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TREE SURVEY AND PROPOSALS FOR URBAN TREE MANAGEMENT IN A RESIDENTIAL COMPLEX IN NITRA CITY, SLOVAKIA

Denisa Halajová, Peter Halaj

Slovak University of Agriculture in Nitra, Trieda Andreja Hlinku 2, Nitra, Slovakia

Abstract

Greenery at housing estates forms a large part of public green spaces in Slovak towns. It was usually planted without designing and its maintenance is also often neglected. Currently, it is necessary to solve many problems of green spaces at housing estates, such as poor general condition, high maintenance costs, poor design qualities or loss of green spaces due to an expanse of the static traffic (parking). The aim of this paper is to evaluate the results of the tree inventory conducted at the residential complex Párovce in Nitra, Slovakia. The tree inventory and the management programme for tree maintenance in the residential complex Párovce was conducted in 2013. The document was intended for an evidence of trees, the tree maintenance planning, issuing regulation of construction activities and planning of compensatory tree plantings. The tree inventory includes identification data, dendrometric values and quality assessment (landscape value of trees and vitality). Based on the tree assessment, proposals for tree maintenance were determined according to their priority. In the assessed area, there are 1,286 trees in total, represented by 73 species. The most common species are Acer pseudoplatanus L., Acer platanoides L. and Tilia cordata Mill.

Key words: *housing estates, greenery, tree care, tree inventory*

INTRODUCTION

Greenery of housing estates is represented by public green spaces in the premises of residential structures of collective housing (Supuka et al, 2008). Residential complexes of collective housing (housing estates) in Slovakia were established mainly in the 50s due to population migration to cities. They were created as separate functional units in the suburbs. Since the 70s, manufactured standardised elements have been applied to the buildings of collective housing. This led to the uniformity of residential complexes. Collective houses were usually built in rows or freely organized without creating semi private intra-block areas. According to Finka (Supuka et al, 2008), housing estates in Slovakia are formed almost entirely by single-purpose collective houses with a low degree of urbanity and the absence of humanity. Greenery in these residential complexes, although growing usually without designing and proper maintenance, has after years softened the visual and spatial dominance of huge gray concrete buildings. However, it has also brought a number of problems, from the presence of allergens through the limitation of the social control of the space and overshadowing of residential houses, up to the static disruption of buildings.

Dobrucká (Supuka et al, 2008) states, that the lack of greenery at housing estates cannot be compensated by other means and recreational facilities outside towns. The proportion of greenery should not fall below 40 %. It is necessary to create sufficiently large and functional green spaces, which are well maintained, with a minimal degree of green space fragmentation and their intersection with underground engineering utilities. Green areas should form a stable anthropogenic ecosystem. They should be an integral part of the inner town structure and image. Urban greenery should also be linked to the landscape green system. All these attributes and functions of the urban greenery and green spaces make them an integrated part of the urban structures and form the urban green infrastructure which stands for an important component of sustainable urban and rural landscapes (Tóth & Feriancová, 2013).

Current towns are characterised by changed environmental conditions. Plants are negatively impacted by a number of biotic, abiotic and technical factors that affect their growth and development. The most significant negative factor in the conditions of cities and towns situated in lowlands and warm areas is mainly drought due to the lack of rainfall and high evaporation. According to Vreštiak (1991) there is a big interception of air pollutants on the leaves and stems of trees in the Nitra city. Tree necroses occur at several plant species. Rózová et al (2013) report based on the evaluation of selected green areas in the city of Nitra conducted in 2011-2012 that the plants with the best health state can be found at locations with low humidity and a suitable canopy of trees due to sufficient lighting. The worst overall condition is reported at the species of the genus *Pinus*, which does not tolerate dense canopy. Rózová et al, (2013) considered species of the genus Tilia to be not suitable for planting in Nitra as they are sensitive to soil salinity, emissions and intolerant of compacted soil. According to

their research results, individuals of the species *Tilia cordata* Mill. have poorer health status than individuals of the species *Tilia platyphyllos* Scop. Based on their evaluation, the undemanding species *Betula pendula* Roth. and the domestic species of the genus *Acer*, which are tolerant to emissions, are considered to be suitable for planting in Nitra. According to Balko (2000), the environmental aspect disappeared from the creation and maintenance of green spaces at housing estates of Nitra city. The maintenance technology is based on incorrect and unprofessional efforts to standardise the operations (their number, frequency and quality), while the local needs and conditions are not really considered.

According to Dobrucká (in Supuka and Feriancová, 2008), there is an overall effort in the maintenance of public greenery abroad to rationalise the maintenance, to minimise the greenery maintenance costs and to improve the ecological aspects of the environment. Ecologisation is not only a consequence of the rising environmental awareness, but also a reaction to fund limitations.

