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SOME ASPECTS OF GREENERY RESTORATION AND MAINTENANCE MANAGEMENT OF WOODY PLANTS IN CEMETERIES IN NITRA, SLOVAKIA

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Greenery of cemeteries creates a substantial part of the public greenery in our towns but often does not subserve greenery functions. The older architectonical burial places where the greenery is diminished on tree-lined communications by reason of spatial limitation represent the most widespread cemetery type of Slovak towns. Existence of woody plants at these conditions is affected by various negative factors which result in vitality decreasing and poor aesthetic standard of woody plants in burial places. The article is focused on evaluation of greenery in the two eldest cemeteries in Nitra town. The obtained data describe complex dendrological analysis, species composition, landscape value and health assessment of woody plants. On base of evaluation results we have proposed the principles of framework methodology for greenery restoration and maintenance management of woody plants in sepulchral places.

Keywords: cemetery, greenery, design, inventory, evaluation

Cemetery greenery has aesthetic, ecological and climatic functions which provide the opportunity for passive recreation (Supuka, Biľušová a Štepanková, 2005). The most widely used type of burial ground in Slovakia is architecturally designed with regular geometric segmentation where greenery is mainly in the form of tree alleys (Halajová, 2006). At present, this type of cemeteries is confronted with the problems of surrounding urbanization (Takáčová, 2011) and cemetery area is disproportionately overcrowded by graves (Halajová, 2006). In this conditions, the existence of plants is also negatively influenced by other factors, such as the lack of plant diseases control, limited vegetation maintenance and damage of trees by cemetery service (Juhásová, 2003). All these factors have resulted in reduction of vitality and aesthetic functions of plants in cemeteries.

Material and methods

The main goal of this work was to analyze the recent dendrological state of greenery and to propose the principles for restoration and maintenance management of greenery in the Main Municipal Cemetery in Nitra town (3.64 hectares, 5,800 graves) and the Cemetery in Nitra – Chrenová (1.5 hectares, 1,600 graves). They belong to the architectural type of burial places with a regular geometric segmentation for burial fields which are surrounded by tree alleys. The complex appearance of the cemetery is negative, marked by high density of graves.

The methodology of inventory and evaluation of woody plants

The inventory and landscape evaluation of woody plants consist of the identification of the data connected to woody plants, dendrometric value, landscape evaluation (Machovec, 1987) and health condition of woody plants, and

proposals for tree treatments and felling. The identification of vegetation elements was carried out by assigning serial numbers for trees, by specifying of the type of vegetation element and woody plant species, and also by giving a grave site identification number for greenery maintenance purposes. The collected data consist of dendrometric values (height of trees, crown width, trunk perimeter, age of trees) determined according to the methodology of Machovec (1987). The determination of immeasurable values of woody plants was the basis for landscape value assessment that consists of 5-point classification system created by Machovec (1987). Landscape value of woody plants indicates complex biological, ecological and functional value of trees, including their health condition. The evaluation of health condition of woody plants was carried out by methodology of Juhásová (2003). The inventory was done in the summer of 2012 and its results were compared with the inventory results for both cemeteries carried out in 2002 (Juhásová, 2003; Halajová, 2006).

As a result of the processed analyses, various measures were determined for greenery maintenance. We propose such measures as felling and treatment of woody plants, special maintenance of trees, elaboration of expertise and planting of new trees. **Special maintenance** of the woody plants was proposed as a set of measures that should result in improving or preservation of their health and landscape value as well as in ensuring their stability and security of visitors. This set of measures should include realization of periodic expertise of health status and stability to enable determination of optimal maintenance type. The treatment includes various kinds of tree cuts, treatment of cavities, plant protection against pests by spraying and also the measures to increasing trees stability. This special system of greenery maintenance should be carried out by specialist – arborists and should be proposed for woody plants with higher landscape value.

