

# **Urban forestry**

Lecture notes

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## FOREWORD

Dear reader,

the version of Urban Forestry lecture notes you are going to read is the first try of our team to offer the students some information about topic that is new and unexplored in Czech Republic. Due to the support of project INOBIO we were able to collect some information and put it together. But, of course, nothing is bright and easy. This first version is based on just few sources now available at our University and on our experiences mainly from area of arboriculture (which is only part of urban forestry).

Take this text as a first step that will be polished and improved during the time as the information will come to us. If you are interested in progress we will made, please visit the web page of INOBIO project (<http://inobio.lfd.mendelu.cz/cz>) for the last version of the text.

On behalf of authors

Ludek Praus

Tato skripta byla vytvořena v rámci projektu InoBio – Inovace biologických a lesnických disciplín pro vyšší konkurenční schopnost, registrační číslo projektu CZ.1.07/2.2.00/28.0018. za přispění finančních prostředků EU a státního rozpočtu České republiky.



## CONCEPT OF URBAN FORESTRY

Urban forestry<sup>1</sup> is very fast developing area of interest. As the interaction between “urban” and surrounding forests grows, the need to manage these interactions (and collisions) led to the creation of this discipline.

Origins of urban forestry are in North America during the 1960s. According to Konijnendijk (2012) the concept has been introduced by Jorgensen at the University of Toronto, Canada, in 1965. Urban forestry covered management of city trees, single tree care and management, but also tree management in the entire area affected by the urban population. Next step for urban forestry was to stretch the influence to all trees (in stands and groups as well as single trees) **in** and **around** urban areas. Jorgensen also stressed the overall ameliorating effect of trees on their environment as well as their recreational and general amenity value. The new concept has been found successful and worthy, so in 1972 the Society of American Foresters initiated an urban forestry working group (Konijnendijk et al., 2005). As the concept experienced some troubles from the foresters on one side and arborist on the other side on the beginning, gradually it found more support from both sides, e.g., through the efforts of the International Society of Arboriculture (ISA). The US government through its Department of Agriculture’s Forest Service recognised the value of the new, integrative concept by establishing a national urban forestry program with strategies and research programs (Konijnendijk et al., 2005).

Very shortly, the urban<sup>2</sup> forestry can be defined as “the management of trees in urban areas” (Costello, 1993). It includes planning, planting, and care of (mainly, but not only, individual) trees on areas where people live and work.

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- 1 Did you ever thought about multidimensionality of the word forest? If we take it in its wide sense, it refers to ‘woodland’, ‘bush’, ‘rainforest’, ‘plantation’, ‘wilderness’ or ‘urban forest’. This is one of the difficulties we experience while we try to talk about forestry. For any nation, for any human, this word can have different meaning, that needn't be equivalent.
  - 2 What does mean 'urban'? It refers to areas, where people live and work. It covers not only the villages and town itself, but also their vicinity, and of course the industrial surroundings. This means a location but also areas with specific needs and functions. This can be clearly see on benefits of trees in urban areas.

The Dictionary of Forestry (Helms 1998) urban forestry is described, according to the definition developed by Miller (1997), as: The art, science and technology of managing trees and forest resources in and around urban community ecosystems for the physiological, sociological, economic, and aesthetic benefits trees provide society. We must take in to account, that the urban forestry as discipline compounds from the same portion of forestry and urbanism.

On the other hand, urban forestry didn't come out of nowhere. Growing urbanisation in latest centuries led to the spread of urbanized areas into forests. Europe has a rather rich tradition of municipal forest ownership and of 'town forestry'. Several of Europe's cities have owned and managed forests for several centuries (Konijnendijk 1999).

The urban forestry development did not stop. New concepts and terms have emerged within the field of forestry in line with the changes in society. As many non-productive functions of forest are recognised (and sometimes they are taken to be more valuable than wood and timber production) the management of trees and forests is redefined and improved. Concepts like social forestry<sup>3</sup> or community forestry<sup>4</sup>, for instance, are new approaches incorporated into the urban forestry.