The aim of the project is to elaborate an inventory of trees and a tree maintenance management document for the residential complex Párovce in the city of Nitra, Slovakia. The document is intended for evidence of trees, tree maintenance planning, issuing regulation of construction activities and planning of compensatory tree plantings.

MATERIALS AND METHODOLOGY

Natural conditions

The city of Nitra is located on the coordinates 48°18´N, 18°14´E, on the alluvial plain of the Nitra River, at an altitude of 140 m. Nitra is located in a predominantly hot and dry climate with a very moderate winter and an average annual temperature of 9 to 10 °. The number of days with snow cover is less than 50 a year. The average annual rainfall is 500 to 600 mm; the total precipitation in the vegetation period is 300 to 350 mm. Within the urban area, the most common soil type is the brown earth and there are smaller areas of alluvial soils, fluvial soils, cambisols and loess. In the urban area and its surroundings, there are forests within which the predominant tree species are *Quercus robur* L. and *Quercus cerris* L. The species composition of these forests is further supplemented by the species *Carpinus betulus* L., *Fraxinus excelsior* L., *Tilia platyphyllos* Scop. *Tilia cordata* Mill. Rarely *Fagus sylvatica* L. In the floodplains, the dominant species are *Salix fragilis* L., *Salix Alba* L. and *Alnus glutinosa* L.

History and urbanism

At the present area of the residential complex Párovce in Nitra, there was the oldest historically documented Jewish settlement within the present territory of Slovakia. In the mid-18th century Párovce was an independent community, mercantile and craft suburb of Nitra. The former Párovce was demolished in the 50s of the 20th century. Next to the old family houses, a new housing estate of residential buildings with 2,300 apartments grew up from 1956 to 1963. This was designed in the spirit of modernism. The most common two types of houses are the high-rise 11-storey houses and the 4- to 6-storey longitudinal houses.

Urban greenery

In the city of Nitra, there are about 140 m2 of urban green spaces per capita. However, in the territorial units of Nitra city with a predominant proportion of collective houses (like in the housing estate Párovce), there is a lack of greenery and the green spaces are of a considerably low quality. Green spaces within the residential complex Párovce are included among secondary centre of the urban greenery of Nitra with an area of 2-10 hectares. The municipal park close to Párovce is the most important green space in the city, which is according to its tree canopy to 100% considered as a local urban bio-centre. In the urban plan of Nitra, there is a plan for the future to construct a bio-corridor in the territory of Párovce, which would link the municipal park, as a local bio-centre, with other green urban spaces in the city.

Studied territory

The studied territory of the residential complex Párovce in Nitra is delimited by the Štúrova, Palánok, Ďurkova, Vikárska and Janko Kráľ streets. The residential complex covers an area of 24.7 ha (59.3 ac).

Methodology

The basis for elaborating the document of tree maintenance management plan was a tree survey, which was conducted in the summer 2013. The document consists of texts and maps. The map part is elaborated in digital format and is connected with the database which enables its update.