Results and discussion

The results of woody plant abundance and species composition in the Main Municipal cemetery (Figure 1) show that there are totally 37 species and 366 individuals of trees and shrubs. The species composition is poor and the three most abundant species represent together 73% of all individuals. Conifers *Thuja occidentalis* L. and *Thuja orientalis* L. represent more than half of the trees (55%). Deciduous trees are mainly represented by alley's trees such as *Tilia cordata* Mill. (18%), *Aesculus hippocastanum* L. (5%) and *Acer platanoides* L. (3%), making totally only 26% of all individuals. Poor species diversity presents high risk in the case of possible damage by diseases and pests. The comparison of the inventory results with the last survey of trees condition in the cemetery carried out by Juhásová (2003) in 2002 showed that the number of woody plants decreased from 565 to 366 (status of the year 2012). It means that there were removed 199 plants, which is 35% of the all individuals. Number of alley's trees was also decreased: *Tillia cordata* Mill. from 90 (year 2002) to 65 individuals (year 2012) and *Aesculus hippocastanum* L. decreased from 23 (year 2002) to 18 individuals (year 2012). New tree planting and restoration of alley at the cemetery have not yet been made. We assume that this intensity of the tree removal will result in elimination of all trees in alley.

The dendrological survey of woody plants in the Cemetery in Nitra – Chrenová (Figure 2) shows that there

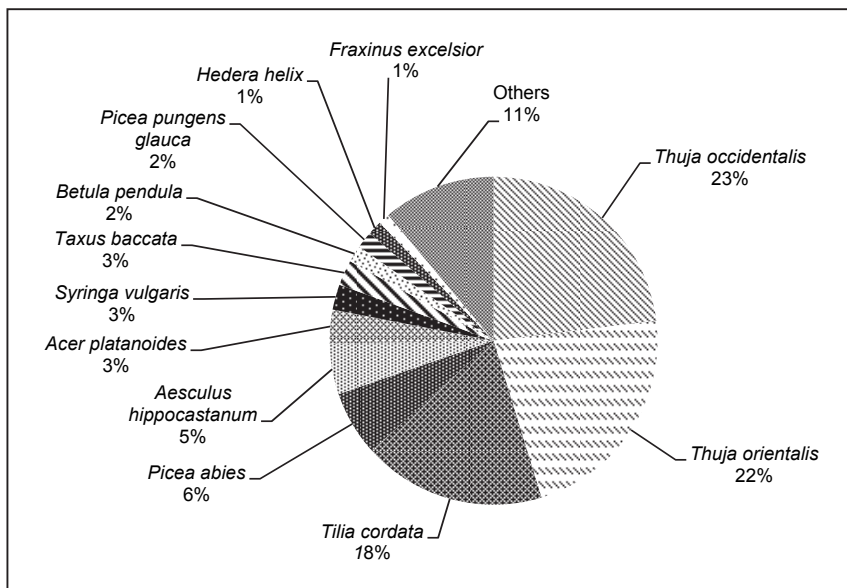


Figure 1 Percentage of woody plants species in the Main Municipal Cemetery in Nitra

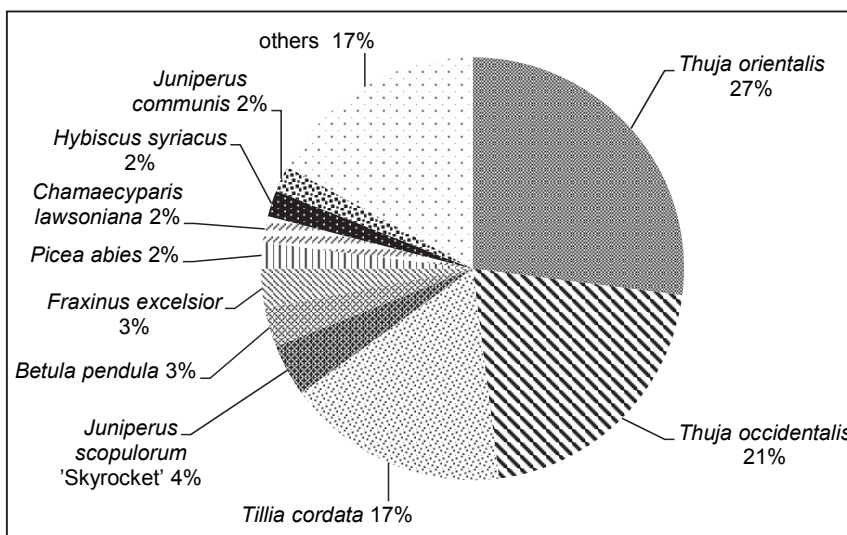


Figure 2 Percentage of woody plants species in the Cemetery in Nitra – Chrenová

Table 1 Landscape value of the most abundant woody species *Tilia cordata* Mill., *Thuja occidentalis* L., *Thuja orientalis* L.