The development of urban forestry brought some collisions with established professions – horticulturists, arboriculturists and landscape architects. These professionals were used to take care for trees in parks and green spaces in cities. It is traditional in Europe, that the landscape architect plans and manages green spaces in cities and the horticulturists do the work needed to keep the lawns, shrubs and trees in good condition. The need to take proper care of urban trees (because they are big and the collisions with inhabitants

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3 Social forestry could be defined as forestry catering for social needs and uses (Konijnendijk et al., 2005).

4 Community forestry has been defined as any form of social forestry based on the local people's direct participation in the production process, either by growing trees themselves or by processing tree products locally. Community forestry has been developed in a rural, mostly developing-country context, but is to an increasing extent being applied to urban areas (Konijnendijk, 2012).

can be dangerous) led to the emergence of the concept and profession of arboriculture as it deviated from horticulture. Arboriculture is primarily concerned with the planting and care of (mainly single) trees and more peripherally (or not at all) concerned with shrubs, woody vines and groundcover plants (Harris et al. 1999).

All involved professions had different interests and mutual cooperation was not easy. Recent years, however, have seen an increasing focus on dealing with urban green structures as a whole. The emergence of concepts and policies related to sustainable development and urban ecology played an important role in this respect. The United Nations' Habitat-conferences and its Conference on Environment and Development (UNCED, held in 1992) stressed that development of cities could only be achieved by incorporating social, economic and ecological dimensions. Urban green structures rather than individual green elements have become the focus. To an increasing extent, practitioners, researchers and politicians deal with the contributions of the entire urban green structure to the quality of urban life and environment. Moreover, they have started to realize that more integrated, green-area planning and management are required to meet current societal demands when operating in high-pressure environments. This led to the emergence of new, integrated concepts and approaches. Urban ecology, as urban proponent of ecology, has been mentioned earlier. Urban agriculture is another example. (Konijnendijk et al., 2005).

### The Concept of Urban Forestry in Europe

The concept of urban forestry reached Europe later than USA, during the 1980s. First project was Forest of London. Then, many projects were carried out in the UK, Ireland, The Netherlands and others. Urban forestry research in Europe as well as efforts to define the concept have benefited from recent international networking activities such as COST Action E12 'Urban Forests and Trees', the annual IUFRO European Forum on Urban Forestry set up in 1998,

and the European Urban Forestry Research and Information Centre (EUFOR-IC), established as Project Centre of the European Forest Institute (EFI) in 2001 (Konijnendijk 2003).

### *European Urban Forestry*

First steps in the effort to establish urban forestry in the Europe dealt with the definition of it. The North American definition was accepted in UK<sup>5</sup> and Ireland, but in other countries the urban forest wasn't so easy to define, because this term already refers to city woodland.

We can have two main positions. The conservative and conventional is, that only woodland and forests/forest ecosystems should be included in an urban forest. According to the Konijnendijk (1999) it means urban forestry as encompassing all forests primarily managed for the benefit of the urban population, with limited or no production functions. Then, the connection of the forest and the urban area can be very weak.

Second (an prevailing) position understands urban forestry as a broader discipline, where single trees, woody vegetation in general, as well as non-woody structures should also be included. Urban forestry deals with individual as well as stands of trees situated in or near urban areas. This green spaces, tree groups, stands and individuals offer many benefits, not only aesthetic influence on humans welfare.

So, what is the European understanding of urban forestry? According to Konijnendijk et al. (2005), the key strengths of the urban forestry approach:

- It is integrative, incorporating different elements of urban green structures into a whole (the 'urban forest').

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<sup>5</sup> British National Urban Forestry Unit (NUFU 1999), describe urban forestry as a 'planned approach to the planting and management of trees and woods in towns'. The urban forest collectively describes all trees and woods in an urban area: in parks, private gardens, streets, around factories, offices, hospitals and schools, on wasteland and in existing woodlands'. (Konijnendijk et al., 2005)

- It is strategic, aimed at developing longer-term policies and plans for urban tree resources, connecting to different sectors, agendas and programs.
- It is aimed at delivering multiple benefits, stressing the economic, environmental and socio-cultural goods and services urban forests can provide.
- It is multidisciplinary and aiming to become interdisciplinary, involving experts from natural as well as social sciences.
- It is participatory, targeted at developing partnerships between all stakeholders.