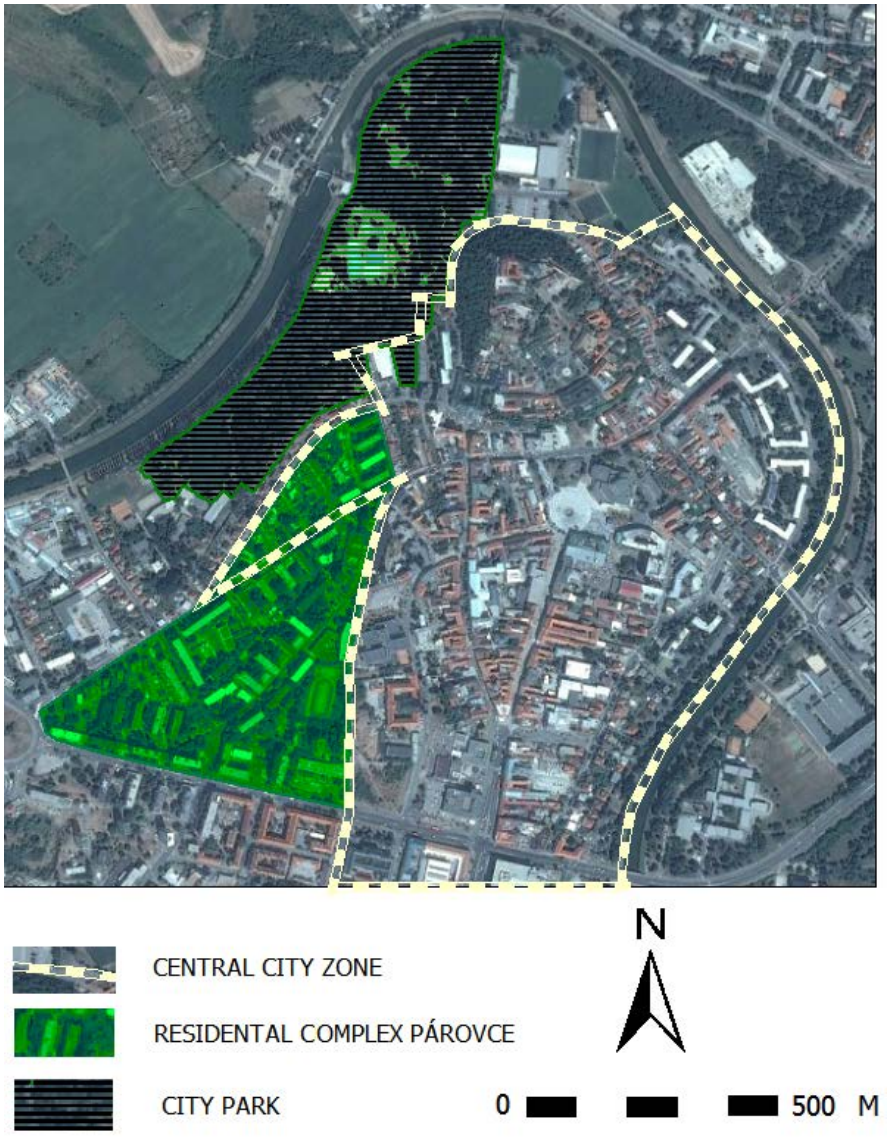


Figure 1. The area of the residential complex Párovce in the city of Nitra, Slovakia.

The document consists of the following parts:

1. Tree inventory: geodetic survey of trees, tree identification data, dendrometric values and quality assessment of trees, evaluation of the composition, function and significance of green spaces.

2. The urban tree maintenance plan consists of the determination of prospectivity of trees, the priority of treatment operations and the ways of cultivation measures,

3. Analysis of the results of tree surveys.

4. Proposals for framework operation related to the tree care and the green space concept of the area: recommended tree care operations and tree maintenance, determination of the target tree species, recommended tree species for new plantings and specifying a list of grounds suitable for compensatory plantings of trees (Straňáková & Halajová, 2013).

The methodology of inventory and evaluation of trees

The evaluation of greenery in the urban area of Párovce focused on assessing woody plants, which are considered as trees. The evaluation of shrubs was not required because of their different maintenance management. The tree inventory includes tree identification data, tree dendrometric values and tree quality assessment. Based on the tree assessment, proposals for tree maintenance were determined considering their priority.

The tree identification data include address (city part, street, house number), serial number of tree, tree species (botanical name in binomial nomenclature, Latin and Slovak names), and the character of the vegetation element (deciduous tree, coniferous tree). The dendrometric data (tree height, crown width, trunk perimeter at breast height) were collected according to the methodology by Machovec (1987). The tree height is indicated in categories: 1) 0-5 m; 2) 5-10 m; 3) 10-15 m; 4) 15-2 0m; 5) 20-25 m; 6) 25-30 m; 7) 30-35 m; 8) 35-40 m. The crown width is referred in categories : 1) 0-2 m, 2) 2-4 m, 3) 4-6 m, 4) 6-8 m, 5) 8-10 m, 6) 10-15 m, 7) 15-20 m, 8) 20-25 m, 9) 25 and more.

The overall tree condition (health, vitality) and the significance of the tree in the landscape composition (habitus, vigour) are indicated in the landscape value assessment that consists of 5-point classification system created by Machovec (1987).

Table 1 Landscape value of woody plants, classification system of assessment created by Machovec (1987)

Rating	**Landscape value of woody plants** (Machovec, 1987)	
LV 5	**Excellent**	**Very valuable woody plants**, absolutely healthy, without defects, very good vitality, habitus typical for the species, full-grown tree, high lifespan. The woody plant must be always preserved.
LV 4	**Good**	**Woody plants of above-average value**, healthy, very good vitality, possibility of small defects in the habitus (absence of lower branches – crown canopy lifting), full-grown tree, high lifespan. The woody plant must be protected; tree removal is possible only in exceptional cases.
LV 3	**Fair**	**Woody plants of average value**, healthy, without diseases, low presence of dry branches, good vitality, high lifespan, habitus may vary from the typical, but still aesthetic, crown canopy lifting, also young trees (tree size less than 1/2 average height and crown width). Tree removal is possible in cases of thinning of tree groups, or changes in the landscape composition.
LV 2	**Poor**	**Woody plants of below-average value**, presence of major defects, signs of poor vigour and diseases (injuries, dry branches, and tree holes), aged trees, low vitality and lifespan. Trees can be left to grow only in the case, that they cannot endanger people or healthy trees.
LV 1	**Unsatisfactory**	**Woody plants of low value**, unsatisfactory, presence of diseases and tree damages, aged trees (state of dieback and decay) or dead standing tree (snag). Trees endanger safety of humans and other healthy trees. Woody plants removal is necessary immediately.

