanowska tree valuation method (2009), based on tree replacement costs.

The method refers to other EU methods, in which the basic value of an "ideal tree" is calculated as the real, market value of the tree with the use of realigning factors (Fig. 1). Several factors are used in the method: species, location, condition and mechanical damage. The current legal requirements for tree valuation in Poland are administrative rates, which do not reflect tree replacement costs or any distinguishing factors (Szczepanowska, Latos, 2009).

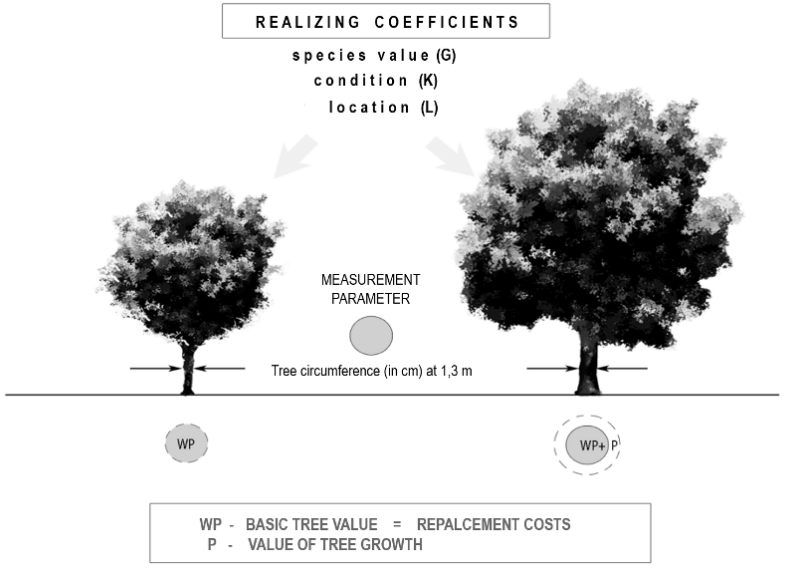

Figure 1. Trunk formula method of the Szczepanowska method. On the left: tree to be replaced by one from the market – Value = WP x G x K x L. On the right: tree too big to be replaced by one from the market – Value = WP + P x G x K x L

Goals and objectives

The research was conducted to show the influence of a road buliding investment on trees condition and their value. The aim of the research was also to check the extent to which a tree damage affects a motorway property value decrease. The aim was to compare the value of trees calculated with the use of the Szczepanowska method to the value of trees caluculated according to the current law regulations. There was also a hope that the results would help in delivering a proper tree management tool for decision makers and politicians.

Methods

For the purpose of the research, existing trees value as well as value of the cut and damaged trees was calculated according to the road investment for a part of Central Highway in Gliwice. The Central Highway in Katowice – Gliwice is an important project for the economic and transport development of the region. In the frame of the project, several works had been planned: road works, building engineering structures, retaining walls, dehydration systems, road lightening, rebuilding of the cities infrastructure. The objects dedicated to environmental protection, such as small water reservoirs for amphibians, protection systems for amphibians migration routes, separator of petroleum

derivative substances, acoustic screens, and roadside vegetation had been developed. As the research was being conducted, the first excavation was started, which enabled to estimate the scope of the intervention.

The research was conducted on the 'G2' part of the The Central Motorway in Gliwice, enclosed by Franciszkańska, Johna Baildona, Robotnicza, and Hutnicza streets. For the purpose of the research a dendrological inventory of the site was acquired and verified. Then the value of the trees was estimated with the Szczepanowska method. The value of the cut trees was estimated as well. Damage simulation was then made to assess the negative influence of the building investment. Finally, the results were confronted with the current law regulations concerning tree protection.

The Szczepanowska mehod of tree value estimation

The tree value estimation was made on the basis of the Szczepanowska method. The method was developed by a team of scientists supervised by Szczepanowska in 2009 (Borowski, Pstrągowska, 2009; Kosmala, Rosłon-Szeryńska, Suchocka, 2009; Szczepanowska, Latos, 2009; Szczepanowska et al., 2009). The modified version of the method will be introduced to the Polish Environmental Protection Act.

The method is based on the assumption that trees are part of the permanent value of land (according to article 48 of The Civil Code). The method is based on the actual costs of producing a tree. The method distinguishes between two options: (1) when a damaged tree can be replaced by a similar tree available on the market – in this case costs of a similar tree are the basis for valuation, and (2) when a damaged tree cannot be replaced – in this case the costs of producing a similar tree on the market, increased by certain coefficients, are the basis for valuation. The coefficients are set for trees of a certain size and include their species value, the speed of growth, and adapting to city conditions.

It is assumed in the method that the trees which can be replaced through natural restitution are the ones with 20-25 cm of trunk circumference. The assumption, however, does not exclude the possibility of planting an older tree if it is economically and functionally justified. Planting younger trees can also be considered if they meet functional requirements of a site. In the method, the value of a tree of 20-25 cm of trunk circumference is called the basic value (WP - wartość podstawowa). The basic value is the starting point for economic value calculation of trees of a different (bigger and smaller) trunk circumference.

The following parameters are used in the tree valuation:

- Basic tree value (PWD, podstawowa wartość drzew) – it refers to an „ideal" tree, correctly planted and maintained in the right location:
  - For trees of 20-25 cm of trunk circumference it is equal the basic value (WP): $PWD_{20/25}$=WP
  - For trees <20 cm of trunk circumference a decreasing coefficient (M) is used (0,35 – for 10-13 cm of trunk circumference; 0,45 – for 14 – 16 cm of trunk circumference; 0,65 for trunk circumference): $PWD_{<20}$=WP x M
  - For trees >25 cm of trunk circumference a species value coefficient (G), and a tree growth coefficient (P): $PWD_{>25}$ = WP x G x P are used
- The actual tree value – basic tree value supplemented by two coefficients: condition (K) and location (L)

The condition coefficient (K) refers to the quality characteristic of a tree, such as crown condition or deadwood (A), presence of basic branches (B), and horizontal damage of trunk (C). The assessment of A,B,C characteristics is made visually. The value of A,B,C can be: 1,0; 0,8; 0,6; 0,3; 0,0.

