CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Forestry and Wood Sciences

Department of Forest Ecology

Woody species composition of gardens on the site of Vimperk

DIPLOMA THESIS

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

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DIPLOMA THESIS ASSIGNMENT

Bc. Petr Kotrba

Forest Engineering

Thesis title

Woody species composition of gardens on the site of Vimperk

Objectives of thesis

The aim of thesis is to make inventory of gardens in Vimperk, evaluation of development in terms of woody species representation and the way of using garden.
The aim is also to compare built-up area vs area with vegetation.

Methodology

Within the inventory, the individual species on selected locality will be examined to determine the taxa up to the level of the cultivar (if possible), basic dendrometric characteristics (height, diameter of the tree, diameter of the crown), estimated (determined) age of the trees and determined health condition and evaluation of the care for greenery . The results will be statistically processed taking into account the size of the garden and its purpose. In this work, at least 30 gardens will be evaluated.

The proposed extent of the thesis

50 s.

Keywords

gardens, woody vegetation

Recommended information sources

Bowler, D.E., Buyung-Ali, L., Knight, T.M., Pullin, A.S., 2010: Urban greening to cool towns and cities: a systematic review of the empirical evidence. Landscape and Urban Planning, 97: 147 155.

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Statement

I declare that I have developed this thesis on topic “Woody species composition of gardens on the site of Vimperk” by myself and independently under the supervision of Ing. Vladimír Janeček Ph.D. and I have quoted only from sources listed in bibliography.

In Prague 18th April 2018 ……

Bc.Petr Kotrba

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I would like to thank my thesis supervisor Ing.Vladimír Janeček, Ph.D. (Department of Forest Ecology, Czech University of Life Sciences, Prague) for his patience, willingness and guidance during my work. Words of thanks also belongs to all owners of visited gardens for their willingness and cooperation during my visits, Ing. Pavla Jirsová for lending of measuring equipment, all the university lecturers who provided me valuable knowledge during my studies and last but not least to my family that supports me and allowed me to study at Czech University of Life sciences.

Abstract

Diploma thesis is describing woody composition of gardens on site of Vimperk town. On this site were researched 30 individual gardens. Basic dendrometric parameters of 1729 individuals were recorded (tree height, diameter of trunk, tree crown diameter), the woody species age was estimated (determined), Health condition and care of individual woody species representatives was evaluated and recorded. The information about care for greenery, about history of gardens, and in some cases information leading to refinement of tree age estimation and cultivar determination were found out by interviewing owners of garden. Recorded data was subdued by basic statistical analysis in Microsoft Excel.

Key words: gardens, woody vegetation

Diplomová práce spočívá v inventarizaci dřevinného složení zahrad v lokalitě města Vimperk. Na této lokalitě bylo zkoumáno 30 zahrad. Byly zjištěny základní dendrometrické charakteristiky 1729 zaznamenaných dřevin (výška, průměr kmene, průměr koruny), odhadnuto (určeno) stáří dřeviny, vyhodnocen zdravotní stav jednotlivých dřevin a zdokumentována péče o jednotlivé dřeviny. Formou rozhovoru s majitely zahrad byly zjišťovány informace o péči o zeleň, historii zahrad a v některých případech informace vedoucí k upřesnění odhadu stáří jednotlivých dřevin a určení kultivaru. Zjištěná data byla podrobena základní statistické analýze v programu Microsoft Excel.

Klíčová slova: zahrady, dřevinná vegetace

Table of Contents

1 INTRODUCTION

Gardens are close part of our way of life from the ancient times. They are forming a landscape character of the surroundings of our dwellings. Garden serves as a place for both active and passive relaxation. Offers to it's owners a place to refrain from daily stress, enjoy moments with family or friends in the immediate vicinity to their dwelling, but also a place where cultivating of own crops takes role. The garden greenery isn't created only by grasses, flowers and herbs, but from big part by woody species.

This diploma thesis is concerned with representation and composition of woody species on the site of town Vimperk. Thesis documents woody species composition, their condition, and way the gardens are used.

2 OBJECTIVES

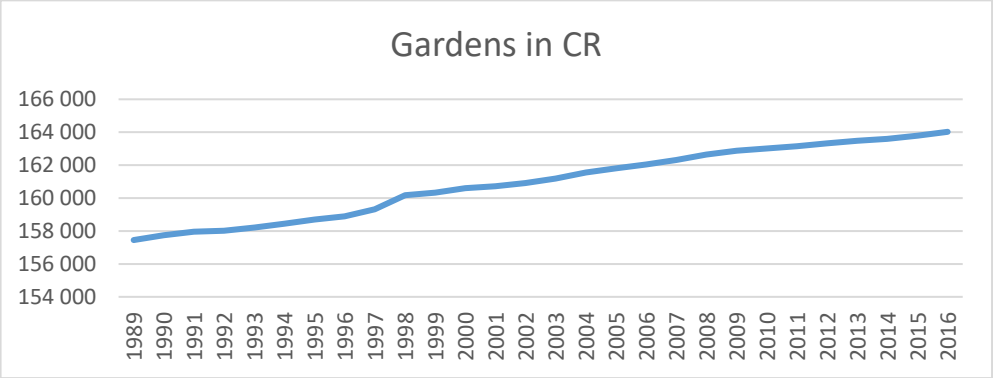
The aim of thesis is to make inventory of individual gardens visited in Vimperk, making synoptical tables and graphs evaluating development in terms of woody species representation and the way of using garden. The aim is also to compare size of built-up areas vs areas with vegetation and analysis of observed data.

3 LITERATURE RETRIEVAL

3.1 The relationship between man and the garden

Garden is one of many tangible expressions of relationship between the man, the nature and the society. Basic values of this relationship were mainly represented in two ways – on agricultural level and on the social level. Agricultural function of garden is undoubtedly the first and oldest way of usage of gardens, originating from very beginnings of human settlement. Intensification of soil management and growing of food, connected to reducing of distance between managed soil and human dwelling and subsequent demarcation of cultivated soil led to creation of first type of gardens known to nowadays. Social function was in fulfilment of aesthetical, living and representative functions of garden. Human kind needed to have their subjects of everyday use to be practical on one hand and beautiful on the other hand, and the garden was no excuse. People started to beautify their surroundings and they spend more time in their gardens not just for farming, but also relaxing and spending free time. The garden's and the dwelling's missions are getting closer and it reflects on a lifestyle of many nations which is equally divided between the house and the garden environment. Growing differentiation of social classes led to new aesthetical elements used in garden so as a need for representativeness as another manifestation of different lifestyles of variant society classes. Improvement of economic and social conditions in society was always closely related to improving quality of gardens and conversely. Qualitative and quantitative value of gardens was therefor very sensitive indicator of rise or fall of economic and culturally-social relationships in given era (Mareček, 1991). The trend of gardening in Czech Republic is on the rise as you can see on figure below. It is given by increasing standard of living, building of new family houses and need for private place to rest during free time. Figure represents increasing acreage (in hectares) of gardens registered in cadastral plan in Czech Republic over the years.

Chart 1. - Acreage of gardens in Czech Republic [ha] (https://www.czso.cz/)

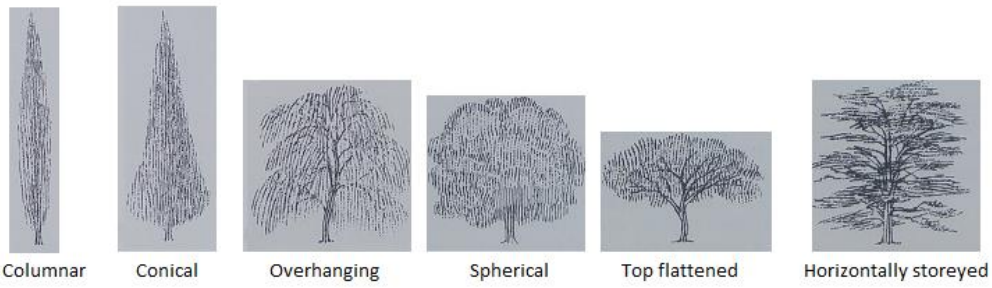


3.2 Tree – essential element of garden architecture

Trees are the main compositional elements of landscape and garden architecture. This is caused not only by it's habitus, but also by it's effect in time. During ages, a special relationship between human and the tree has developed, relationship between two living entities – One is for the centuries aiming to the stars and offers protection and safety, and the other one with regard to its transience is finding the protection and symbolism in it. The symbolism is reflected in sacred myths, religion and artworks in all cultures around the globe. The tree is an architectural element. It has its architectural segments and serves in garden as any other architectural or art element. Tree's advantage is in attribute, that it is living element that changes both in short-term and long-term period. No other architectonic element changes its shape, size and color completely spontaneously of its essence of live (Otruba, 2002). Trees will always be largest elements in the garden and during planting is important to think about their growth in time. That's why we have to consider future height, width and overall appearance of the tree (Brookes, 1994).

In general we categorized the shapes of trees as follows:

- Columnar
- Conical
- Overhanging
- Spherical
- Top flattened
- Horizontally storeyed



Picture 1. – Tree shapes (Brookes, 1994).

We can find these basic shapes across all species of trees - from trees in forest to small decorative hybrid species. The impression of tree is different according to it's shape – for instance, impression of horizontally spaced trees is more dynamic, but on the other hand vertically shaped trees creates impression of static items in the garden and catches our sight (Brookes, 1994).

3.3 Development of garden styles

Formation of gardens has developed simultaneously with building architecture and other disciplines of fine arts – statuary and painting. Usually with a short time delay. Gardening was influenced by socio-political, economical and religion conditions so as by national traditions, relationship between people and nature, climatic conditions, and so on. By the term "garden style" we understand the way of artistic rendition of gardens based on reflection of social bases or as a summary of aesthetical traits and rules characterising the gardens of specific time era or specific nation. According to arrangement of significant elements and visibly prevailing influence of nature or human we distinguish the styles into two basic groups: architectural styles and landscape styles (Hurych et al., 2011).

3.3.1 Architectural styles

Basic element of architectural style is division of ground projection, which is often composed of geometrical shapes. The area is divided into straight lines, or geometrical curves made up of paths, roads, beds, parkways or walls. The shape is superior to function. Garden style refers to the style of building and sculptural artworks. Terrain is modified to be flat, steady slope or terraced. Woody species are modified and trimmed to keep geometrical shapes. Flower beds are rich and dense. Establishment and maintenance of garden in architectural style is very expensive and demanding to achieve perfect aesthetical impression (Hurych et al., 2011).

Egyptian garden

In Egyptian gardens, love to water and plants was significantly reflected in high contrast between vast deserts and cultivated gardens. All the elements typical for gardens of Middle East and Mediterranean Sea region were applied here. Elements like taciturnity from surrounding environment, direct connection with house, geometrically shaped beds, regular spacing between trees and positioning of water source as a most valuable element in the middle of garden. Presence of shadow was valuable and rare in these geographical conditions during the day. That led to planting of wide crown tree species and building of pergolas (Mareček, 1991).

Babylonian and Syrian garden

These gardens were constructed on gradual terraces and had remarkable cultural and social importance. These terraced gardens together with gardens on rooftops were very popular in southern countries. Establishment of these gardens was extremely difficult to realize. The whole antiquity considered as most famous The Hanging Gardens of Babylon build by king Nabukadnezar, which are known as one of seven wonders of world (Mareček, 1991).

Persian and Median gardens

Persian and Median gardens were very rich on floral décor. The leading role here played roses, daffodils, tulips and whole large group of aromatic flowers. Also here were used pergolas, terraced gardens and gardens on rooftops. Very significant element of these gardens was various use of water, expensive and decorated paving, and varied architectonic accessories (Mareček, 1991).

Indian garden

Gardens built in this era represented nation culture and lifestyle. Two types of greenery were established: royal gardens and municipal, public gardens. Large rectangular pools serving as a spa were built. Species of aesthetical and religious plants and trees were planted. Garden pavilions served for pleasure of garden's owner – later on as the crypts. Gardens were often constructed like terraces and were water supplied from mountain springs (Pacáková-Hošťálková, 1999).

Greek garden

Basic element of Greek garden was pristyl – residential yard transformed into a garden. Garden was structured to regular geometrical patterns supplemented by regular water canals. Shrubs and trees were trimmed to form walls, low hedges or geometrical ornaments (so called "xystus"). Palms, Cypress, Buxus, Olive trees, Citrus trees or Pomegranates were the most frequently planted species. Greenery was also planted into containers made of stone or clay. (Wagner, 1981) Greek gardens continuously took over many principles, elements and species typical for Egyptian gardens or gardens of Middle East and developed them in new economical and social conditions (Mareček, 1991).

Roman garden

Roman gardens were inspired by Greek garden style and elements like peristyl were extended by atrium surrounded by trees and plants planted both in ground soil or in containers. These elements were complemented by sculptures, vases or fountains. On the countryside were built large aesthetical gardens realized in geometrical shapes. Rosarium was involved – large garden with rich variety of rose species (Wagner, 1981).

Byzantine garden

Gardens were similar as Greek gardens but much richer on architectural elements and artworks. Strong emphasis were placed on water element – canals, cascades, fointains, waterfalls. Roads were lined with flower beds, hedges and alleys. Gardens were supplemented not only by domestic species but also by many exotic species (Wagner, 1981).

Islamic garden

Islamic religion is based on idea that heaven is a garden. All pleasures of gardens are representing heaven for Muslims (Pacáková-Hošťálková, 1999). Gardens were surrounded by tall wall, usually they have one entrance. Water system used for humidifying of gardens and reduction of temperature was complemented by flower beds, hedges and various artworks. In sloping terrain, water cascades were built (Wagner, 1981).

Medieval garden

Medieval gardens in Europe were reflecting new religion ideologies. Influence of Christianity led to change of architectonical perception of gardens. Flashy and rich aesthetical impression and architectural composition were suppressed and replaced by practical and farming approach. Gardens were mostly used for cultivation of healing herbs, vegetables and fruit (Mareček, 1991). Beds were situated rectangulary and close to well, which was often creating the center of garden (Wagner, 1981).

Renaissance garden

Gardens of renaissance era represents significant turn in further development of garden architecture in Europe. Thinking of scholastic medieval was suppressed by humanistic culture, philosophy and science – religion stopped to be viewed as the only function of art. Essential influence on development of renaissance gardens in Europe were in Italian gardens following-up antic thinking and rational approach to life and art (Mareček, 1991). In this era, the garden is becoming common part of nobles settlement

and reflects change in the way of feudal life – Leaving of straitened castle and building of comfortable settlement close to city. Fortification is still present but also large gardens are established and equipped with many facilities like summerhouse or stables (Dokoupil, 1957). Various domestic and exotic species were present in gardens. Shadow was ensured by "bosket" – small forest-like area with dense canopy. Along roads were placed plants in containers which had to be moved in orangery or glasshouse during winter. These facilities were also placed in garden without disturbing gardens character (Pacáková-Hošťálková, 1999).

Baroque garden

Baroque garden is typical for 17th and 18th century. Garden is mainly perceived as a representative space (Dokoupil, 1957). Axiality is the new leading element of garden architecture. It is represented by chateau or other building and supplemented by arrangement of other matters (greenery, sculptures, etc.) along designated axis. Next important principle was intersection of garden out of its limited area into landscape. That is one of the main contribution of baroque garden architecture (Mareček, 1991).