The assessment of the vigour and prospectivity of woody plants is determined by three categories of classification: prospective trees, trees with high probability of mortality (low lifespan of tree) and trees determined for removal. The evaluation of greenery composition consists of the assessment of trees composition elements such as trees alley, solitary trees and groups of trees. Within the notes, various tree defects were mentioned, e.g. forks, tree holes, lean of trees, multiple stems, invasive seedlings and lianas, structural defects, unbalanced crown of trees and conflicts between trees and buildings or pavements.In the proposals of tree care operation and tree maintenance, different types of trees pruning, treatments of defects, damages, diseases and preventions against diseases are reported. The measures were determined in accordance with the system of tree care operation in Nitra as follows:

- Removal of the individual,
- Appropriate response process, hazard assessment,
- Integrated Pest Management (IMP),
- Treating of trunk and crown wounds,

- Treating of root wounds (Straňáková & Halajová, 2013).

The system of tree pruning is adapted for tree maintenance of Nitra according to the methodology by Kolařík et al, (2003):

Formative pruning:

- Formation of crown,
- Structural pruning,

Maintenance pruning:

- Crown cleaning,
- Safety pruning (dead wood, pruning of broken branches and stubs),
- Reduction pruning:
  - Local reduction pruning towards the obstacle,
  - Local reduction pruning to improve the tree stability,
  - Raising.
- Removal of epicormic shoots,
- Removal of lianas.

Stabilising pruning:

- Crown reduction,
- Crown thinning,
- Crown restoration,
- Decapitation.

Other type of pruning:

- Pollarding,
- Heading back,
- Shaping of hedges.

Priority of the tree care operation is classified by three categories: 1 – it is necessary to implement immediately, 2 – it is necessary to implement regularly, 3 - it is implemented as needed (Straňáková & Halajová, 2013).

RESULTS

Analysis of woody plant species occurrence and greenery composition

Within the studied area, there are in total 1,286 trees represented by 73 species. The most common species are *Acer pseudoplatanus* L. represented by 149 individuals which stand for 11.6 %. These are complemented by *Acer platanoides* L. (9.3 %), *Tilia cordata* Mill. (9.3 %), *Pinus sylvestris* L. (7.4 %), *Pseudotsuga menziesii* Mirb. (7.3 %), *Betula pendula* Roth. (7.2 %), *Acer negundo* L. (4.8 %), *Acer saccharinum* L. (4.3 %), *Pinus nigra* Arnold (3.7 %), *Thuja occidentalis* L. (3.1 %), *Picea abies* L. (2.9 %), *Fraxinus excelsior* L. (2.8 %), *Picea pungens* Engelm. (2.3 %), *Tilia platyphyllos* Scop. (2.3 %). Further 59 species have a share lower than 2 %. Deciduous trees are represented by 852 individuals (66.25 %), coniferous trees by 434 individuals (33.75 %). A positive aspect is the high proportion of native species of broad-leaved trees, especially the genus *Acer* and *Tilia*, which comply with environmental conditions of Nitra city and the residential area Párovce. On the other side, there are many plants in this area, which are not suitable for existing natural conditions or for greenery of the residential zone, for example light-demanding, pioneer trees, short-lived trees or allergenic trees. *Betula pendula* Roth. and *Pinus sylvestris* L. suffer from lack of light in groups of trees. The first tree planting in this residential zone was conducted 50 years ago. *Betula pendula* Roth. in the age of 50 years is an over-age tree. *Acer negundo* L. and *Acer platanoides* L. are suitable species in these conditions, but together with *Fraxinus pennsylvanica* Marsh. and *Ailanthus altissima* Mill. spread aggressively on less maintained green spaces. In

terms of climate conditions, the species *Picea abies* L. and *Abies alba* Mill. which were planted in front gardens by inhabitants are not suitable for planting.