Landscape value	The Main Municipal Cemetery in Nitra			The Cemetery in Nitra – Chrenová		
	<i>Tilia cordata</i>	<i>Thuja occidentalis</i>	<i>Thuja orientalis</i>	<i>Tilia cordata</i>	<i>Thuja occidentalis</i>	<i>Thuja orientalis</i>
	number of individuals					
5	0	0	0	0	0	0
4	4	0	1	9	1	0
3	41	52	25	28	27	3
2	19	28	48	8	28	57
1	1	3	6	0	1	13
Total number	65	83	80	45	57	73

1 – unsatisfactory, 2 – poor, 3 – fair, 4 – good, 5 – excellent

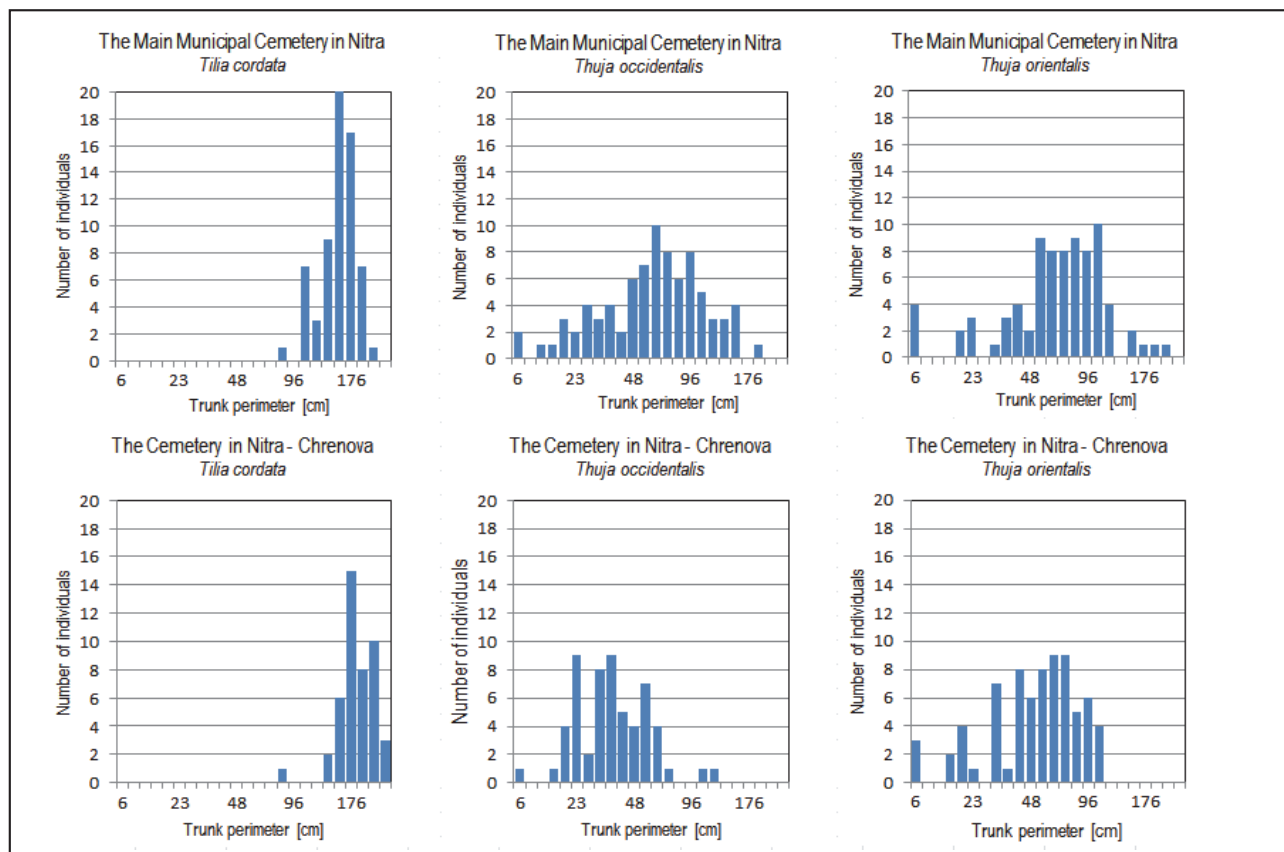


Figure 3 Abundance distribution of the main woody species (*Tilia cordata* Mill., *Thuja occidentalis* L., *Thuja orientalis* L.) by tree trunk perimeter