	The urban forest		
	Individual trees		Urban woods and woodland
	Street and roadside trees	Trees in parks, private yards, cemeteries, on derelict land, fruit trees etc.	(forests and other wooded land, e.g., natural forests and plantations, small woods, orchards, etc.)
Form, function, design, policies and planning			
Technical approaches (e.g. selection of plant material, establishment methods)			
Management			

Fig. 1: The Urban Forestry Matrix, representing the magnitude and scope of urban forestry. (Konijnendijk et al., 2005)

Fig. 1: The Urban Forestry Matrix, representing the magnitude and scope of urban forestry. In terms of urban forest resource, the Matrix includes three different types of urban forest locations. The first concerns paved areas, the sites of street trees, trees on squares, lines of trees, rows, and alleys. The second includes individual or small groups of trees growing in gardens, parks, cemeteries, on derelict land and in industrial areas, and others. The third type refers to stands of trees in woodland and shrub vegetation. All three types are to be found in or near urban areas. Moreover, all types relate to woody vegetation elements. The Matrix also describes how the different tree-dominated structures are dealt with in planning, management, research or any other activity related to the urban forest. There are three categories of activity or involvement: (a) overall policy-making, planning and design, (b) technical approaches, including plant selection and establishment, and (c) management (Konijnendijk et al., 2005).

## HISTORY OF URBAN FOREST

### *Why do we need trees around*

There are many stories about the origin of humankind. At least two of them are connected with trees, or the tree played important role there. First is the Genesis, where Adam and Eve found they are naked under the tree and they first time acted against the Lord. The second story was told first by Charles Darwin, in his book *The Descent of Man*<sup>6</sup>, where he offers his opinion, that apes are our ancestors, and there is probably something apelike left in us. The proven fact is, that the origin of humankind we can find in planes of south and east Africa. Trees were the safe place, refugium when predators sneaked around. This type of landscape is written in our psyche, so we usually feel comfortable on places, where are some trees, so we can hide, but not so many so we have free view to spot the danger.

Humans and trees were bounded tightly together, just the last centuries, that take people from countryside to the towns, broke this connection. But the need is still deep inside us. Trees are significant signs in our lives. Due to their lifespan and dimensions they create a matrix of our landscapes. A tree that has been planted hundred years ago by an unknown guy is still part of the environment of his children and grandchildren. This is something we can not ignore.

### *Urban forest*

Our ancient ancestors lived in close contact with nature and trees, as they hunted and gathered seeds and fruits. Than, first settled populations arose in Africa about 15 000 B.C. This is connected with the development of agriculture. Independence on hunting and gathering (so, no need to move because of exploitation) allowed rise of small communities, that grew into cities.

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<sup>6</sup> I apologize to anyone who will feel this offensive – it isn't. Actually, it was meant to be funny beginning. This is text about trees not philosophical book or theological disputation about origin of man.

The trees and woodlands has been used as a source of timber and firewood mainly (and fruits of course). With the development of society this type of use remains. Special way of management were developed: coppices and pollards to produce building material, firewood, pasture and feed for animals.

City forests were used as places of recreation, as protectors of water sources and as a source of timber for construction. A main function of forests near cities remained their use for hunting by royalty and nobility. For example in Epping Forest (UK) the monarch kept deer, commoners and landowners grazed two thousand sheeps and a thousand cattle and had wood cutting rights on tens of thousands of pollarded trees. Many others grazed goats and other animals illicitly (Konijnendijk et al., 2005).<sup>7</sup>

But not only such an utilitarian use of woodlands was on the beginning of UF, also aesthetic function of trees was in the interest of people. Parks, gardens were created to recreation of aristocracy, but also common people. This trend can be dated to the 17th century when industrial revolution take its turn and people moved from country to towns. Before this, in the Medieval period, people would have used "Commons and Greens", lands used by the common people, for recreation and there is little evidence of the construction of public parks.

Open spaces within the city walls were primarily used for growing vegetables, fruits, herbs and ... for drying laundry. Trees were mostly within the walls of private gardens, e.g. of monasteries. In the 17th and 18th century existing forests were transformed and new ones were planted adjacent to cities and used by the aristocracy and later the developing class of rich merchants (bourgeoisie) for recreational purposes (Konijnendijk et al., 2005).