Gardens of Romanticism

Romanticism preferred emotional aspect of human being, impulsivity and excitement. Admiration to medieval, resulting in resurrection of gothic elements in architecture. Romanticism was focusing also on exotic elements of Oriental architecture (Hurych et al., 2011).

3.3.2 Landscape styles

Gardens of landscape style are designed as a painting (Pacáková-Hošťálková, 1999). Ground plan imitates free nature, there is absence of any boundedness of elements. Terrain is irregular, rounded shapes are prevailing. Roads resembles snake-like curves and creates premeditated circuit to show visitor the most interesting places of garden. Water areas are irregular and in natural shapes resembling ponds, streams, brooks, rivers and lakes (Hurych et al., 2011).

Chinese garden

Chinese gardens were unregular, natural and full of symbolism. One of basic principles was nanism represented in cultivating of scrubby, dwarfed species in small ceramic containers (Pacáková-Hošťálková, 1999). Important component of Chinese garden was blossom. Blossoms presents important element of Chinese culture. Flowering trees, shrubs, lilies, roses or peonies were planted very often – flowering species represented the symbol of relationship between human and nature, they symbolled love, goodness, happiness (Wagner, 1981).

Japanese garden

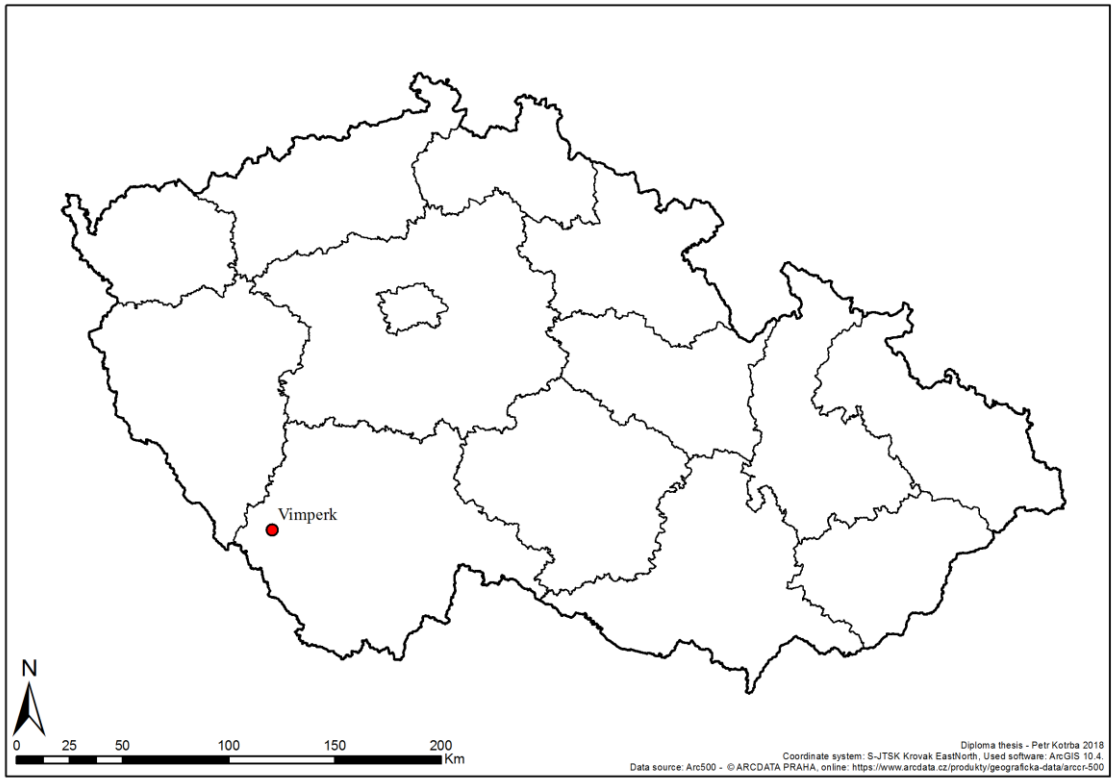
Japanese took over Chinese culture and customized it to their conditions. Garden was established as a landscape space. Principle was to underline picturesqueness and irregularity. Terrain was artificially customized and changed. Water was situated into brooks, ponds or streams. Woody species were trimmed and customized into variety of different shapes (clouds, ships, birds, etc.) lower vegetation was often created by mosses and grass. Stones were selected according to their shape and color and later on placed to create religious motives. Japanese gardeners excelled in cultivating of miniature woody species – called bonsai (Hurych et al. 2011).

English landscape garden

This style was created in England at the turn of 18th century. England was most developed society in that era. Basis of English landscape garden came from three principles. First of all it was change of English landscape character - farmlands to pastures. That was reflected in frequent tree stands in landscape, occurrence of hedges and big share of permanently grassed areas. Second principle was in continuous loosening of baroque gardens and leaving of geometrical principles. Third source, that helped to develop new gardening style was baroque and romanticism painting where founders of landscape gardens were looking for inspiration during establishment of English landscape gardens (Mareček, 1991). Water areas were predominantly modified into lakes and ponds. Borders of property were created by ditches and bulwarks instead of walls (Hurych et al., 2011).

3.4 Vimperk – short introduction of site

Vimperk is a small historical town on the foothills of Šumava mountain range. It's located in South Bohemian region of Czech Republic, in Prachatice district. Town is historically known for its location on Golden trail, which was main trade route for transport of salt and other valuable resources between the Bohemian empire and the Danube. First written mention of the town came from year 1264 (Kuča, 2011). In past there were significant printing, glass and wood processing manufactures and companies. Small prayer books and calendars printed in Vimperk during 19th and 20th century were literally known all over the world (Anděra, Zavřel et al., 2003). Nowadays lives in Vimperk about 7500 inhabitants on area of 80 km^2. Vimperk is also known as "The Gate of Šumava mountains". The town is frequent starting point for many tourists who can admire many beauties of this lovely town, such as renaissance chateau (originally castle, based in middle of 13th century) situated on rock spur above the town (Konečný, 2017)



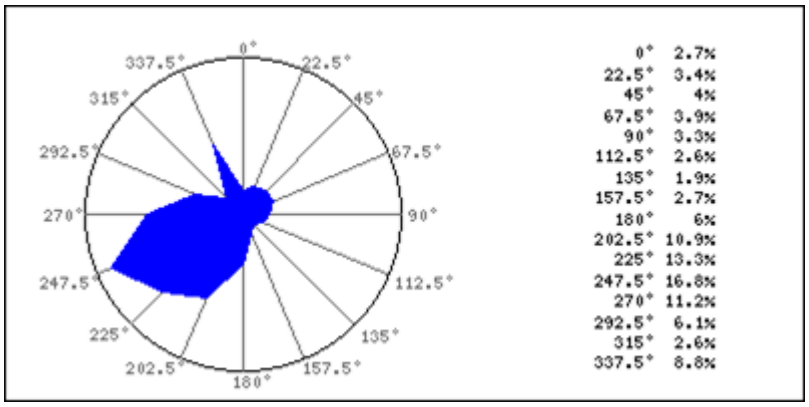
Picture 2. – Location of town Vimperk in Czech Republic.

3.5 Natural conditions on the site of Vimperk

Geomorfologicly town Vimperk is situated on border between Šumava highlands and Boubín ridge in the valley of Volyňka river (Demek et al. 1987) in the height about 700 meters above the sea level. The river had significant influence on relief of local landscape. It forms deep valley in hard rocks of Moldanubikum geological region, represented here by pararula and migmatit from Paleozoic era (ČGS 2018a, Mísař et al., 1983). Quaternary layers are mostly represented by fluvial and deluvial sediments. On such geological surface developed mostly Cambisols and entic Podzols (ČGS 2018b). It is related to local vegetation cover which was originally made up of mixed forest. Local forest are in 5th or 6th vegetational zone according to geobiocenological classification system, on the border between Bohemian Mesophyticum and Oreophyticum Massivi bohemici (Skalický, 1988).

Map of potentional natural vegetation (Neuhäuslová et al., 2001) shows beech forests (Dentario ennaphylli - Fagetum and Luzulo - Fagetum). Climate is cool, region CH7 according to Quitt (1971). That means long winter (100 - 120 days long blanket of snow), average temperature 8° C and total precipitation between 850 and 1000 mm/ $1m^2$ per year. Data recorded in recent hot years 2016 - 2017 shows average temperature 8,5 - 8,8 °C and 600 - 700 mm/ $1m^2$ per year (CHMI, 2017). Discrepancy in precipitation is mostly due to location of town in a rain shadow of Šumava mountains, that stands between Vimperk and south western direction from where most of the wind flows (Picture 3.).

The surrounding countryside of Vimperk is well known for its valuable and conserved nature. It lies on borders of Protected landscape area Šumava and also the main headquarters of nearby National park Šumava is situated in here. These large protected areas are declared as Special Protected Area and Site of Commuity Importance declared by European Comission. It is also part of World Network of Biosphere reserve (AOPK, 2018).



Picture 3. – Diagram of prevailing winds derived from all measurements of Wheater station Vimperk – Homolka, 2017

3.6 Basic functions of greenery in garden environment

Specific microclimatic and hygienic function of garden environment is based mainly in the influence on temperature, air humidity, circulation of air, dustiness suppression, noise regulation and many others particular hygienic functions (Mareček, 1992).

These functions represented by greenery on our gardens are used for instance during establishment of different facilities in garden, such as resting areas, children's corners, residential terraces, or establishment of protected green. These functions create suitable conditions for growing of species demanding special stand conditions (Šonský, 1999).

3.6.1 Positive functions of greenery

3.6.1.1 Garden as a biodiversity hotspot

Increasing rate of urbanization and fragmentation makes gardens more important for biodiversity conservation. European commission (2017) consider losing of biodiversity as most significant global environmental threat. Importance of gardens for biodiversity and nature connectivity is more focused last years in Europe. Garden flora is one of the richest in countryside due to huge number of alien plants. For example about 70% of 1166 garden plants in Great Britain and Ireland are introduced (Smith et al., 2005). It means that gardens are probably the greatest source of invasive plants. In consequence

gardens are for biodiversity benefits and threats together. Some authorities are trying to motivate people to “wildlife-friendly management“, which may cause change of view on garden development (Goddard et al. 2009, Goddard et al. 2012). Future gardens in highly urbanized areas could by developed not only for agriculture and aesthetical, but for wildlife as well.

3.6.1.2 Influence on microclimate

Due to transpiration on assimilative organs of greenery and partly due to cooperation of other influences, changes of microclimatic characteristics of stand takes place. Among the list of the most important influences belongs heat balance and relative air humidity. Decreasing of air temperature lies in:

- Reflection of solar irradiation back to atmosphere
- Consumption of part of energy for photosynthesis
- Consumption of energy for purposes of transpiration, interception and water evaporation from vegetation surface
- Transformation of solar irradiation to heat energy that takes place on several storeys of vegetation and not directly on soil surface

Vegetation can permanently increase air humidity in several ways:

- Evapotranspiration (evaporation from soil and transpiration of greenery)
- Evaporation of dew condensed on the surface of vegetation
- Evaporation of precipitation

(Kolařík et al. 2003).

Increasing of relative air humidity can be expected especially by multi-storeyed greenery in vegetation with balanced water regime. In this case, the stated differences of air humidity between the surface of vegetation and paved area are around 10-20% (Suchara 1977).

Also the influence of tree crown shade, when amount of sunlight impacting on paved areas is reduced. Even the trees with less dense crown can catch 60–80% of solar irradiance. Through the dense canopy can penetrate only 2-3% of sunlight. That reduce significantly amount of energy falling for instance on surface of human body (Kavka and Šindelářová, 1978).

3.6.1.3 Reducing of dustiness

Reducing of dustiness is very important function for human being. Woody species vegetation so as grasses works as filters. Dust particles are captured on vegetation and by the precipitation washed down into the soil. Vegetation supports dust sedimentation in two ways – capturing of dust on aboveground organs of plant and reducing of velocity of air flow in the garden which results in faster sedimentation. Important fact is, that in case of sedimentation on paved surface is the dust returned into air after first stronger gust of wind – that means that purposeful effort of reducing the air flow in desire for smaller dustiness makes sense only in vegetation with undergrowth or grass (Kolařík et al. 2003).

3.6.1.4 Reducing of air flow

Windbreak function of vegetation is needed mainly on exposed sites with strong influence of prevailing winds. Wind resistant woody species with semi-permeable crown seems to be very effective in fulfilment of windbreak walls. In measurements done by Kavka and Šindelářová (1978) was noticed that on windward side is the vegetation reducing velocity of wind by 30-50% for distance of 5-10 times tallness of the tree. And on the leeward side is the velocity reduced by 40-70% for distance 15-20 times tallness of tree.

Vegetation cover is also able to cause so called convection flowing. Which means that cool air is flowing to the places with higher temperature and cools them (Kolařík et al., 2003).

3.6.1.5 Reducing of noise

Noise is a basic stress factor influencing comfort on gardens. Maximal allowed noise in residential areas (including garden environment) in Czech Republic is 45dB, in rural residences 50dB and in city centres and industrial areas 65dB. Real value is often much higher. That is mainly caused by traffic and technological indiscipline (Mareček 1992). Vegetation can reduce the noise level in dependence on frequencies of noise, spatial orientation of noise, composition of vegetation, and so on. Branches acts like oscillators and absorbs noise energy via resonance. Stripes of closed canopy tree species are most effective in a way of noise absorbing barrier and they are reducing the noise up to 10-12 dB (Kolařík et al., 2003).

3.6.1.6 Releasing of biologically active substances

Stomata on leaf releases biologically active substances which are beneficial to human organism. Most important are oxygenated, bacteriostatic and repellent substances. Releasing of substances into the soil is also important. These substances play inhibitory role for other organisms during competitive processes. In most of the cases ethylene, etheric oils, alkaloid compounds of phenol, alkaloids, glycoside and derivates of coumarin. Vegetation releases these substances to air, in soil via root system or they are washed down to the soil by precipitation (Larcher 1988).

The ability of vegetation capturing CO_2 and production of oxygen in urban areas is often overrated by public. Bernatzky (1969) study works in favour of trees as a producers of O_2 when describing that a 100 years old Beech can consume 2350g of carbon dioxide and release 1710g of oxygen during one hour of photosynthesis. On the other hand Meyer (1982) proves that large amount of produced organic matter (leaves and other) is decayed by bacteria, fungus, and other, while oxygen is consumed. And that urban agglomeration does not record any increase of oxygen form photosynthetic processes during winter time, while it's consumption continues. Meyer (1982) claims that role of vegetation in urban areas as a producers of oxygen is negligible (Kolařík et al., 2003).