Figure 4 Landscape value of woody plants in the Main Municipal Cemetery in Nitra
1 – unsatisfactory, 2 – poor, 3 – fair, 4 – good, 5 – excellent

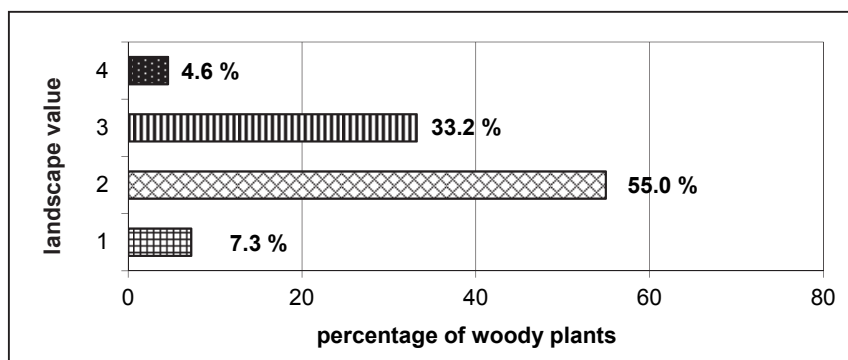


Figure 5 Landscape value of woody plants in The Cemetery in Nitra - Chrenová
1 – unsatisfactory, 2 – poor, 3 – fair, 4 – good, 5 – excellent

are totally 267 individuals and 32 species of trees and shrubs. The most abundant tree species are *Thuja orientalis* L. (26%), *Thuja occidentalis* L. (21%) and *Tilia cordata* Mill. (17%). By a comparison of the inventory results with the results of the last survey of trees condition at the cemetery in 2002 (Halajová, 2006) it was found, that the number of woody plants did not decrease significantly.

In terms of **landscape composition** there are very valuable especially deciduous trees in alley which form the main compositional axis of the cemetery, help to organize the space and improve orientation of visitors. As a negative factor of the landscape composition we may consider the individual planting of conifers inside the grave fields, especially introduced plants of the genus *Thuja*. These woody plants may cause the problems with maintenance of the cemetery, but also with the orientation and safety of visitors. The results of abundance distribution of the main woody plants by tree trunk perimeter (Figure 3) show that for alley trees (*Tilia cordata* Mill.), aging occurs due to nonexistence

Table 2 Health conditions of the most abundant woody species *Tilia cordata* Mill., *Thuja occidentalis* L., *Thuja orientalis* L.

Health conditions	The Main Municipal Cemetery in Nitra			The Cemetery in Nitra – Chrenová		
	<i>Tilia cordata</i>	<i>Thuja occidentalis</i>	<i>Thuja orientalis</i>	<i>Tilia cordata</i>	<i>Thuja occidentalis</i>	<i>Thuja orientalis</i>
number of individuals						
4	4	0	1	0	0	0
3	15	1	6	0	0	2
2	24	17	11	9	1	6
1	17	3	21	24	8	10
H	5	62	41	12	48	55
Total number	65	83	80	45	57	73

H – healthy woody plants, 1–5 degree of damage, 5 – the highest degree of damage

Table 3 Types of damage of the most abundant woody species (*Tilia cordata* Mill., *Thuja occidentalis* L., *Thuja orientalis* L.)