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<sup>7</sup> If you found this interesting, I recommend you to look for book *Trees & Woodland in the British Landscape* by Oliver Rackham, that gives very interesting information about the topic.

In next period, influenced by the industrial revolution, while many forests were felled, others were planted for timber production. Forests in



urban areas were increasingly also used for recreation by large parts of urban society. Greenbelts, areas where housing or industrial development could not take place were designated around many cities (Konijnendijk et al., 2005).

Nowadays urban forests and woodlands have more the recreational function than productive, but new concepts of social forestry and community forestry with strong movements of city gardening can change this in few decades. We live in urbanized environment, that is full of artificial materials and structures. People suffer with unfriendly city condition, e.g. polluted air, high temperatures etc., and many of us looks for escape from cities to nature<sup>8</sup>. People also have tendency to move closer and closer to the natural landscape and thus the environment became more and more urbanized.

Thus, presence of trees in our environment is very important

<sup>8</sup> Did you noticed the boom of various outdoor activities, starting from geocaching, through various survival activities, re-enactment groups (pretending they are Vikings, Slavs, Indians, at least for a weekend), to almost military organized groups of paintball and airsoft enthusiasts that floods forest and woodlands?

## BENEFITS OF OF URBAN TREES

As have been mentioned before, trees and forest are enormous organisms with long lifespan. They are non-negligible part of the environment due to their dimensions, variability, changes of colours and structures. As a living organisms they communicate with environment, they affect it and change it. Many effects of trees are very beneficiary for inhabitants, but it should be mentioned here, they can also collide with people’s demands.

Next table shows in short benefits of trees. The division used in the table is not the only possible, but it covers most of effects tree have.

Social benefits	Recreation opportunities, improvement of home and work environments, impacts on physical and mental health. Cultural and historical values of green areas
Aesthetic and architectural benefits	Landscape variation through different colors, textures, forms and densities of plants. Growth of trees, seasonal dynamics and experiencing nature. Defining open space, framing and screening views, landscaping buildings
Climatic and physical benefits	Cooling, wind control, impacts on urban climate through temperature and humidity control. Air pollution reduction, sound control, glare and reflection reduction, flood prevention and erosion control
Ecological benefits	Biotopes for flora and fauna in urban environment
Economic benefits	Value of market-priced benefits (timber, berries, mushrooms ect.), increased property values, tourism

Table 1: Benefits of urban trees and forests (Konijnendij et al., 2005)

Now we can go through the groups of benefits and discuss it closer.

### ***Social benefits***

The most known non-productive function of trees and forests is their recreational function. Till the Industrial Revolution changed the relation of people to the nature, recreation as we know it was a right of the aristocracy and later also rich citizens. The main outdoor activity was hunting. Later, the alleys and street trees were a sign of success and politic power. Especially French revolution erased differences between social groups of people and took them

right to access the areas just for recreation. With Napoleon, this was imported into whole Europe.

But this was just beginning of the change. From early years of Industrial age, the poor people weren't visitors of this recreational areas. Poor hygiene and housing conditions, long working hours every day in week were the reason, why people who had no time for or interest in green-space recreation, neither they have access to.

As the living conditions improved, the urban working class get access to recreational use of urban green spaces. The thing that started it was – leisure time, that became more common among other social classes. The formal separation of a person's life time into working hours and leisure time made recreation an explicit social demand (Konijnendijk et al., 2005).

Nowadays, the recreation in the green spaces and especially in the forests and woodland on the urban perimeter, is very important. A lot of activities are located in green areas and people prefer them significantly in comparison with built-up areas. Activities like running, walking, cycling are very popular. Other outdoor activities like camping, picnicking, various survival activities are popular.

### ***Health benefits***

If we left the indirect effect of trees on health to the later discussion (dust and pollutants inhibition, cooling and moisturising effect, shading and so on), the positive influence of green spaces on mental health have to be mentioned. The stress reducing effect of natural sceneries, of the experience with natural environment, is described and proved. similar results in Sweden (e.g., Hartig et al. 1996).