3.6.1.7 Aesthetical function

One of many basic needs of a human is beauty, which is bounded to many aspects in human life, such as happiness, optimism, joy, satisfaction or good mental condition. The garden should report aesthetical values to influence perception of human in positive way what can in long term lead to positive mental condition followed up by better physical condition as well. Also perception of green color plays significant role in human life. Look on green color is considered as a visual relaxation, because the eye is stressed the least while watching green. Second important ability of green color is, that induces optimistic mood. Both these facts can be explained that human has been surrounded by green color during millions years of development and that's why green color is perceived as a sign of rich and healthy nature and represents some level of certainty and safety (Mareček 1992).

3.6.2 Negative functions of greenery

3.6.2.1 Distortion of buildings

Most significant negative influence of greenery on buildings can be observed in localities with volume unstable soil conditions. Buildings built on such soil can be endangered by the vegetation's ability of transpiration, which allows especially woody species to drain up to several hundred litres of water from the soil. If they grow on soils where loss of water content in soil can lead to change of volume proportions, it causes damages or destruction of surrounding buildings (Kolařík et al., 2003).

3.6.2.2 Production of allergenic pollen

Production of allergenic pollen represents issue in case of people suffering of allergies. Especially allergenic pollen of anemophilous species like: *Alnus incana, Populus spp., Corylus avellana, Betula pendula, Salix caprea, Philadlphus coronarius, Fraxinus excelsior, Corylus colurna* or *Sambucus nigra* represents large issue in the way of dustiness. Restriction of using allergenic species is difficult to realizable due to limited number of species useable in urban environment. Solution can be found in

planting of non-flowering species or male individuals of dioecious species (Kolařík et al., 2003).

3.6.2.3 Threatening of operational safety

Stabilizing ability of woody species individual is stable due to growth – the tree can react on burden effectively. Tree deals with excessive burden or aging by fall off of branches or breakaway of part of the crown. Operational safety has to be ensured by regular supervisions and cultivating interventions during whole lifespan of given tree (Kolařík et al., 2003).

3.6.2.4 Pollution of garden

Most common pollution of garden is caused by fall off of mature fruits, or by honeydew (from *Tilia spp*.) or pollution caused by pulpy fruits. These issues can be eliminated by planting of fruitless individuals or appropriate placement of greenery in the garden. Significant negative effect is represented by autumn leaves, that causes clogging of drainpipes. This can be solved by drainpipe grids, planting small-crown cultivars or regular reduction of crowns (Kolařík et al., 2003).

3.6.2.5 Source of invasive species

Garden is in its nature collection of local and introduced species (Moloney et al., 2009). In some case it may be threat for original fauna and flora around. Most of all in spreading of invasive plants or other organisms hosted on these plants. Some papers identify gardens as the greatest source of invasive plants in countryside of urbanized countries (Reichards, White, 2003, Smith et al., 2006).

4 METHODOLOGY

4.1 Selection of gardens

Chosen gardens were selected intentionally to cover not only geographical variability, but also different ways of their use and fulfilment of different functions on given locality as much as possible. Thirty selected gardens differs by their size (from 260 m^2 to 2847 m^2), their altitude (from 680 m a.s.l. to 753 m a.s.l.), but also by their way of use (from individual gardens fulfilling aesthetical, fruity, vegetable, or other function, to gardens that combinates all of these functions).

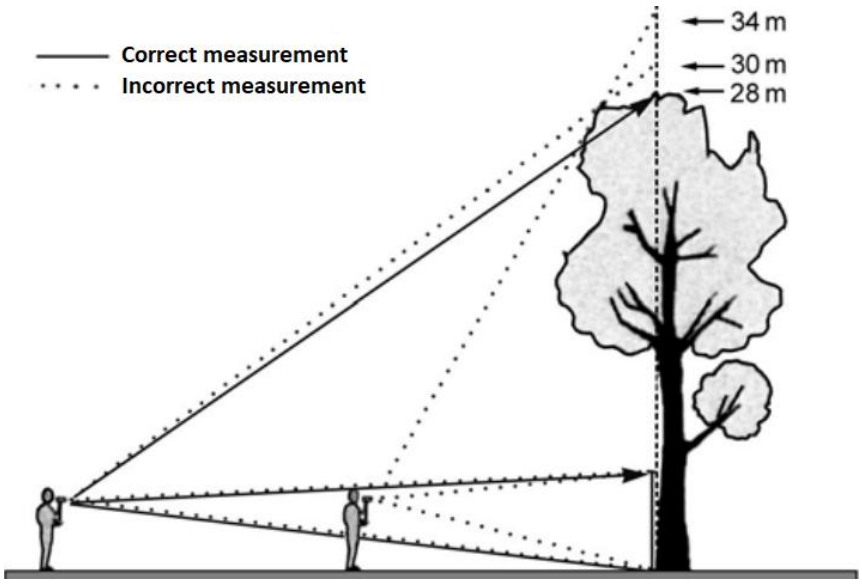
4.2 Tree height measurement

Tree height is defined as a distance between two parallel plains placed perpendicular to the axis of tree – first one is going through the butt of trunk and the second one is going through the highest tip of the crown. For determination of tree height are used “indirect measurement methods” which means, that during measurement, the measuring tool and measured object are not in physical contact. Altimeters – tools used for indirect measuring of tree heights are based on geometric or trigonometric principles (Kuželka et al., 2014).

4.2.1 Principles of tree height measurement

Correct values during measuring tree height can be reached only when tee butt and top of the tree is aimed precisely. That’s the main reason why to measure the tree from appropriate distance where from the whole tree is clearly visible from the butt to the top. In case of measuring trees with patulous crown is important to correctly estimate the top

of the crown and aim through the crown to point of expected presence of top. In case of measuring to the visible edge of tree crown a mistake leading to overstatement of tree height occurs (Kuželka et al., 2014).



Picture 4. - Principles of tree height measurement.

During measurement of inclined trees is important to measure from position which is perpendicular to axis of inclination of measured tree i.e. from the point of view of the measurer, the tree is inclined to the sides, not in the way to, or away from the measurer (Kuželka et al., 2014). In case of proper measuring the difference between actual and measured height doesn't extend the value of 0,1 m to 0,5 m in dependence to inclination and tree height – this mistake can be accepted (Šmělko, 2007).

4.3 Tree trunk diameter measurement

Diameter of cross section of the trunk is one of the basic dendrometry values. By the Cross section diameter we understand the distance between two parallel tangents placed in two opposite points of circumference of cross section. According to fact that shape of tree trunk is not perfectly symmetrical we can obtain endless number of results during measurement on cross section (Values between d_{min} and d_{max}). Standardly the cross section diameter is measured at height 1,3 m above the bottom of tree trunk. This value is called DBH - Diameter in Breast Height (DBH = $d_{1,3}$) and represents standard

way of measuring cross section of standing trees in forestry. DBH is in most of the cases easily accessible and usually is measured by simple calipers (Kuželka et al., 2014).

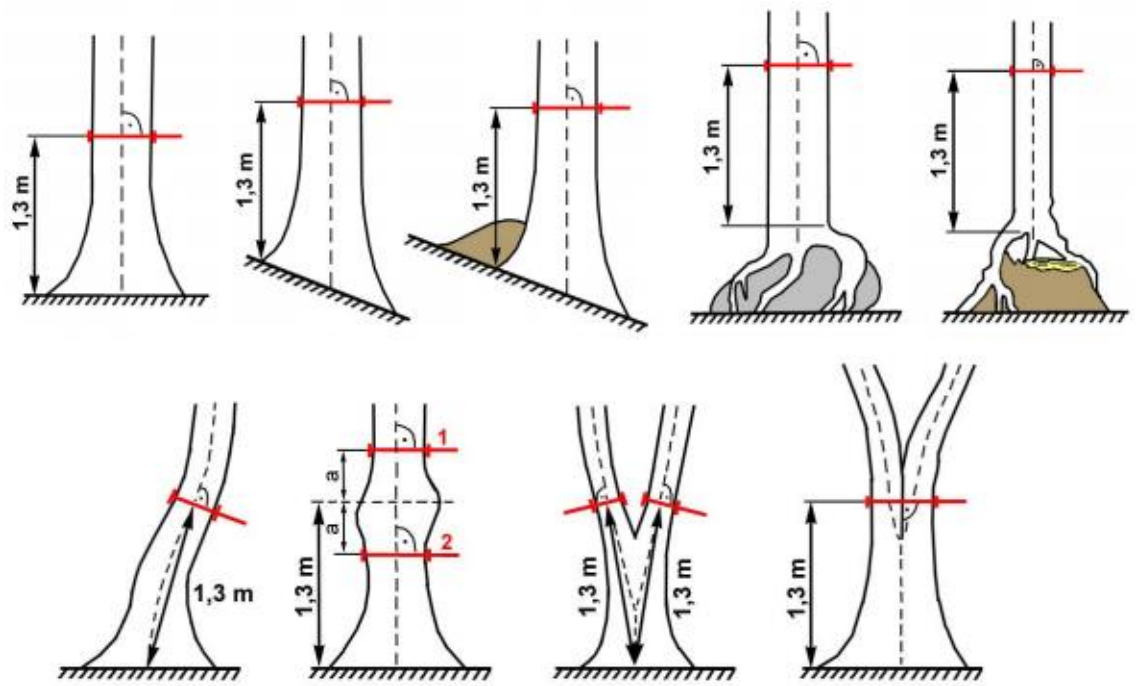
Alternative way how to obtain thickness of cross section is not to measure its diameter by caliper, but measure the circumference by using the circumference measuring tape. The relationship between circumference and diameter of cross section can be expressed as a relationship between circumference and diameter of the circle:

$$O = \pi \times d$$

Typical attribute of most of circumference tapes is the presence of two scales on the tape. First one is in centimeters and serves for reading of circumference and the second cale is in π centimeters and we can easily read thickness/diameter of the cross section directly. Measuring tape is often used in cases of very thick trunks where size of caliper is not sufficient (Kuželka et al., 2014).

4.3.1 Principles of trunk thickness measurement

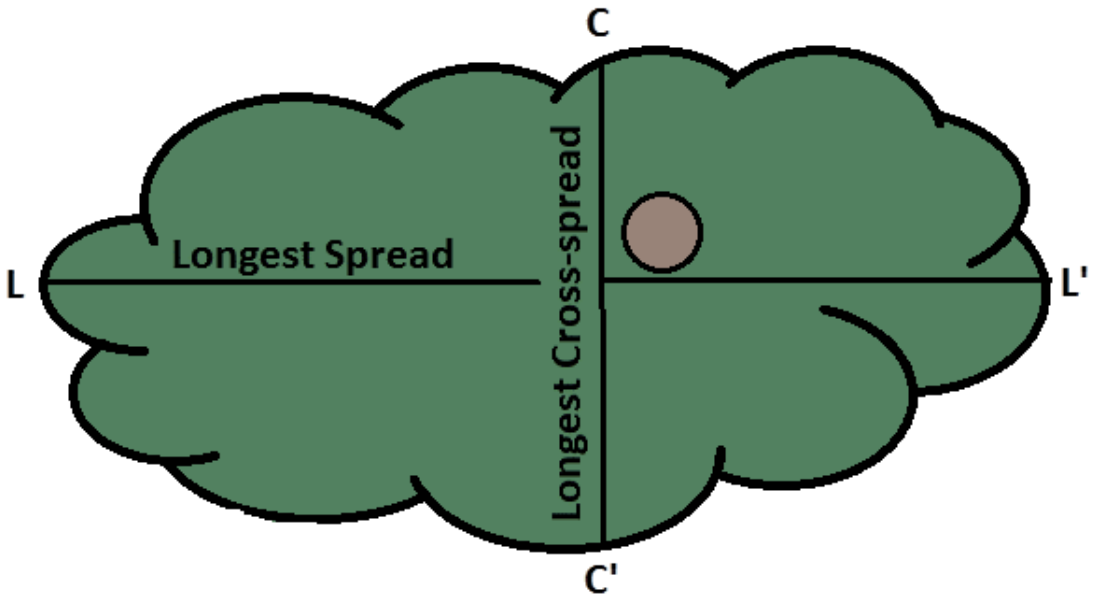
There are basic rules for measuring of cross section thickness for all types of calipers. It is important to keep all the measurements dome at the correct height on the trunk. The height of DBH is set as 1,3 meters above the tree butt in a parallel direction with the axis of trunk. (Picture 5.) Simultaneously it is important to place the caliper in a perpendicular way to the axis of the tree trunk. Important rule while using caliper is that during measurement should caliper touch the trunk in three points (both arms and the scale) to avoid inaccuracies caused by deflection of caliper from the perpendicular angle (Kuželka et al., 2014).



Picture 5. - Principles of tree height measurement.

4.4 Tree crown diameter measurement

Average crown spread or crown diameter is obtained by measuring the longest and shortest extent of the crown and averaging these two figures. Crown diameter is measured independent of position of the trunk. We measure the diameter between the tips of two opposite branches and trying to avoid “notches” in the tree crown. We are trying to keep the ninety-degree angle, to have these two measurements perpendicular to each other (Bolzan, 2004).



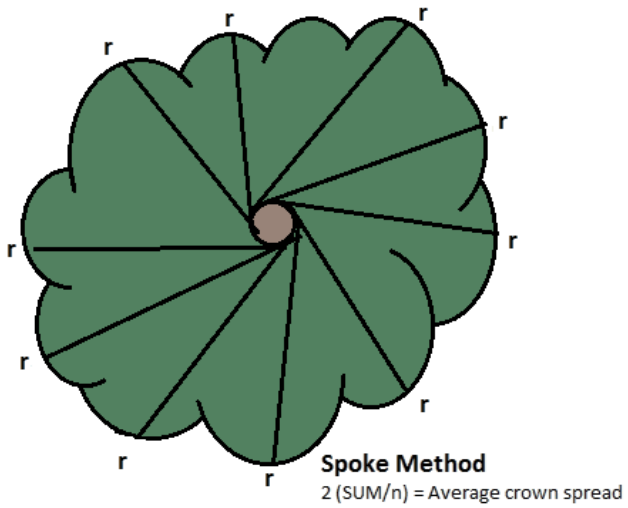
Picture 6. - Measuring of crown spread.

Average crown spread= (longest + shortest)/2

During the measurements on a slopes steeper than 15 degrees, it is important to remember that this steepness must be considered. To avoid inaccuracy during measurement we have to take the cosine function of the angle of slope in degrees and multiply it by the slope distance (Bolzan, 2004).

Another method how to measure diameter of tree crown is the “Spoke Method”. There are taken several measurements (ten or more) from the middle of the trunk to the edge of tree crown. This method is preferred by canopy researchers and seems to be most accurate, on the other hand is very time demanding (Bolzan, 2004).

2 (SUM/n) = Average crown spread



Picture 7. - Spoke method.

4.5 Tree age estimation

Trees in gardens or parks are often pampered and protected and often it is more of an art to estimate the age of these trees without significant error.

Tree age can be easily determined by using two invasive ways, first one is to cut the tree followed by counting of annual rings on the stump. This method has one essential disadvantage – in our case (during estimation in gardens) is inapplicable. Only in case we found stump of tree that was cut down by owner of garden and there is high possibility that neighbouring tree was planted in the same time – we can estimate the age of standing tree quite accurately. The second invasive method is to use auger. Drill the auger into the centre of trunk, pull it out and count annual rings. This method is significantly less destructive, but there is still some chance that we can damage the tree.