$K_1 = (A + B + C)/ 3$

The location coefficient (L):

$$L = (A + B + C)/ 3 \times U$$

Where:
A,B,C – refer to the place and function of a tree in a local system
U – refers to the place of a tree in urban areas

The actual tree value (RWD) is the sum of the basic tree value (PWD) and condition and location coefficients:

$$\mathbf{RWD = PWD \times K \times L}$$

The following formulas are used for different trees depending on their trunk circumferences:
20 – 25 cm: $RWD_{20/25}$ = WP x K x L
<20 cm: $RWD_{<20}$ = WP x M x K x L
>25 cm: $RWD_{>25}$ = WP x G x P x K x L

Results

123 trees were identified on the research site, 4 of them were already dead. Therefore, 119 trees were taken into account for the future estimation. 237 trees had been cut down earlier so that the investment could be started. 119 trees represented 14 species: mainly *Tilia cordata, Robinia pseudoacacia* and *Populus x canadensis*. *Salix* and *Acer* species also constituted a major group of

trees present on the research site. Most numerous trees on the site were those of trunk circumference above 25 cm. The trees were in overall good condition.

The metal fence streching on wooden poles was the only protection used on the building investment site. For the purpose of the research four zones were marked out to assess the influence of the applied protection system on the mechanical damage of trees. Table 1 presents the relations between the distance from the metal fence and the scope of damage.

Table 1. Damage type and trees percentage in four zones

Distance from fence	Crown damage	Trunk damage	Roots damage	Percentage of trees (%)
0-1 m	up to 40%	up to 20%	up to 40%	21
1-5 m	up to 30%	-	up to 35%	30
5-10 m	-	-	up to 30%	16
10-15 m	-	-	up to 10%	33

The value of 119 trees on the research site was estimated at 1 991 951 PLN (466 171 €, 1 € = 4,273 PLN) according to the Szczepanowka method. 237 trees cut down for the purpose of the road investement were estimated at 2 997 115 PLN (almost 702 000 €). The average tree value was 2 925 €. The value of the cut down trees was 43 168 288 PLN (10 101 379 €) according to the administrative fees. However, when trees are cut down for the purpose of road investments, no fee is charged for trees removal and that is why the actual cost of cutting down 237 trees was 0 €.

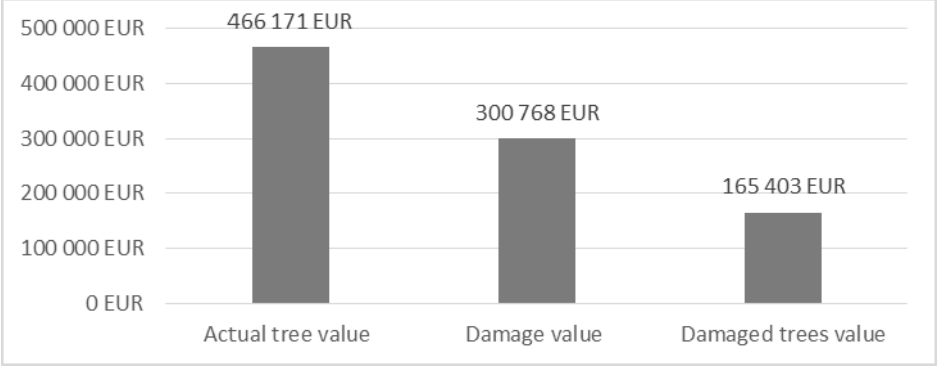

Figure 2. Trees, damage and damaged trees value (€)

The damage value of trees on the site was 1 285 222 PLN (300 768 €) according to the Szczepanowska method, and 36 trees would be destroyed (Fig. 2). The Environment Protection Act of Law does not provide the possibility of partial tree damage valuation. The road modernisation plan includes tree planting, however the new trees will not compensate for the old ones.

Discussion and conclusion

The tree value definition is basic for urban forest management in terms of a lasting value. There is a huge difference in costs of trees estimated according to the Szczepanowska method in comparison to the administrative fees in Poland. Currently, a tree removal often requires paying fees which bear no relation to the trees real value (if any fees are charged at all).

Such a big difference between the value of trees calculated on the basis of replacement cost method and administrative fees does not seem to have any reasonable explanation. The administrative fees do not include the condition factor or the location factor. Therefore, the price for cutting down dying trees and trees with very good life expectancy is always equal. The lack of tree protection on the investment sites results in tree devaluation (and the site devaluation at all). Therefore, there is a fundamental need for implementation of methods based on tree replacement costs and partial tree damage assessment in the Polish law as an example of the sustainable tree management tool. It is the only way to give rise to a sense of justice and to public acceptance for tree removal costs and eventually to creating a proper tool of an urban forest management.

The Szczepanowska method enabled to estimate the value of all the trees growing on the research site before the building investment started, as well as the trees cut down due to the construction works. The method also enabled the value estimation of the site, decreased by the tree damage, which is a very important aspect of tree protection cost planning and the site owners' responsibility of the public value. The method is based on the replacement costs and thus provides a realistic economic calculation of the results of tree protection. Therefore, it is acceptable for all the people involved in the investment processes. Without a reasonable method of tree valuation there is little chance of an efficient development and management of greenways.

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