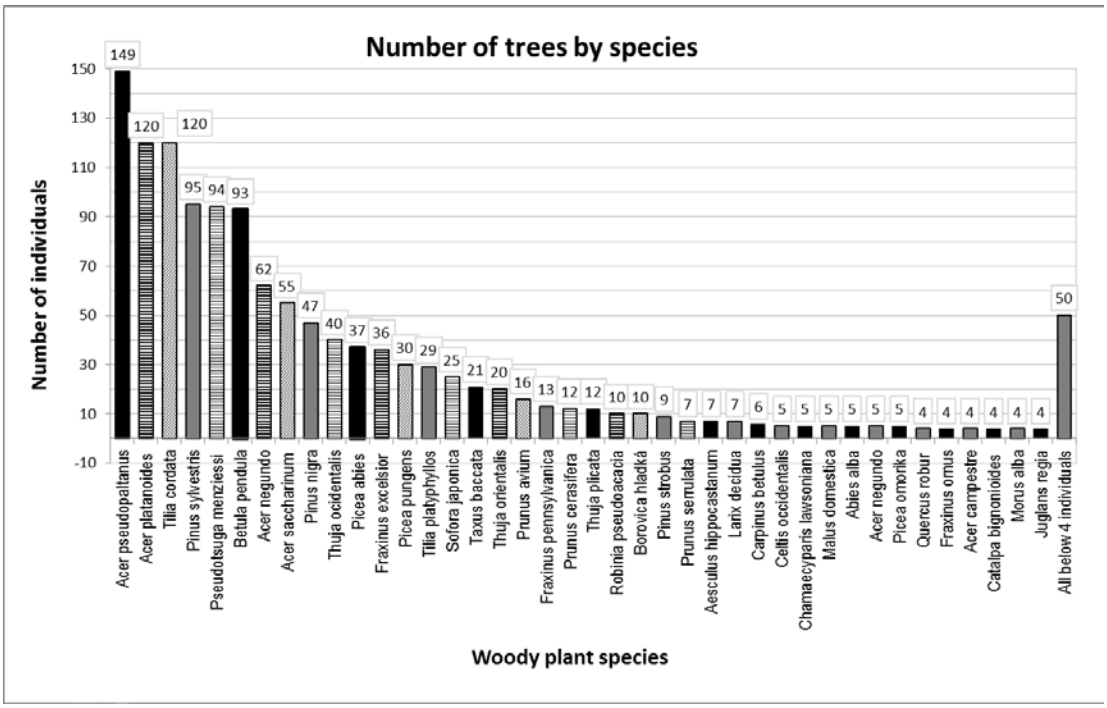


Figure 2. The occurrence and diversity of woody plant species in the residential complex Párovce, Nitra, 2013

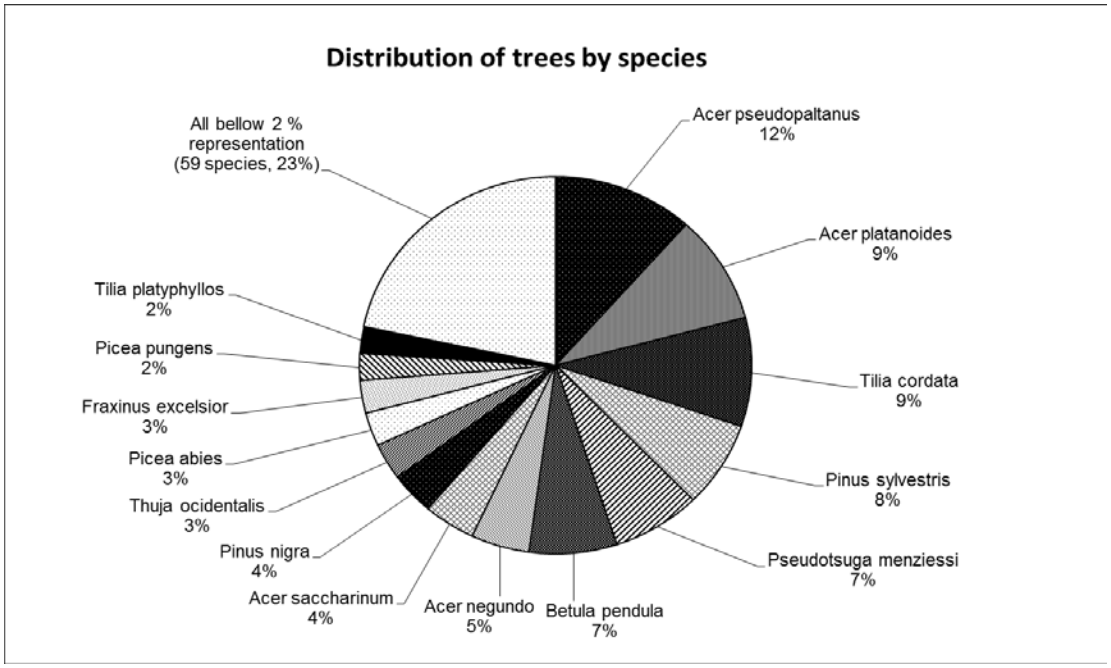


Figure 3. The percentage of woody plant species in the residential complex Párovce, Nitra, 2013