There can be found some non-invasive tree age estimation methods. For instance tree age estimation based on trunk diameter – easiest method based clearly on trunk diameter (Jura, 2001). Decisive value is average annual ring width of given tree specie recorded in table (Chart1). Tree age is calculated by formula:

$$V = (5/[\pi \times d]) \times R_L$$

(where d = diameter, R_L = annual ring width).

Chart 1. – example of values used for calculation. Data from Kolařík, 2005

Taxon	from mm	to mm	average mm
Abies alba	1,33	2,87	2,10
Acer campestre	2,37	2,90	2,635
Acer platanoides	2,92	3,00	2,96
Acer pseudoplatanus	1,56	2,85	2,205
Betula pendula	2,46	4,43	3,445
Carpinus betulus	1,17	3,18	2,175
Fagus sylvatica	1,69	3,79	2,74
Picea abies	1,65	3,13	7,00
Quercus petraea	2,38	2,92	2,65
Quercus robur	2,17	4,06	3,115
Salix alba	4,54	6,47	5,505
Tilia cordata	2,68	3,64	3,16

Tree age estimation using curve of growth model – For age estimation of solitaire trees were developed curves of growth models, that allows us to estimate age of most common tree species growing in our conditions based on trunk diameter. This method is more precise because it respects different dynamics of annual rings growth during the life of tree. This method was developed for purposes of programme Virdis. Background for construction of these growth curves were results of empiric measurements publicated in dendrological literature (Kavka, 1968, 1969, 1974) supplemented by own measurements (Kolařík et al. 2005).

$$V = B2 \times (d / [B1 \times d])^{(1 / B3)}$$

(d = trunk diameter, parameters B1, B2, B3 in figure 4.5.2.)

Chart 2. – example of parameters used for calculation. Data form Kolařík, 2005.

Taxon	B1 (mm)	B2 (mm)	B3 (mm)
Abies alba	0,748450	47,09700	2,666400
Abies cephalonica	0,838747	49,48101	1,963999
Abies nordmanniana	1,133059	93,26323	1,429299
Acer campestre	0,685803	61,04789	1,469931
Acer negundo	1,031410	82,97321	1,466120
Acer platanoides	1,411762	117,7541	1,391022
Acer pseudoplatanus	1,042161	67,86073	1,597655
Acer saccharinum	1,444541	103,9619	1,486177
Aesculus hippocastanum	1,049695	60,69151	1,669193
Ailanthus altissima	1,028838	47,65854	1,762070
Alnus glutinosa	1,121101	87,43639	1,029668
Betula papyrifera	0,848811	64,03297	1,080148

Age estimation of woody species recorded during field work in Vimperk was based on three basic aspects:

1) Interview with the owner of the garden
2) The age of the property
3) Qualified estimation taking into account site conditions such as slope orientation, access of sunlight, water regime, supported by dendrological knowledge about woody species gained during my studies at CULS.

4.6 Tree health condition and care

4.6.1 Tree health condition

The value of health condition reflects the stage of mechanical damage and weakness of individual woody species. The woody species are rated according to the level

of mechanical damage, level of colonization by wood-decaying fungus, existence of cavities and growth deformations (Kolařík et al.,2003).

Used scale:

1 perfect health condition

2 good condition (moderate defects without any influence on stability of supportive elements)

3 worsened (disruption of tree character, often requires a stabilizing intervention)

4 significantly worsened (concurrence of defects or damages decreasing perspective of rated individual, requires a stabilizing intervention)

5 strongly disturbed (without chance for stabilizing, significantly shortened perspective) / dead individual

4.6.2 Care

The care of given individual was recorded in the form, based on observation and consultation with owners of garden.

Shortcuts used in form have following meaning:

0 Individual left without any intervention

K Individual was intentionally trimmed or cut, to keep bush-like habitus

P Individual ensured by supportive pole to avoid damage or break caused by strong gust of wind or strong snow cover.

R The branches were intentionally and regularly trimmed for a purpose of aesthetical shaping of individual or removed in the bottom part of trunk for a purpose of spatial arrangement in the garden.

R R Irregular strong intervention for a purpose of dramatical reduction of growth possibilities of individual woody species.

4.7 Equipment used

4.7.1 Rage-finder TruPulse 200B

Small laser range-finder, that can measure oblique distances, horizontal and vertical distances and inclination. With these data, rage-finder can solve basic geodetic tasks. Connected to GPS transceiver, can be directly determined coordinates of focused point. Rage-finder transmits resulting values using serial port or Bluetooth.

Could be elegantly connected (as a external sensor via Bluetooth) to Trimble devices and field software Trimble TerraSync.

Professional laser range-finder measures:

- Horizontal distances
- Vertical distances
- Inclinations
- Absolute distances

Picture 8. – Laser Rage-finder Tru Pulse 200B.

4.7.2 Dural caliper Kinex 50cm

Very light dural caliper of proven construction. The scale is in centimeters and is embossed into the material. Caliper is suitable for common use. Caliper is easy to manipulate with. The arm slides easily and holds tightly at the set value. Values on caliper are easy readable even after long term use and thanks to embossing (not only paint) they stay readable for whole material life.

Picture 9. – Dural caliper Kinex 50cm.

4.7.3 Measuring tape Richter – BM 2,5

Textile tape that measures circumference and diameter of tree trunk at once.
Used for more accurate measurements and trunks with big diameters which can not be measured by caliper.

Measuring range:

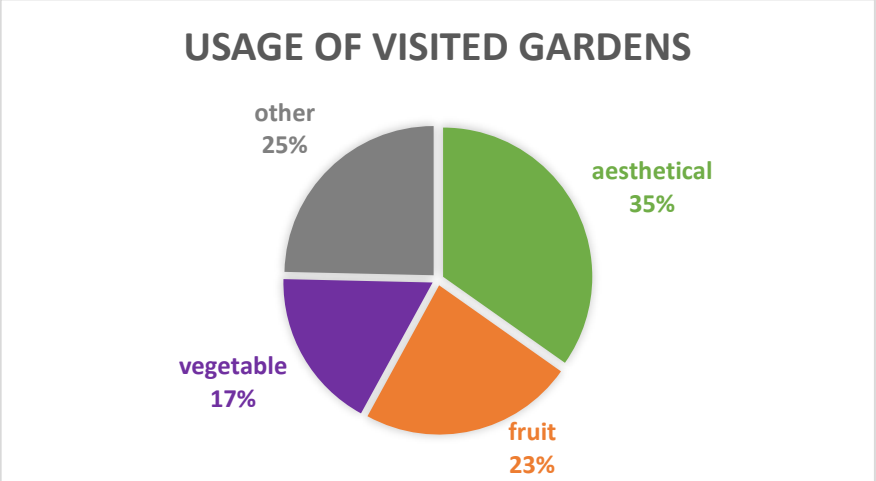
- circumference 10 - 800 cm
- diameter 5 - 255 cm.

Picture 10. – Measuring tape Richter – BM 2,5

5 RESULTS

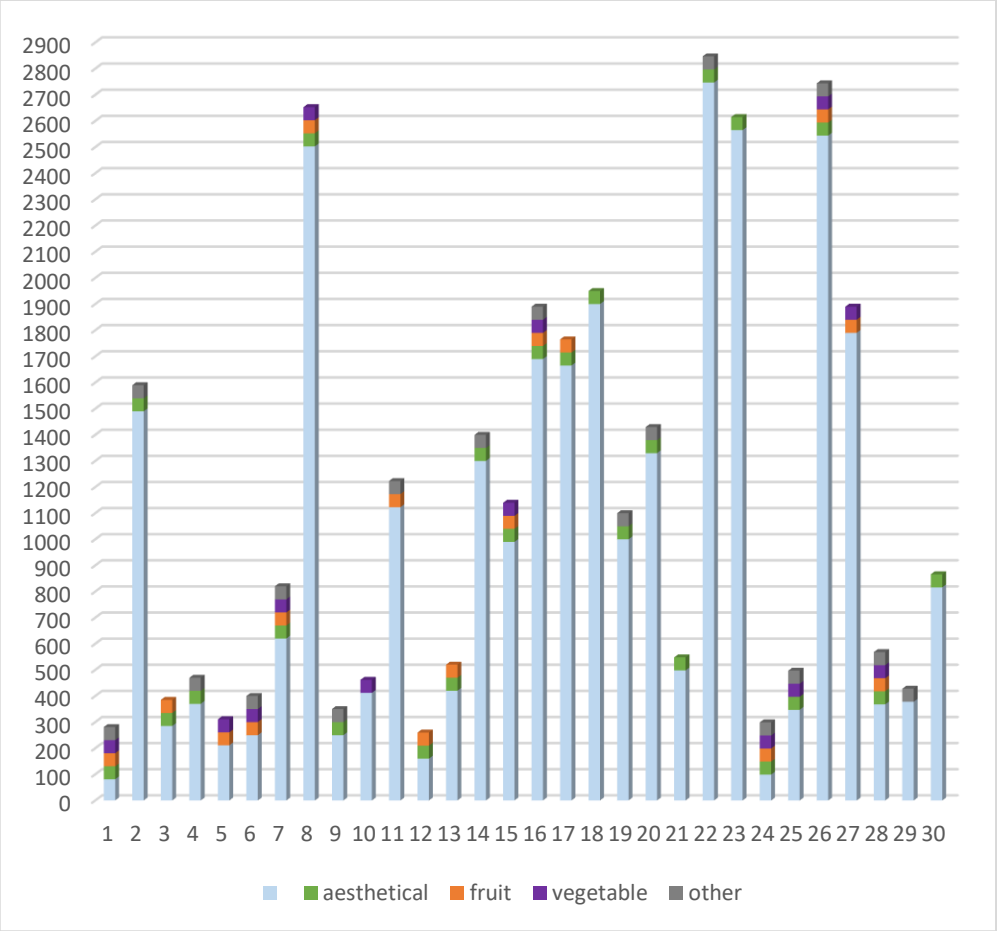
On first chart we can see usage of gardens expressed in percentage. Four basic groups were set: Fruit, Aesthetical, Vegetable (kitchen garden) and Other. The owners of gardens were questioned during visits, how they perceive the purpose of their gardens? Most of interviewed owners used more than one group, to describe their garden. Prevailing answer of gardens owners was “aesthetical” (35%) and “other” (25% - i.e. as a place where owners can store pulp wood, or the garden serves as an enclosure for domesticated animals) followed by perceiving their garden as a source of fruit (23%).

Chart 3. – The usage of visited gardens.



On diagram (Chart 4.) is displayed usage of individual gardens represented by colored blocks according to their acreage [m^2].

Chart 4. – The usage of individual gardens.



On following diagram is expressed the ratio between total area with vegetation and built-up area on the gardens. This relationship is expressed both in percent and in acreage [m^2]. On the chart is clearly visible that area covered with vegetation is strongly prevailing (82% / 34 002m^2 out of 41 441m^2).

Chart 5. – The vegetation/built-up ratio

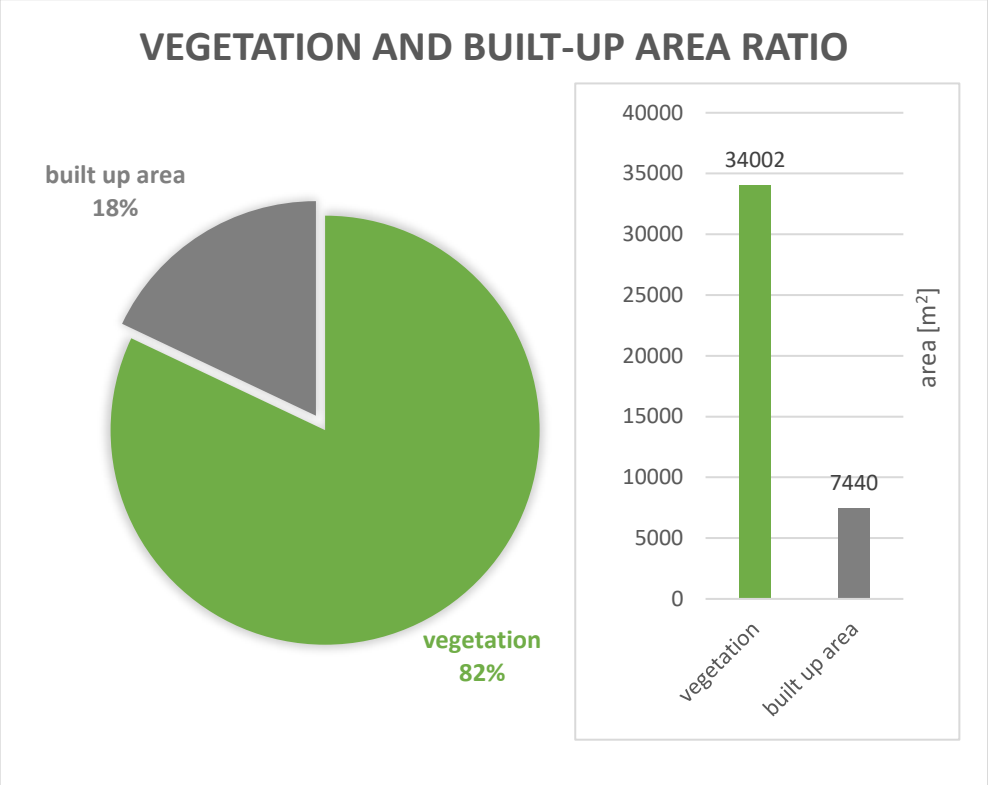
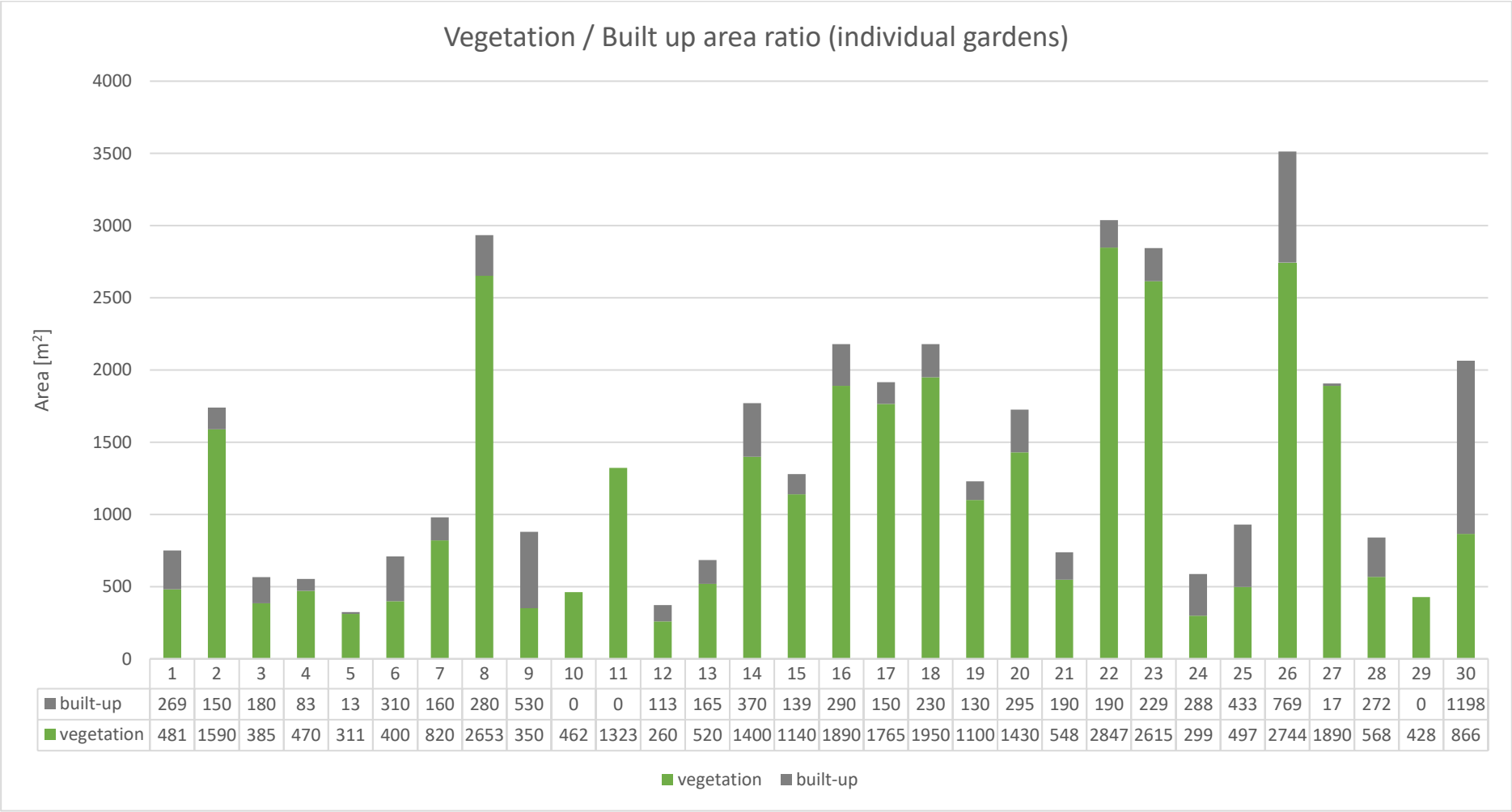