Type of trees damage	The Main Municipal Cemetery in Nitra			The Cemetery in Nitra – Chrenová		
	<i>Tilia cordata</i>	<i>Thuja occidentalis</i>	<i>Thuja orientalis</i>	<i>Tilia cordata</i>	<i>Thuja occidentalis</i>	<i>Thuja orientalis</i>
number of individuals						
Dry branches and leaves	27	0	18	15	0	3
Tree trunk cavities	24	0	1	11	0	0
Damage of branches (unprofessional cutting, broken branches)	12	1	1	3	0	0
Tree habitus damage, atypical habitus (tree crown reduction by cutting, overshadowed tree crown, overgrown with lianas)	16	12	31	4	9	27

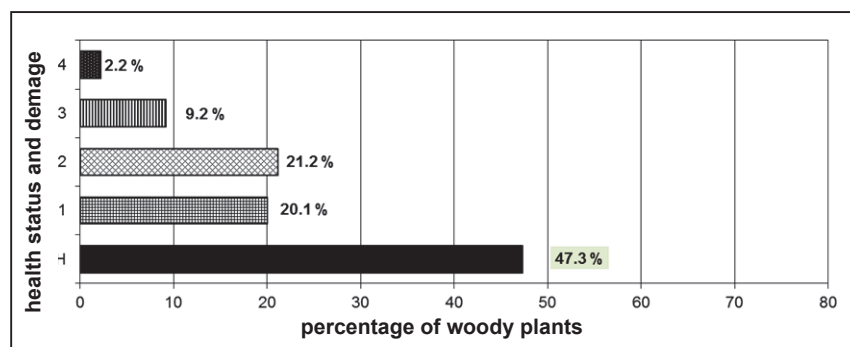


Figure 6 Health status and damage of woody plants in The Main Municipal Cemetery in Nitra
H – healthy woody plants, 1 – 5 degree of damage, 5 – the highest degree of damage

of new trees planting. On the other side, the species of genus *Thuja* have continuously been planted by owners of graves.

The results of the analysis of woody plants landscape value indicate that the individuals with fair and poor landscape value form together 94% of all trees in the Main Municipal Cemetery (Figure 4) and 88% in the Cemetery in Nitra – Chrenová (Figure 5). The landscape value of

woody plants is reduced mainly due to minimum or unprofessional maintenance, which is significantly reflected in the health conditions and appearance of the trees. In case of alley trees, in spite of their worse health status, their landscape value is still considered to be good, because they are very valuable elements of the landscape compositions. The results of landscape value analysis showed that the highest landscape value

possess the individuals of deciduous alley tree of species *Tilia cordata* Mill (Table 1).

On the base of assessment of the health condition of woody plants in the Main Municipal Cemetery in Nitra (Figure 6) it has been found that almost half of the woody plants at burial ground are healthy (47.4%). In The Cemetery in Nitra – Chrenová (Figure 7) 76.5% of woody plants are healthy, with no signs of diseases. In the cemeteries there are no trees with the highest degree of damage (degree 5), as a consequence of intensive and regular tree felling. The most common kinds of damage of alley trees are unprofessional cuttings of woody plants, tree trunk cavities, damages of tree roots during burials and construction works and dry branches (Table 3). From plant health point of view it follows that the worst health conditions are connected to the individuals of species *Tilia cordata* Mill. On the other side, the prevailing healthy individuals belong to species *Thuja* (Table 2).

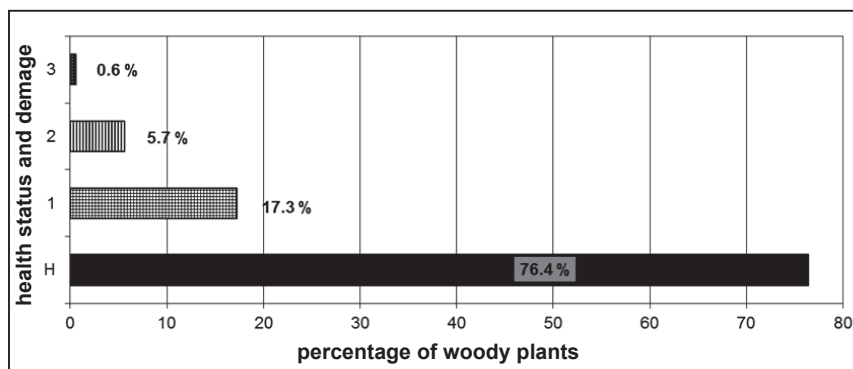


Figure 7 Health conditions and damage of woody plants in The Cemetery in Nitra – Chrenová
H – healthy woody plants, 1 – 5 degree of damage, 5 – the highest degree of damage