In terms of landscape composition, the most common arrangement form in the residential complex Párovce, Nitra is represented by groups of trees (62.4 %). Solitary trees represent 31.5 % and alley trees 6.1 % of all trees (figure 4). This status of tree composition relates to the landscape composition of greenery in the residential complex Párovce, where there are a lot of small green areas between residential houses. Only 64 trees are planted along roads and 38 trees are located in the only pocket park in this area. Other trees (1,184 individuals) grow in residential areas, thus next to residential houses, in their front gardens, courtyards, playgrounds, car

parks and next to the buildings of services. These areas are densely planted by trees, without planting design. Many trees were planted by inhabitants, most of them in front gardens and close to the house facades.

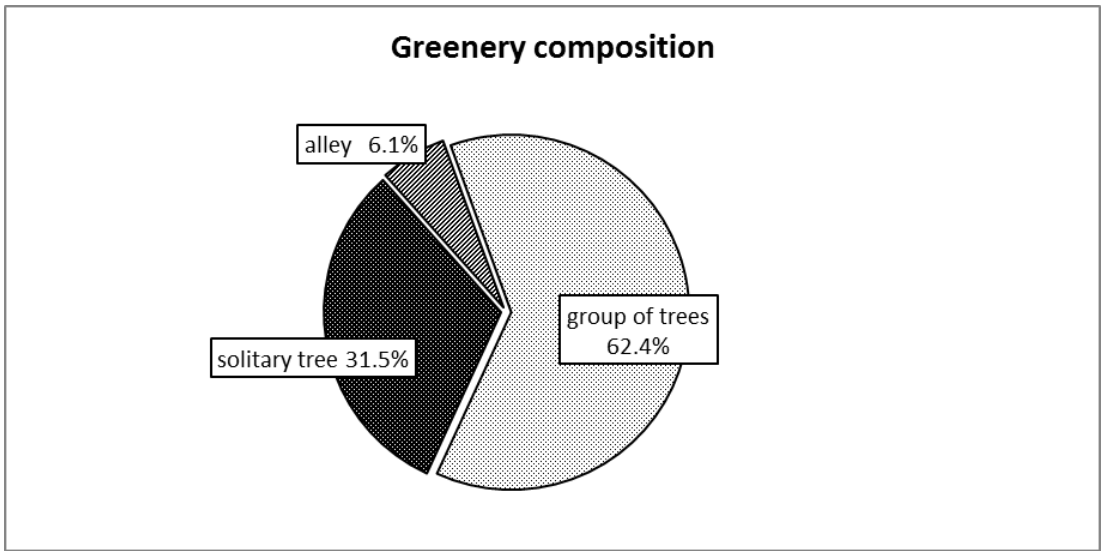


Figure 4. Representation of trees according to their role in the greenery composition in the residential complex Párovce, Nitra, 2013

Analysis of the landscape value and prospectivity of trees

The results of the analysis **of woody plants' landscape value** (figure 5) indicate that individuals with a fair landscape value (59.6 %) and poor landscape value (29.3 %) form together 88.9 % of all trees in the assessed area. The most common reasons of low landscape value of trees are signs of poor vigour and diseases (injuries, dry branches, tree hole) and habitus, which vary from the typical (trees with crown canopy lifting or crown reduction close to the house facades, pollarding trees, and overshadowed individuals). In terms of **vigour and prospectivity of trees** (figure 6) the most represented are prospective trees (84.4 %), for which we assume a high lifespan and a good overall condition for the coming decades. Trees with a high probability of mortality (10.7 %) are left to grow (only in case, that tree can not endanger people or healthy trees). Removal of trees is proposed for 4.8 % of trees, mainly due to poor overall condition of trees or threat to people, buildings or other trees. In the studied area, not a great number of trees has been proposed for removal, as there have been removed many trees during reconstructions works in the recent years (thermal insulation of facades, reconstruction of engineering networks). Many trees have been removed at the request of inhabitants as they overshadowed their flats.

Proposals for tree maintenance and their priority

Based on the tree assessment, proposals for tree maintenance were determined. Removal of trees was reported for 62 individuals. The need for tree care operation was reported for 507 individuals as follows: hazard assessment (19), pest management (15), treating of trunk and crown wounds (6), structural pruning (29), crown cleaning (167), safety pruning (27), local reduction to improve the tree stability (13), raising (132), removal of epicormic shoots (128), seedlings removal (12), lianas removal (15), crown reduction (21), decapitation (5), pollarding (52), shaping (3).