Chart 6. - The ratio between area covered by vegetation and built-up area on individual gardens.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
built-up	269	150	180	83	13	310	160	280	530	0	0	113	165	370	139	290	150	230	130	295	190	190	229	288	433	769	17	272	0	1198
vegetation	481	1590	385	470	311	400	820	2653	350	462	1323	260	520	1400	1140	1890	1765	1950	1100	1430	548	2847	2615	299	497	2744	1890	568	428	866

On chart (Chart 7.) is expressed representation of individual health values (described in chapter 4.6.1. Tree health condition), for all recorded woody species individuals. Care and active attitude of most of the owners is reflected in very good condition of woody species individuals.

Chart 7. – health condition

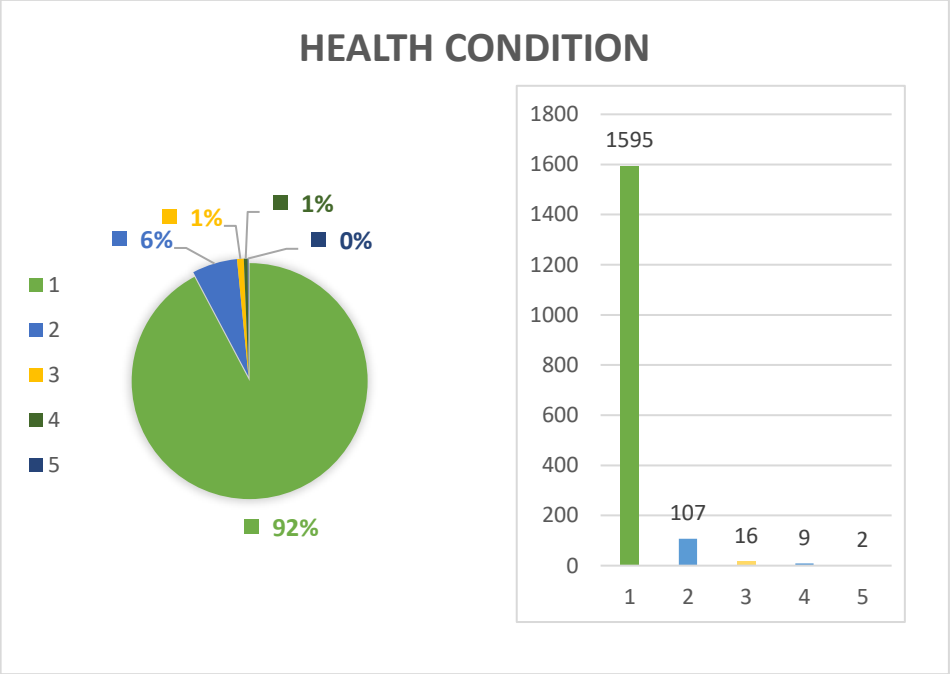
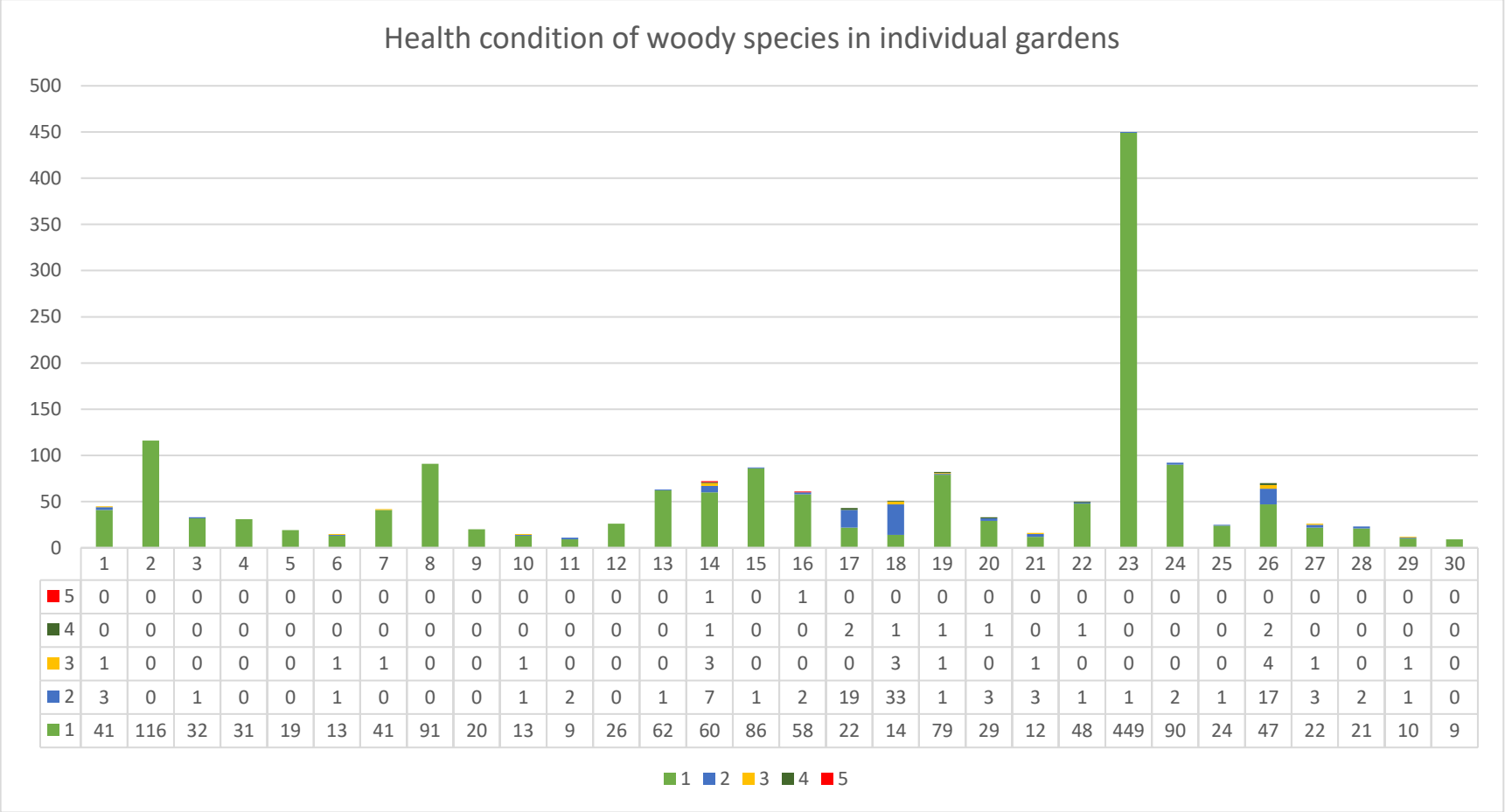
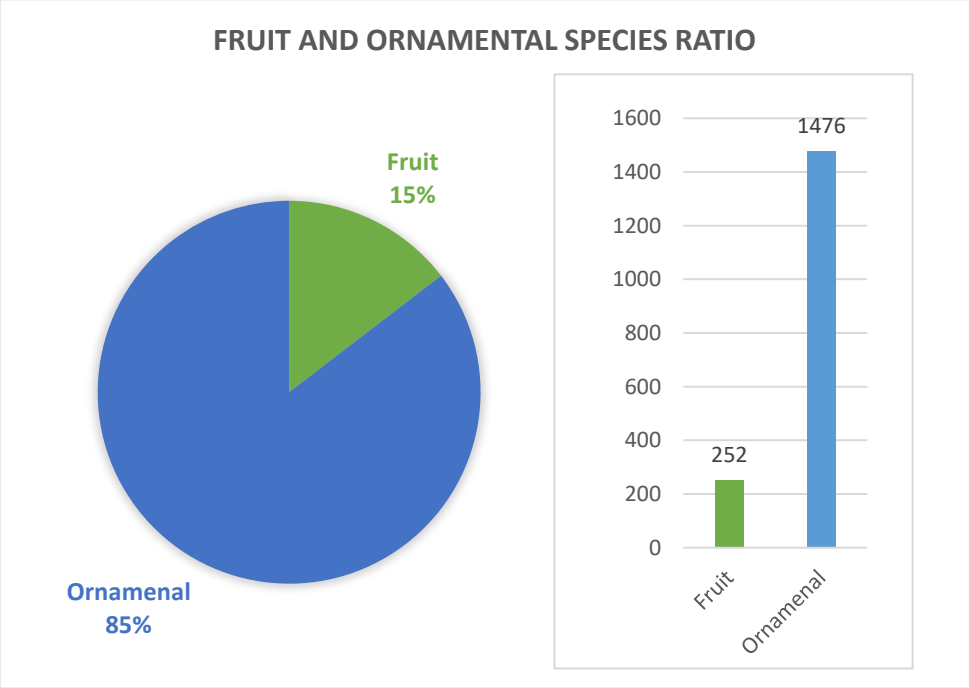


Chart 8. – The health condition on individual gardens



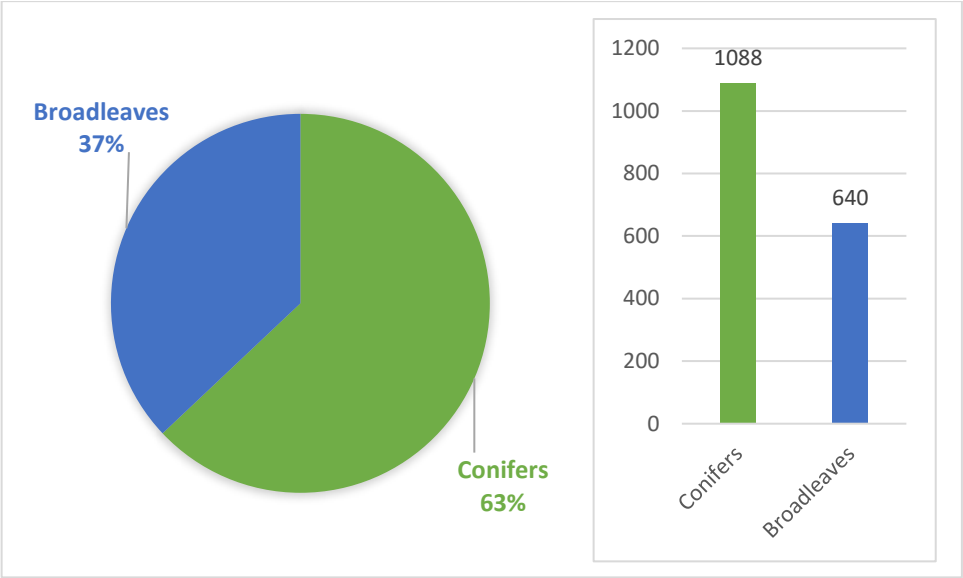
Fruit / ornamental species ration represented in chart (Chart 9.) displays strong predominance of ornamental woody species (85%) on given locality. This fact is caused by climatic conditions of the site which are not ideal for growing fruit species, and significant amount of *Chamaecyparis* and *Thuja* genus used often as hedges.

Chart 9. – The ratio between fruit and ornamental species



Following scheme shows the representation ratio of broadleaves and coniferous woody species recorded in visited gardens.

Chart 10. – Share of coniferous and broadleaves on gardens



On chart (Chart 11.) is visualised how owners cares about greenery on their garden. Five ways of care are described in chapter 4.6.2 . Prevailing label “R” is standing for regular trimming and cutting of species for shaping purposes or cutting of branches to get more aesthetical spatial impression of garden. Individuals marked as “0” don’t show any marks of intervention. Third category is “RR” which represents individuals reporting strong irregular intervention for a purpose of dramatical reduction of growth. Followed by category “P” standing for individuals ensured by supportive pole to avoid damage or break caused by strong gust of wind or strong snow cover. The least represented category is “K” – intensive effort to trim the specie to keep bush-like habitus.