Proposal for cultivation measures and treatment of woody plants (Table 4, Table 5)

Felling of woody plants was mostly proposed for trees inside the grave fields, namely from species of *Thuja orientalis* L. (Table 5) because of the risk of grave damage. As for deciduous plants, the tree felling was

proposed only for the trees in the alley because of their poor health conditions and posing threat to visitors. There was further proposed measure the felling of few seeding trees. Plants with low vitality which yet do not endanger the safety of visitors are proposed to survival.

In the treatment of woody plants there have been proposed different kinds of cuts of trees, removing of seeding trees, cavities treatment and treatment of trees by chemical spraying. The most of the measures have been proposed for alley trees. It is also recommended to follow the expansion of liana *Hedera helix* L. and ensure its removing from alley trees.

The special maintenance has been proposed mostly for species of *Tilia cordata* Mill. (Table 5) and *Aesculus hippocastanum* L. located in the tree alley.

The elaboration of the expert opinion is proposed mostly for the alley trees – namely species *Tilia cordata* Mill. (Table 5), which need phytopathological assessment or expertises of the tree stability before the use of expertise system of measures for improving their health status.

The new planting of woody plants is proposed for the reconstruction of

Table 4 Proposal for cultivation measures and treatment of woody plants

Proposal for cultivation measures and treatments of woody plants	The Main Municipal Cemetery in Nitra (percentage of woody plants)	The Cemetery in Nitra – Chrenová (percentage of woody plants)
Felling of woody plants	5.5 %	6.4 %
Woody plants proposed for survival	6.8 %	1.1 %
Woody plants proposed for the treatment	10.0 %	5.6 %
Woody plants proposed for the special maintenance	23.5 %	15.3 %
Woody plants proposed for the elaboration of expert opinion (including woody plants proposed for the special maintenance)	10.0 %	2.3 %

Table 5 Proposals for cultivation measures, treatments and maintenance management of the most abundant woody species (*Tilia cordata* Mill., *Thuja occidentalis* L., *Thuja orientalis* L.)

Cultivation measures and treatments	The Main Municipal Cemetery in Nitra			The Cemetery in Nitra – Chrenová		
	<i>Tilia cordata</i>	<i>Thuja occidentalis</i>	<i>Thuja orientalis</i>	<i>Tilia cordata</i>	<i>Thuja occidentalis</i>	<i>Thuja orientalis</i>
	number of individuals					
Felling of woody plants	4	2	11	1	1	7
Woody plants proposed for survival	5	6	11	4	0	0
Woody plants proposed for the treatment (except special maintenance)	3	5	7	1	1	2
Woody plants proposed for the special maintenance	47	0	0	38	0	0
Woody plants proposed for the elaboration of expert opinion (including woody plants proposed for the special maintenance)	19	0	1	5	0	0

alleys. We propose 39 pcs of *Tillia cordata* Mill. on The Main Municipal Cemetery and 18 pcs of *Tillia cordata* Mill. and *Tillia platyhyllus* Scop. on The Cemetery in Nitra – Chrenová. The reconstruction of alleys is problematic mainly for lacking space for new plantings.

Conclusion

On the basis of the results of inventory and landscape evaluation of woody plants in cemeteries in Nitra we may state that there is a significant decrease of the alley's deciduous trees, which are skeletal and long-life trees.

The evaluation results enable to propose the following methodology for restoration of landscape compositions in cemeteries:

- restoration of original landscaping compositions in cemeteries by avoiding inappropriate individual planting of woody plants inside the grave fields,
- implementation of the substitute planting of alley's trees at the original place by using a milled tree stumps, or at other places after abolition of graves,
- preventing root trees damage by abolition of graves, by removing the paved road surface, building of unpaved roads or narrowing of roads,
- management of trees maintenance or required introduction of the special maintenance represented by set of measures leading to the maintenance and improvement of the most valuable trees,
- the cemetery operator should ensure an insurance against the damages caused by woody plants under special maintenance (damages to the tombstones, personal injury claims).

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