The tree care operation priority was determined as follows: by 134 individuals it is necessary to implement tree care operation immediately (removal of individuals, hazard assessment), by 57 individuals it is necessary to implement tree care operation regularly (raising, epicormic shoots removal), by other individuals the tree care operation will be implemented as needed.

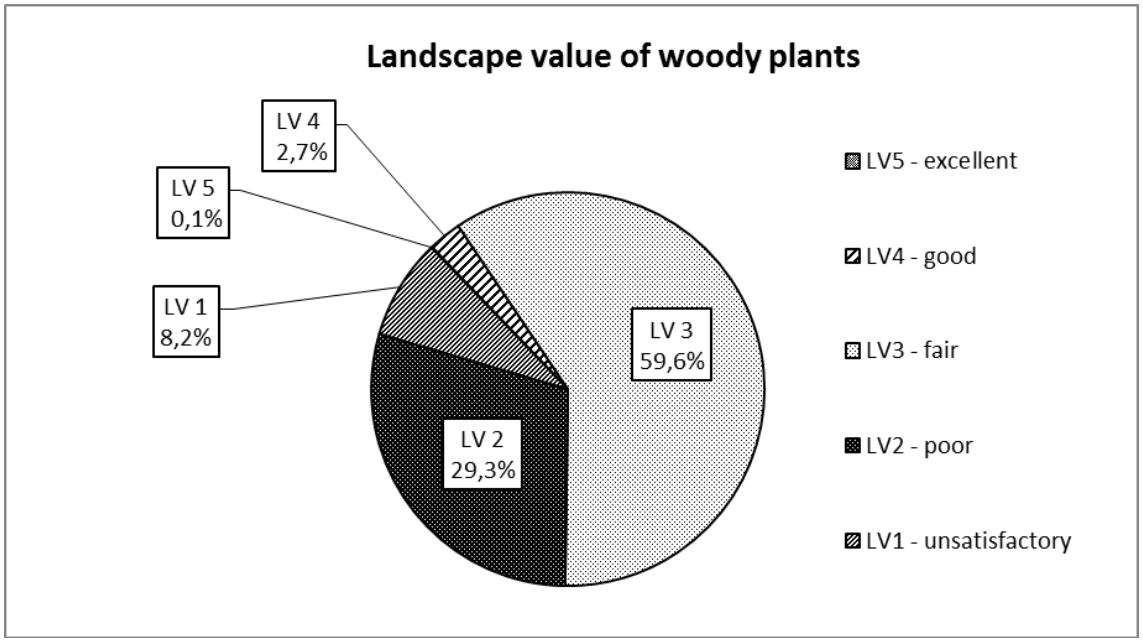


Figure 5. Landscape value of woody plants in the residential complex Párovce, Nitra, 2013

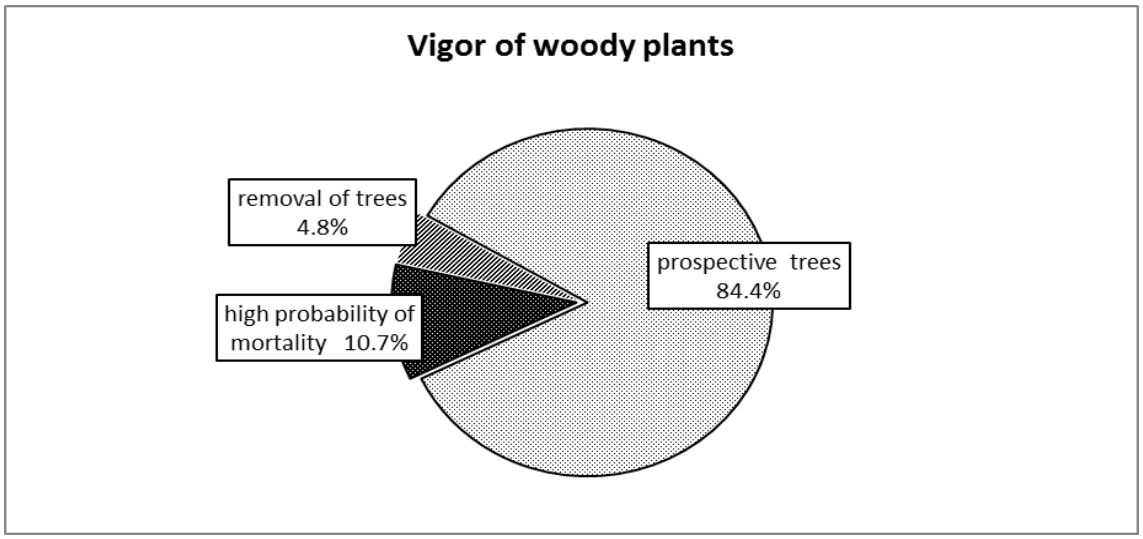


Figure 6. Representation of trees according to their vigour and prospectivity in the residential complex Párovce, Nitra, 2013