Chart 11. – Care of all woody species individuals

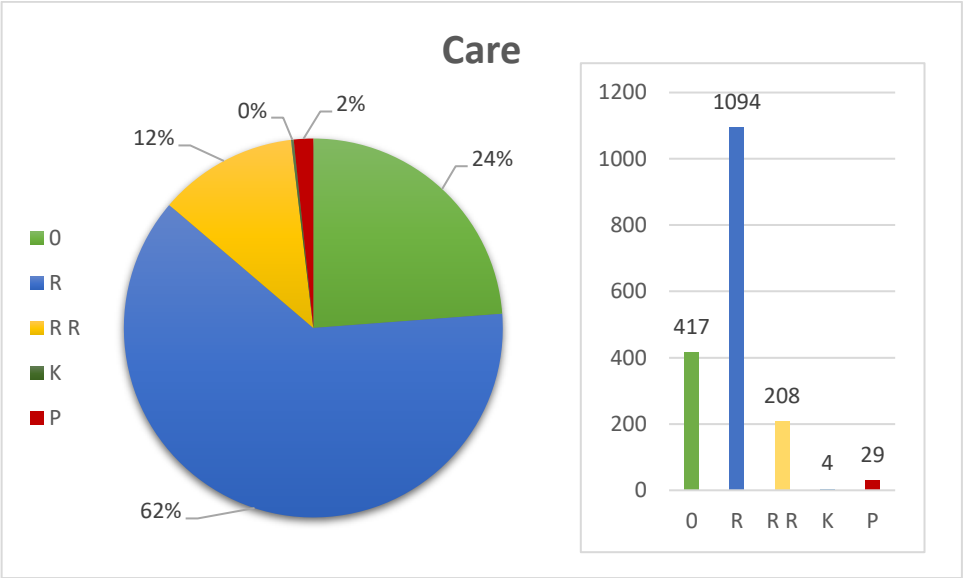
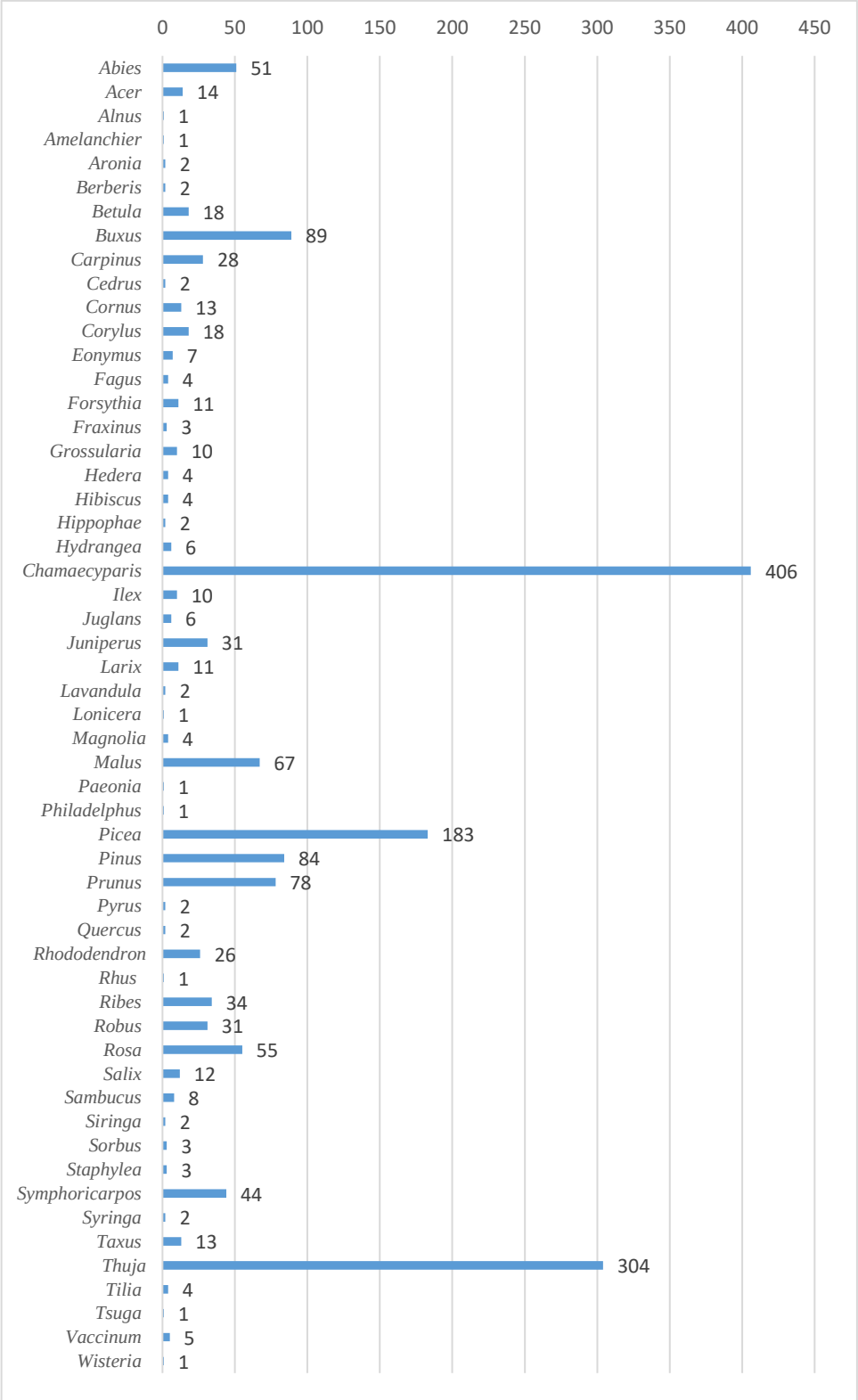


Diagram (Chart 12.) is describing representation of all woody genus recorded.

Chart 12. – The genus representation on gardens



6 DISCUSSION

In thesis are evaluated data about woody species observed on 30 gardens on the site of Vimperk town. Taxa of 1729 woody individuals were determined (in 138 cases up to the level of cultivar). Basic dendrometric characteristics (Tree height, Diameter of trunk, Diameter of crown) were measured and for every woody species was estimated the age of individual and evaluated care on given individual. Owners of gardens were interwieved during measurements for purpose of gathering data about their perception of garden and the history of specific garden environment. All the data were recorded into working sheet and subsequently processed in computer software MS Excel to obtain statistical outputs.

Average acreage of properties on site is 1382 m^2 – average area covered by vegetation is 1133 m^2 and average built-up area 248m^2. In study done in Great Britain was recorded that average acreage of garden is 190m^2 (Davies et al., 2009). The fact that average acreage is in our case much higher is caused by high representation of small city gardens - mainly gardens connected to terraced houses, which are very frequent in suburbs and town areas in Great Britain and a facts presented by United Nations (2018) that population density of United Kingdom (273,6 persons/km^2) is twice as high as population density of Czech Republic (137,5 persons/km^2).

Purpose of visited gardens is perceived by the owners as follows: 35% Aesthetical garden, 25% Other use, 23% Fruit garden, 17% Vegetable/Kitchen garden.

Aesthetical purpose of gardens was recorded in 24 cases. This is fact supported by composition of woody species on garden (85% of all woody species are ornamental), two most frequent species were *Chamaecypars lawsoniana* and *Thuja occidentalis* which are suitable to create hedges separating gardens from surrounding environment and offering privacy to owners (Šonský, 1999).

Term “Other use” stands for way of usage of the garden as a space for storage of construction material, pulp wood or as a enclosure for pets.

18 out of 30 owners perceives their garden partly as a Fruit garden or Vegetable garden – In other words - as a source of food. Usage of garden area as a small agricultural land is by them considered as a welcomed opportunity for production of own vegetables and fruit. Especially nowadays when trend of BIO-food is getting more important for many people, they can have total control about usage of pesticides and other artificial substances in process of growing their own food. This finding refers to statistical

conclusion processed by Ing. Hrabalová (2012) and her study dealing with ecological agriculture. Motivation can be found also in economic reasons.

Relatively low percentage of representation of fruit tree species (15%) can be caused by prevailing natural conditions on the site. This could change in future due to global warming and increasing of annual temperatures (Houghton, 1998). In my opinion we will be witnessing increase of fruit tree species in future according to increasing interest of public in production of own food and moderate decrease of numbers of coniferous species demanding frequent maintenance (especially hedges).

Sufficient care given to woody species on visited gardens corresponds with very good health condition of most of individuals on site (92% of all woody species shows perfect condition). This fact is connected to representative function of garden. Gardens often reflects owner's way of life and attitude to nature (Brookes, 1994). Majority of gardens is managed by their owners, only in two cases are involved specialised companies taking care of greenery.

The age of gardens differs a lot. It is given by fact that newest of visited gardens were established less than 10 years ago, on the other hand, gardens situated in old historical centre of town fulfils their functions for several centuries - oldest gardens were established in middle of 14th century (Čepička, 2018).

Maps contained in attachments were processed using ArcGIS 10.4 software.

Results of this thesis can be used as a source of information for comprehensive study evaluating woody species composition on gardens in wider scale. This thesis can serve as a blueprint for repetition of measurements within several years or decades to get closer view on development of woody species composition on the site of Vimperk, changing trends in gardening or influence of owners needs reflected in state of gardens. Growth increment of recorded woody species on selected gardens can be analysed and evaluated in future according to growth affecting factors on gardens (such as water regime on gardens, soil type, orientation of garden to the world sides, amount of solar irradiation, etc.)

7 CONCLUSION

In my diploma thesis called Woody species composition of gardens on the site of Vimperk, I was dealing with valorization and inventarization of woody species in selected gardens and their subsequent evaluation. Reached data were synoptically edited into tables and charts. From data outputs is obvious prevailing supermancy of ornamental species over fruit species. The most occurred ornamental specie was *Chamaecyparis lawsoniana* and most occurred fruit specie was *Malus domestica*. From obtained data is evident that majority of woody individuals is in very good health condition and gets sufficient care. Total average area of explored gardens is 1382 m^2 on which greenery represents 82% and built-up area 18%. Most frequent way of use of the gardens is to fulfil aesthetical purposes. This thesis in trying to help introduce perception on view of woody species composition on private gardens in towns situated in higher elevations of Czech Republic and could serve as a source of information during planning of public greenery, requests of subsidies on woody species maintenance or requests of cuttings of woody species.

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9 LIST OF ATTACHMENTS

1) Overviews of individual gardens
2) List of gardens and their characteristics (Excel chart)
3) List of woody species representation and their characteristics on individual gardens (Excel chart)
4) Thematical maps

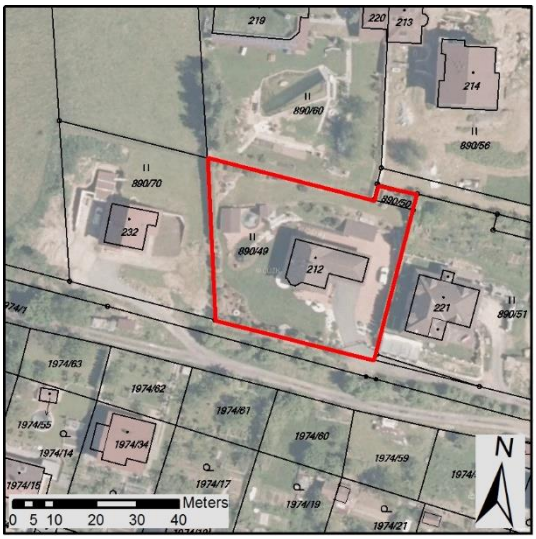
10 ATTACHMENTS

Garden #1

Garden area:	481m^2
Built-up area:	269m^2
Altitude:	679 m a.s.l.
Usage:	Fruit garden, Aesthetic garden Vegetable garden Other purpose
Orientation:	Flat terrain
Maintenance:	self-care
History:	based in 18th century
Characteristics:	Garden connected to family house used mainly for production of fruit and vegetables and relaxation by river.

Woody species recorded:	45 individuals	(14 species)
Most frequent specie:	*Ribes rubrum*	(9 individuals)

Garden #2



Garden area: 1590m^2

Built-up area: 150m^2

Altitude: 722 m a.s.l.

Usage: Aesthetic garden
Other purpose

Orientation: Southwest slope

Maintenance: self-care

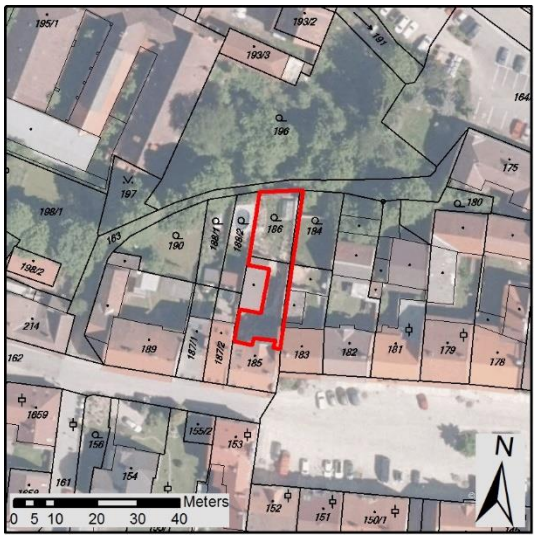
History: based in 2003

Characteristics: Family house garden, very carefully managed, used for relaxation of family members .

Woody species recorded: 116 individuals (21 species)

Most frequent specie: *Thuja occidentalis* (54 individuals)

Garden #3



Garden area: 385m^2

Built-up area: 180m^2

Altitude: 712 m a.s.l.

Usage: Fruit garden,
Aesthetic garden

Orientation: Northeast slope

Maintenance: self-care

History: based in 1907

Characteristics: Garden connected to historic family house on town square, used for growing herbs, fruit and for relaxation.

Woody species recorded: 34 individuals (23 species)

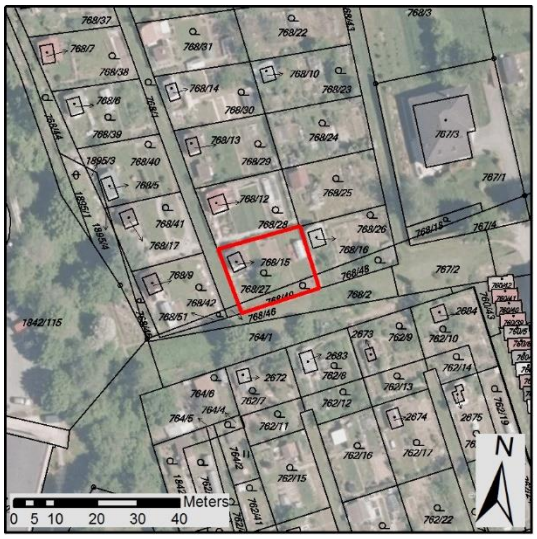
Most frequent specie: *Hydrangea paniculate* (6 individuals)

Garden #4

Garden area:	470m^2
Built-up area:	83m^2
Altitude:	685 m a.s.l.
Usage:	Fruit garden, Aesthetic garden
Orientation:	Southwest slope
Maintenance:	self-care
History:	based in 1975
Characteristics:	Garden connected to terraced family house used mainly for recreation of family members and friends.

Woody species recorded:	31 individuals	(10 species)
Most frequent specie:	*Ribes rubrum*	(9 individuals)

Garden #5



Garden area: 311m^2

Built-up area: 13m^2

Altitude: 685 m a.s.l.

Usage: Fruit garden,
Vegetable garden

Orientation: East/Northeast slope

Maintenance: self-care

History: based in 1980s

Characteristics: Garden situated in gardening colony - visited during weekend, used mainly for production of vegetable and fruit.

Woody species recorded: 19 individuals (8 species)

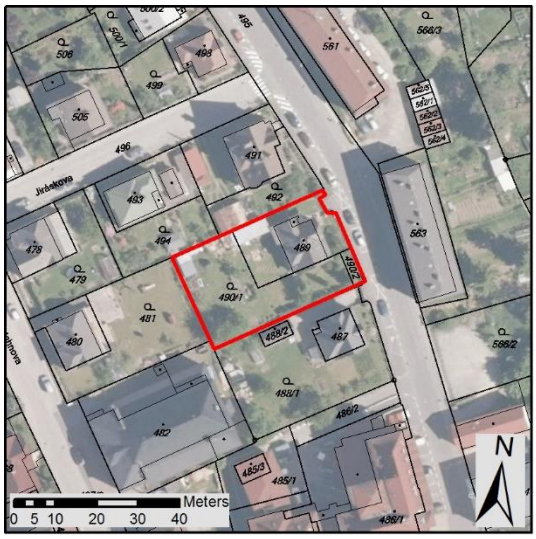
Most frequent specie: *Thuja plicata* (6 individuals)

Garden #6

Garden area:	400m^2
Built-up area:	300m^2
Altitude:	694 m a.s.l.
Usage:	Fruit garden, Aesthetic garden, Other use
Orientation:	South slope
Maintenance:	self-care
History:	based in 14th century
Characteristics:	Garden connected to old family house on town square used for growing of fruit, relaxation and storage of mainly construction material.

Woody species recorded:	15 individuals	(10 species)
Most frequent specie:	*Rosa canina*	(4 individuals)

Garden #7

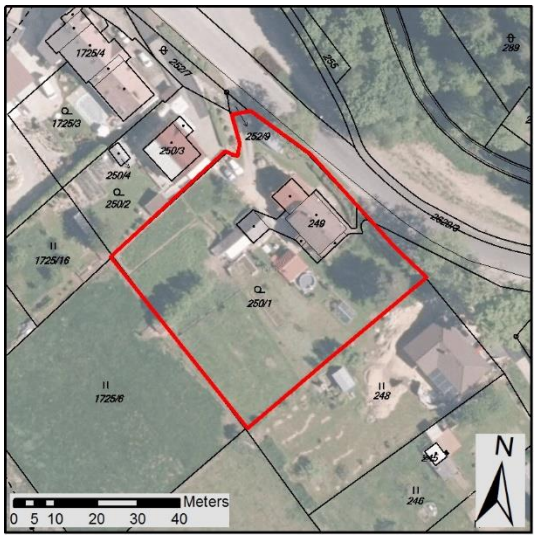


Garden area:	820m^2
Built-up area:	160m^2
Altitude:	680 m a.s.l.
Usage:	Fruit garden, Aesthetic garden, Vegetable garden, Other use
Orientation:	East/Northeast slope
Maintenance:	self-care
History:	based in 1950s
Characteristics:	Garden connected to family house used mainly for recreation of family members and growing of food.

Woody species recorded: 42 individuals (13 species)

Most frequent specie: *Chamaecyparis lwasoniana* (22 individuals)

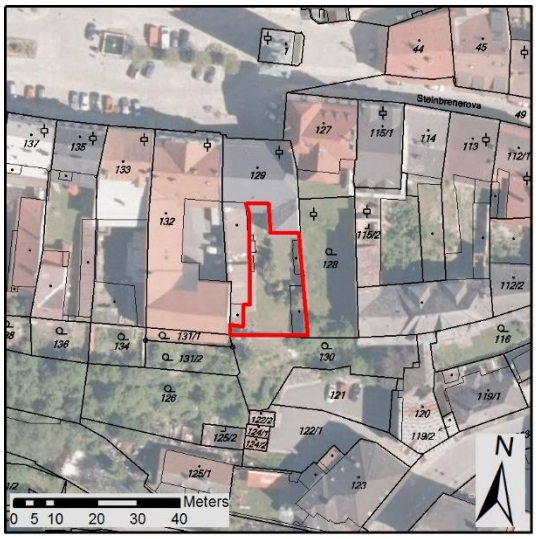
Garden #8



Garden area:	2653m^2
Built-up area:	280m^2
Altitude:	738 m a.s.l.
Usage:	Fruit garden, Aesthetic garden, Vegetable garden
Orientation:	Northeast slope
Maintenance:	self-care
History:	based in 1928
Characteristics:	Garden connected to two generation family house used for recreation of family members and growing of food.

Woody species recorded:	91 individuals	(20 species)
Most frequent specie:	*Robus ideaus*	(31 individuals)

Garden #9



Garden area: 350m^2

Built-up area: 530m^2

Altitude: 692 m a.s.l.

Usage: Aesthetic garden,
Other use

Orientation: South slope

Maintenance: self-care

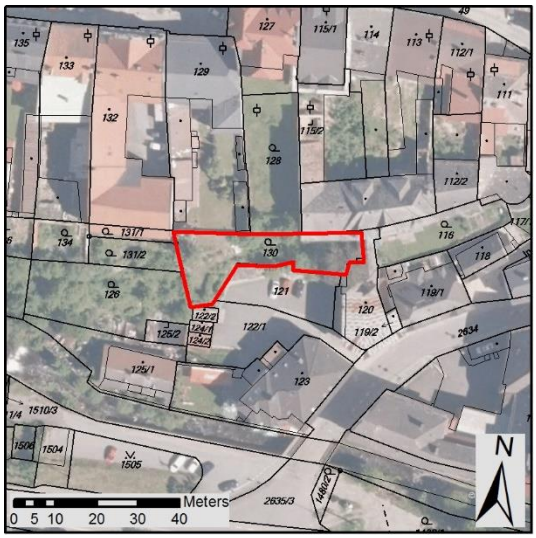
History: based in 14th century

Characteristics: Garden connected to old family house on town square.
used for recreation of family members

Woody species recorded: 20 individuals (8 species)

Most frequent specie: *Chamaecyparis lawsoniana* (9 individuals)

Garden #10



Garden area: 462m^2

Built-up area: 0m^2

Altitude: 690 m a.s.l.

Usage: Vegetable garden

Orientation: South slope

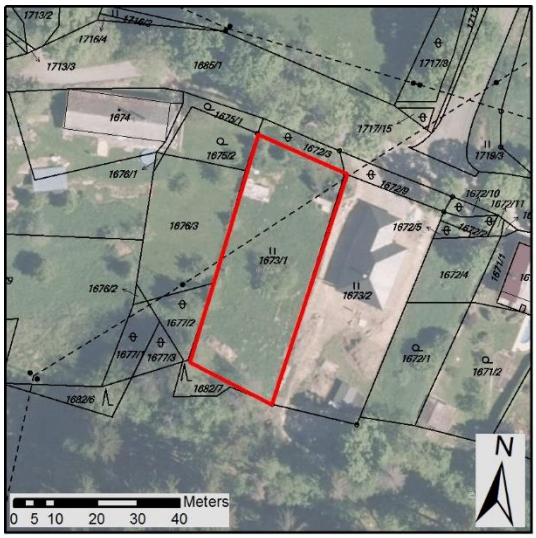
Maintenance: self-care

History: based in 14th century

Characteristics: Garden on steep slope, historically used as a part of town fortification. Nowadays used mainly for production of vegetables.

Woody species recorded:	15 individuals	(7 species)
Most frequent specie:	*Picea abies*	(8 individuals)

Garden #11



Garden area: 1323m^2

Built-up area: 0m^2

Altitude: 753 m a.s.l.

Usage: Fruit garden,
Other use

Orientation: East/southeast slope

Maintenance: self-care

History: based in 1970s

Characteristics: Property is originally building plot, but nowadays is used as small orchard.

Woody species recorded: 11 individuals (4 species)

Most frequent specie: *Malus domestica 'Spartan'* (4 individuals)

Garden #12

Garden area: 260m^2

Built-up area: 113m^2

Altitude: 740 m a.s.l.

Usage: Fruit garden,
Aesthetic garden

Orientation: Southwest slope

Maintenance: self-care

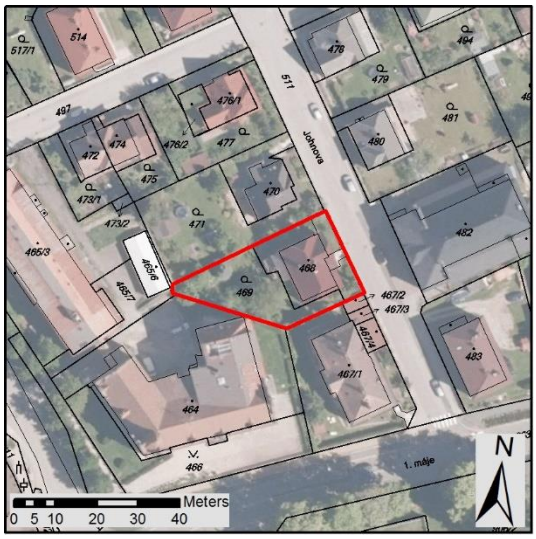
History: based in 1994

Characteristics: Garden connected to family house
used mainly for recreation of family members.

Woody species recorded: 26 individuals (13 species)

Most frequent specie: *Chamaecyparis lawsoniana* (6 individuals)

Garden #13



Garden area: 520m^2

Built-up area: 165m^2

Altitude: 686 m a.s.l.

Usage: Fruit garden,
Aesthetic garden

Orientation: East/northeast slope

Maintenance: self-care

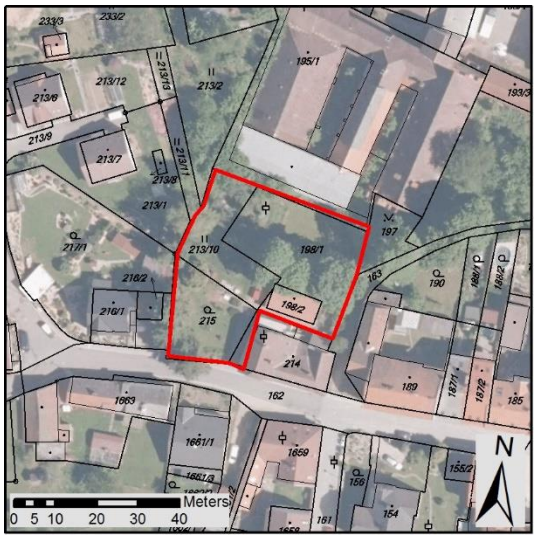
History: based in 1950s

Characteristics: Garden connected to family house
used mainly for relaxation of family members.

Woody species recorded: 63 individuals (16 species)

Most frequent specie: *Buxus sempervirens* (18 individuals)

Garden #14



Garden area:	1400m^2
Built-up area:	370m^2
Altitude:	720 m a.s.l.
Usage:	Aesthetic garden, Other use
Orientation:	Northern slope
Maintenance:	self-care
History:	based in 1908
Characteristics:	Garden connected to family house used mainly for recreation of family.

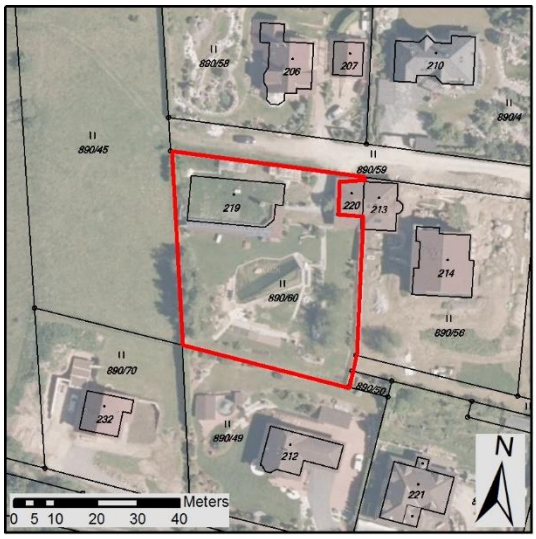
Woody species recorded:	72 individuals	(22 species)
Most frequent specie:	*Picea pungens*	(12 individuals)

Garden #15

Garden area:	1140m^2
Built-up area:	139m^2
Altitude:	731 m a.s.l.
Usage:	Fruit garden, Aesthetic garden, Vegetable garden
Orientation:	Eastern slope
Maintenance:	self-care
History:	based in 2010
Characteristics:	Garden connected to family house used mainly for recreation of family and friends.

Woody species recorded:	87 individuals	(17 species)
Most frequent specie:	*Carpinus betulus*	(20 individuals)

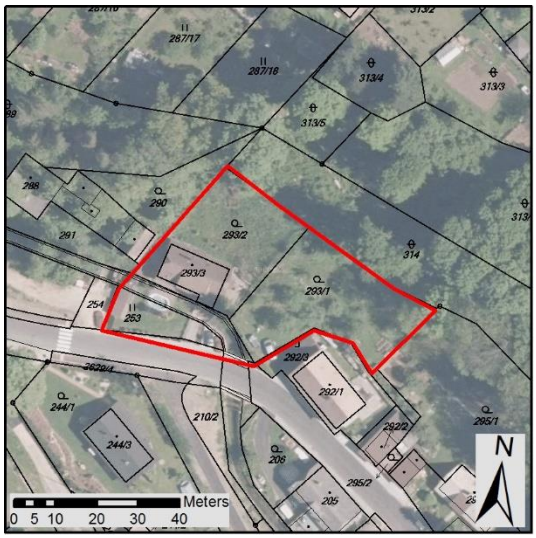
Garden #16



Garden area:	1890m^2
Built-up area:	290m^2
Altitude:	725 m a.s.l.
Usage:	Fruit garden, Aesthetic garden, Vegetable garden, Other use
Orientation:	Southern slope
Maintenance:	self-care
History:	based in 2006
Characteristics:	Terraced garden with small pond connected to terraced family house. Garden is used mainly for recreation of family members and friends.

Woody species recorded:	61 individuals	(24 species)
Most frequent specie:	*Pinus nigra*	(9 individuals)

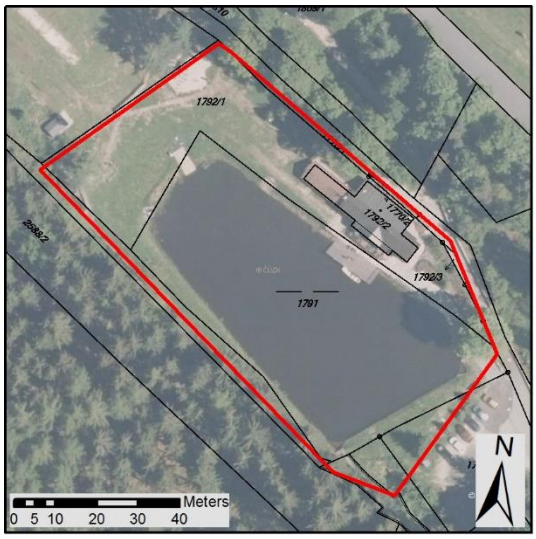
Garden #17



Garden area:	1765m^2
Built-up area:	150m^2
Altitude:	723 m a.s.l.
Usage:	Fruit garden, Aesthetic garden
Orientation:	Southwest slope
Maintenance:	self-care
History:	house built in 2004, garden is aprox. 70y.o.
Characteristics:	Steep garden connected to family house used mainly for recreation of family members and production of food.