CONCLUSIONS

Trees are the basic components of the urban green system and therefore it is important that the trees are in a good overall condition. The overall condition of trees is closely related to the appropriate selection of trees for a specific environment. Therefore, it is necessary to use the long-lived native trees or well-established introduced tree species as main skeletal trees. These should be complemented by others tree species that increase attractiveness of greenery and its species diversity. According to Vreštiak (1991) in Slovak towns, in the lowlands with a warm climate, the native skeletal deciduous trees are *Quercus robur* L., *Carpinus betulus* L., *Acer campestre* L. *Acer platanoides* L., *Fraxinus excelsior* L., *Tilia cordata* Mill., and introduced tree species *Acer negundo* L., *Acer saccharinum* L., *Robinia pseudoacacia* L., *Sophora japonica* L., *Platanus acerifolia* (Ait.) Wild.

Based on the analysis results, it can be stated that the tree species composition is dominated by suitable native broad-leaved species plants, especially of the genera *Acer* and *Tilia*, which comply with the environmental conditions of the city. The tree species of the genera *Acer* and *Tilia* have been proposed as the target plants in this area, thus they must be protected and their removal is possible only in exceptional cases. To be used as compensatory plantings, we propose mainly these species: *Acer platanoides* L., *Acer pseudoplatanus* L., *Acer*

campestre L., *Acer ginnala* Maxim. *Tilia platyphyllos* Scop. *Tilia cordata* Mill. *Tilia x europaea* L., *Tilia tomentosa* Moench. They may be supplemented by following species: *Aesculus carnea* Hayne, *Carpinus betulus* L., *Catalpa bignonioides* Walter, *Fraxinus ornus* L., *Prunus serrulata* 'Kanzan', *Prunus subhirtella* Mig. *Quercus petraea* (Matt.) Liebl. *Quercus robur* L., *Robinia pseudoacacia* L., *Sorbus aria* L., *Sorbus intermedia* Ehrh. The use of conifers is very limited by climate conditions and by the dense canopy of existing trees. For new plantings, it is possible to use species like *Ginkgo biloba* L., *Picea omorika* (Pančič.) Purk. *Picea pungens* Engelm. *Pinus nigra* Arnold and *Pinus strobus* L.

For new plantings in the residential complex, tree species with rapid growth, large crown and frangible branches as species *Sophora japonica* L., *Fraxinus excelsior* L. a *Acer negundo* L. are not recommended due to the limited space. . Furthermore, highly allergenic species of the genera *Betula, Alnus, Corylus* and *Carpinus are also not recommended.*

In terms of landscape composition, it is important to respect the final size and shape of trees. In the front gardens, close to the facades and in the courtyards, smaller cultivars of trees should be used. Along roads and streets, alley tree cultivars should be used. The existing alley formed by the species *Acer saccharinum* L., maintained by pollarding cut, has a low landscape value and requires high maintenance costs. We propose to replace the existing alley trees with new plantings of alley trees of the genus *Acer*. The alley is the connecting element between the greenery of the residential complex and the greenery of the nearby urban park and therefore it is important to restore this element of urban green system. In terms of the greenery composition of the residential complex, there are no large green areas - parks with a size above 4.9 acres (2 ha). There is only a pocket park with an area of more than 1.2 acres (0.5 hectares). Therefore, it is necessary to integrate fragmented small greenery areas into larger units. There is also a need to plant new linear elements of greenery - alleys which currently absent. Alleys should take on the missing function of greenery in the residential complex Párovce, the function of space-forming elements. For a greater success when planting new trees, it is necessary to respect the development of the site and provide for the maintenance and care for three years after planting. When building new parking spaces, it is important to ensure the protection of trees near the parking lots by using protective elements. In the maintenance of urban trees, it is necessary to rationalise the tree maintenance, its extensification and ecologisation. It is necessary to respect the priority of cultivation measures and to introduce more intensity classes of greenery maintenance according to the importance of vegetation elements, both for woody plant elements, as well as for herbaceous plants. By implementation of appropriate selection of plant species, prevention, regular maintenance and nature-friendly measures in the area, ecological stability and value of urban green areas can be increased and the cost of greenery maintenance can be reduced

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