Woody species recorded:	44 individuals	(11 species)
Most frequent specie:	*Thuja occidentalis*	(18 individuals)

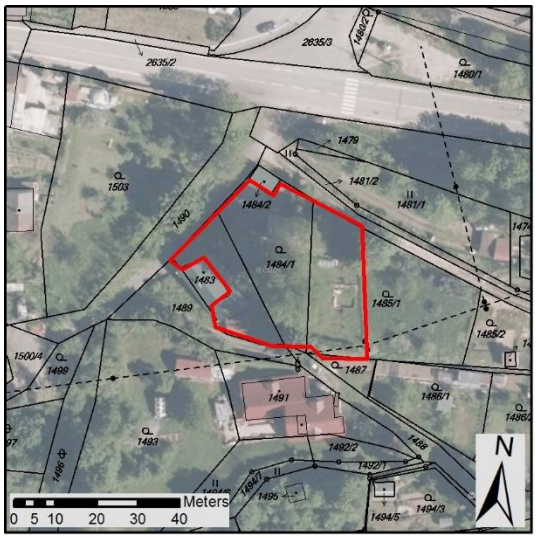
Garden #18



Garden area:	1950m^2
Built-up area:	230m^2
Altitude:	754 m a.s.l.
Usage:	Aesthetic garden
Orientation:	Flat terrain
Maintenance:	self-care
History:	based in 1908
Characteristics:	Landscape garden surrounding water reservoir connected to house, that serves nowadays as a restaurant. Garden is used mainly for relaxation of visitors.

Woody species recorded:	49 individuals	(12 species)
Most frequent specie:	*Picea abies*	(30 individuals)

Garden #19



Garden area: 1100m^2

Built-up area: 130m^2

Altitude: 692 m a.s.l.

Usage: Aesthetic garden,
Other use

Orientation: Northern slope

Maintenance: self-care

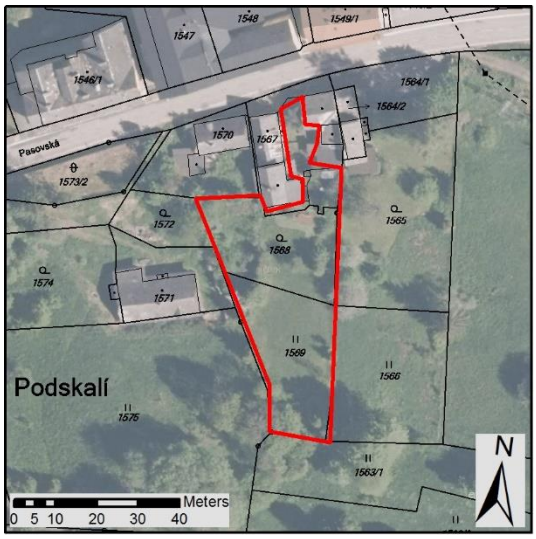
History: based in 18th century

Characteristics: Garden connected to family house
used mainly for recreation.

Woody species recorded: 82 individuals (18 species)

Most frequent specie: *Picea abies* (28 individuals)

Garden #20



Garden area:	1430m^2
Built-up area:	295m^2
Altitude:	699 m a.s.l.
Usage:	Aesthetic garden, Other purpose
Orientation:	Northern slope
Maintenance:	self-care
History:	based in 18th century
Characteristics:	Garden connected to family house used historically as a orchard, but most of the fruit trees were cutted down.

Woody species recorded:	33 individuals	(17 species)
Most frequent specie:	*Picea abies*	(13 individuals)

Garden #21

Garden area: 548m^2

Built-up area: 190m^2

Altitude: 720 m a.s.l.

Usage: Aesthetic garden

Orientation: Eastern slope

Maintenance: self-care

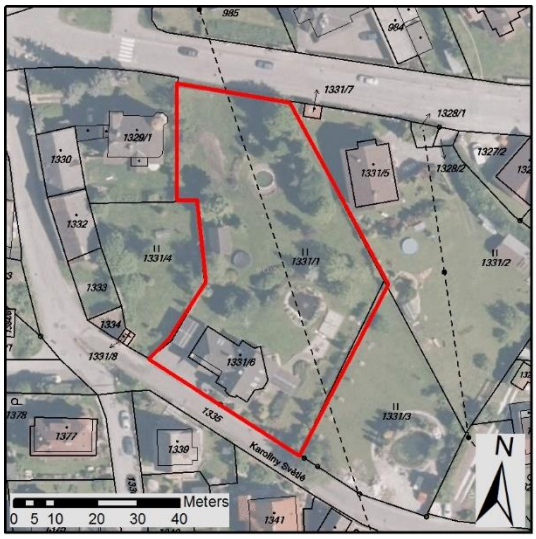
History: based in 1907

Characteristics: Garden connected to family house fulfilling aesthetical function.

Woody species recorded: 16 individuals (10 species)

Most frequent specie: *Thuja occidentalis* (4 individuals)

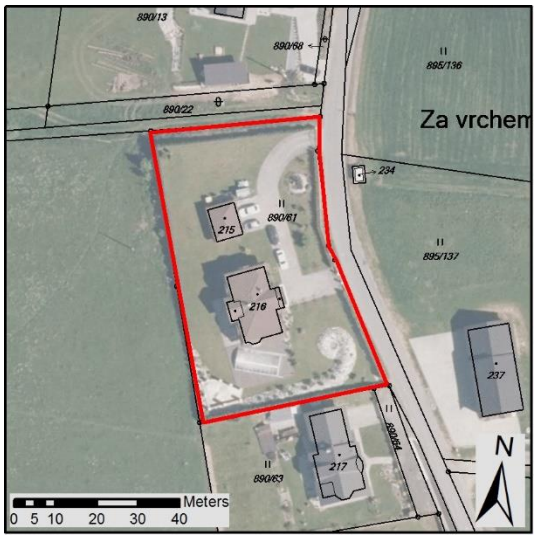
Garden #22



Garden area:	2847m^2
Built-up area:	190m^2
Altitude:	681 m a.s.l.
Usage:	Aesthetic garden, Other use
Orientation:	Northern slope
Maintenance:	specialized company
History:	based in 1995
Characteristics:	Garden connected to family house used for recreation of family members.

Woody species recorded:	50 individuals	(27 species)
Most frequent specie:	*Picea pungens*	(6 individuals)

Garden #23



Garden area: 2615m^2

Built-up area: 229m^2

Altitude: 731 m a.s.l.

Usage: Aesthetic garden

Orientation: Flat terrain

Maintenance: specialized company

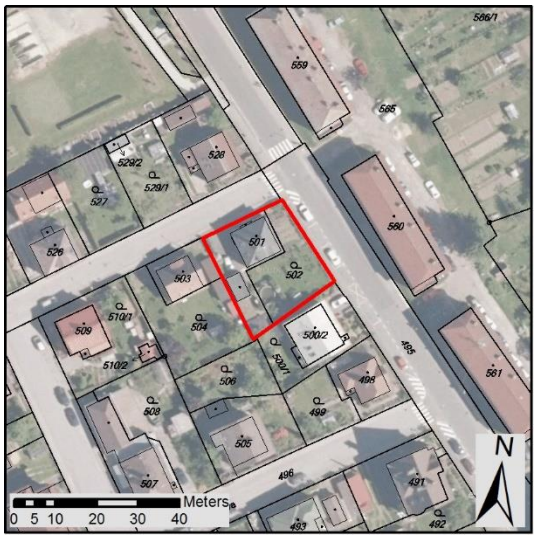
History: based in 2003

Characteristics: Garden connected to family house, surrounded by hedge, used mainly for recreation of family members and friends.

Woody species recorded: 448 individuals (18 species)

Most frequent specie: *Chamaecyparis lawsoniana* (301 individuals)

Garden #24



Garden area: 299m^2

Built-up area: 288m^2

Altitude: 679 m a.s.l.

Usage: Fruit garden,
Aesthetic garden,
Vegetable garden,
Other use

Orientation: East/northeast slope

Maintenance: self-care

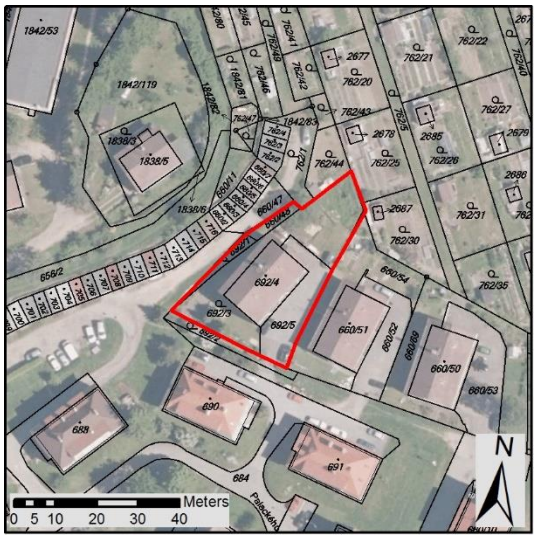
History: based in 1958

Characteristics: Garden connected to family house
used for recreation and food production.

Woody species recorded: 92 individuals (11 species)

Most frequent specie: *Buxus sempervirens* (38 individuals)

Garden #25



Garden area: 497m^2

Built-up area: 433m^2

Altitude: 684 m a.s.l.

Usage: Aesthetic garden,
Vegetable garden,
Other use

Orientation: Eastern/southeast slope

Maintenance: self-care

History: based in 1982

Characteristics: Garden connected to apartment house
used mainly for recreation of family members growing of food.

Woody species recorded: 25 individuals (11 species)

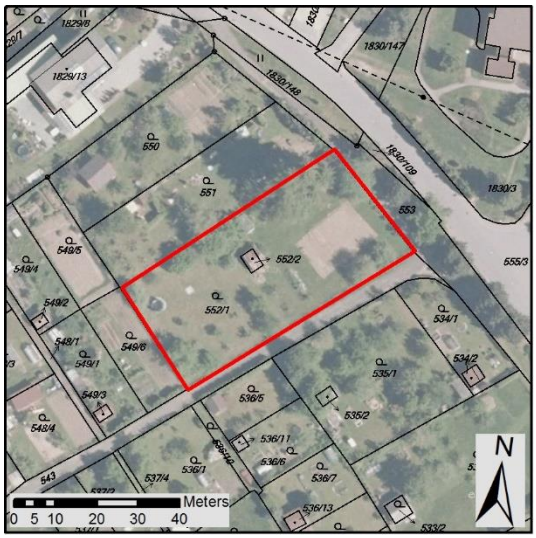
Most frequent specie: *Thuja occidentalis* (13 individuals)

Garden #26

Garden area:	2744m^2
Built-up area:	769m^2
Altitude:	685 m a.s.l.
Usage:	Fruit garden, Aesthetic garden, Vegetable garden, Other use
Orientation:	Northeast slope
Maintenance:	self-care
History:	based in 17th century
Characteristics:	Garden connected to family house (originally tavern from 17th century), used as orchard and place for relaxation of family members and friends.

Woody species recorded:	70 individuals	(15 species)
Most frequent specie:	*Malus domestica*	(19 individuals)

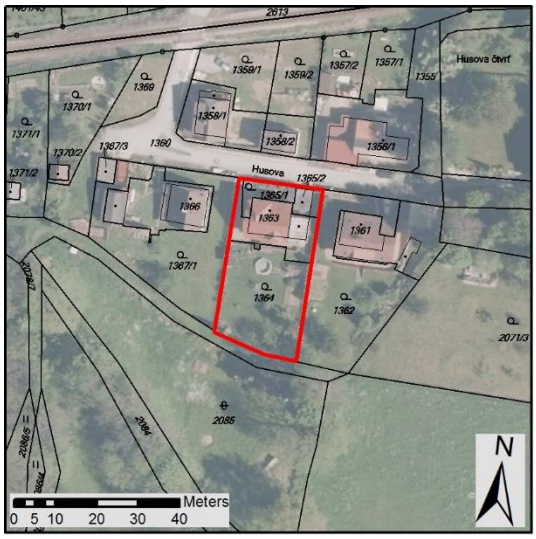
Garden #27



Garden area:	1890m^2
Built-up area:	17m^2
Altitude:	682 m a.s.l.
Usage:	Fruit garden, Vegetable garden
Orientation:	Northeast slope
Maintenance:	self-care
History:	based in 1960s
Characteristics:	Garden placed in gardening colony used mainly for food production.

Woody species recorded:	27 individuals	(9 species)
Most frequent specie:	*Malus domestica*	(12 individuals)

Garden #28



Garden area: 568m^2

Built-up area: 272m^2

Altitude: 711 m a.s.l.

Usage: Fruit garden,
Aesthetic garden,
Vegetable garden,
Other use

Orientation: Northern slope

Maintenance: self-care

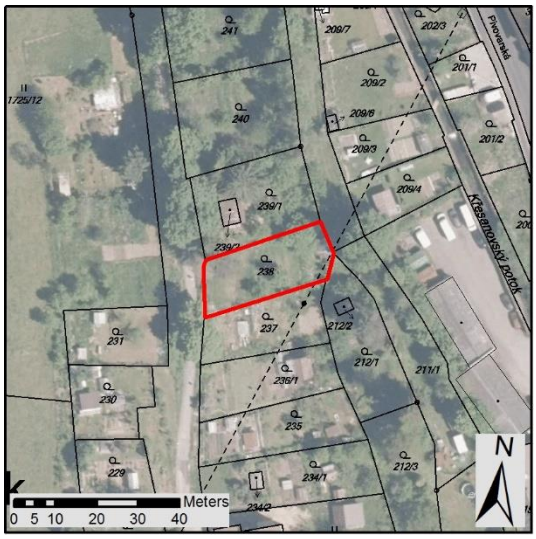
History: based in 1950

Characteristics: Garden connected to family house
used mainly for recreation of family members and friends.

Woody species recorded: 23 individuals (15 species)

Most frequent specie: *Thuja occidentalis* (5 individuals)

Garden #29



Garden area: 428m^2

Built-up area: 0m^2

Altitude: 727 m a.s.l.

Usage: Other use

Orientation: East/northeast slope

Maintenance: self-care

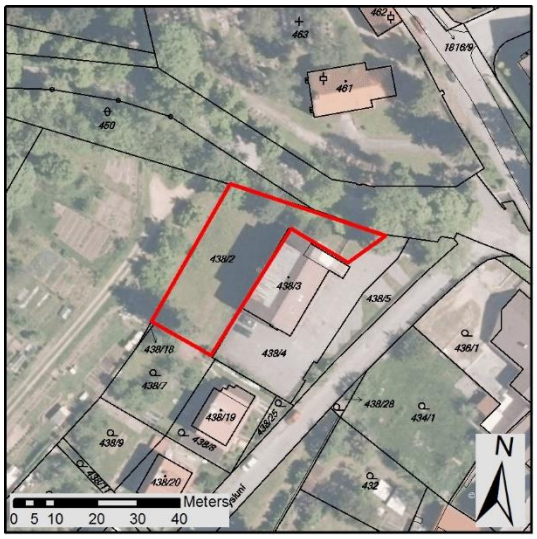
History: based in 1970s

Characteristics: Garden in gardening colony, nowadays under reconstruction for future relaxation and growing of fruit and vegetables.

Woody species recorded: 12 individuals (7 species)

Most frequent specie: *Ribes rubrum* (5 individuals)

Garden #30



Garden area: 866m^2

Built-up area: 1198m^2

Altitude: 700 m a.s.l.

Usage: Aesthetic garden

Orientation: East/southeast slope

Maintenance: self-care

History: based in 1977

Characteristics: Garden connected to company headquater used as aesthetical garden.

Woody species recorded: 9 individuals (6 species)

Most frequent specie: *Rhododendron hybridum* (3 individuals)