Fig. 2: The garden of the Cesky Krumlov castle - an example of aesthetically valuable green space

After short exposition to the green environment, significant and measurable parameters of stress reduction can be obtained (muscle tension, blood pressure and electrical brain activity, Ulrich et al. 1991). The presence of trees can also improve the social health of community, contact with neighbourhood members, and reduce the feeling of social isolation /Konijnendijk et al., 2005).

### ***Social potential***

Modern society is multicultural. This is a phenomenon that should not be omitted. Many various groups of people with different demands, that include demands for specific green spaces design. Constant change of social demands and increased pressure on the different types of green spaces is a challenge for traditional concepts of maintenance, but it collides with the lack of knowledge, thus just the architectural and aesthetic standards with little reference to the local population and its specific needs guide the management.

Nowadays we can see clear demographic trend toward higher urbanisation. Number of people in groups with special demands increases, together with decreasing tolerance to the higher transporting loads, growing pollution. The natural environment is seek by the people very intensively. The task for this time is to accept the changes in the population structure, especially influx of different nations (even pan-European), change in demographic structure (decrease of families numbers, older population, more singles etc.) and bring them into the public green spaces management. Growing number of outdoor events (concerts, festivals) and activities lead to special demands on the space where they are located.



## ***Aesthetic***

Woody plants, especially trees are dominant part of any landscape, due to their dimensions and variability of colours, shapes, structures. They define the landscape, its parts, frame the views, they stress up some elements of landscape. Especially here, in the Czech Republic, the alleys are one of the most important parts of landscape character. From the the Hanging Gardens of Babylon the trees and other plans have been planted to make the surrounding more 'eye-candy'. For the urban green-



Fig. 3: Alley somewhere in the Czech-Moravian Highland

ery, this is the main purpose – to improve over-constructed city space.

Variability of shapes, colours, structures, dimensions and their temporal changes made plants and especially trees defining members of the space. They can form alleys, follow the streets, form parks. They can hide what



Fig. 4: One of the most beautiful trees I ever saw, it changes completely perception of the site

should not be seen but also guide our sight to those things, that should be stressed out, to the buildings, sights, artefacts. The trees and they groups can create an closed private space, can divide open spaces an frame the sight, there is many ways how to use them for aesthetic benefit.



They give to human an opportunity to experience the nature even in the middle of cities.

Of course, the perception of green spaces differs significantly in various groups of users. Young people will look for more wild environment while small children will not feel very comfortable in the dense woodland (probably they will fear the wolf). Population used to forests will have different demands than population from more deforested countries. People from the North of Europe, Finland or Sweden will look for different type of landscape, forest structure and species than people from Czech Republic or from Italy.

Konijnendijk et al. (2005) shows that old and mature forest stands are preferred over young and small trees, but small trees, if they form the lower canopy layer of a two-storey stand, are considered to improve the aesthetic value of the stand. Variation is greatly appreciated, not only due to mixtures with other types of trees, but also combination of trees with fields, meadows and, in particular, water elements.



Fig. 5: Trees changes its site

### ***Climatic and Ecological Benefits***

All previously discussed benefits are difficult to measure and evaluate. This group of benefits is different and we can measure the benefits of trees.

Before we start with the climatic benefits of trees I want to stress out that TREES' MAIN BENEFIT IS NOT OXYGEN PRODUCTION, because photosynthesis/respiration balance is not positive at urban trees. There are many more important benefits than this one in urban trees.

The welfare of people is defined by four basic elements:

- Solar radiation (direct and indirect blockage)
- Air movement
- Air temperature
- Humidity and precipitation

All of them can be affected by appropriate planting of trees and shrubs.

Trees give shade and directly and indirectly affect the sun radiation. This is very valuable effect of trees. Our cities are built from materials that reflect the solar radiation and accumulate it. Thus, the temperature in the city is significantly higher than in the surrounding landscape. It can sound good for a winter season, but in the summer, the elevated temperature causes increase of mortality, brings increased costs for cooling and air-conditioning. The process contributes to smog, global warming and higher energy costs associated with increased air conditioning in buildings. The strategic placement of trees in and around parking lots and similar areas provide the shading necessary to limit the heat island effect. The vegetation has higher heat reflectance (4 – 10 % for asphalt and concrete against 10 – 35 % of the vegetation).

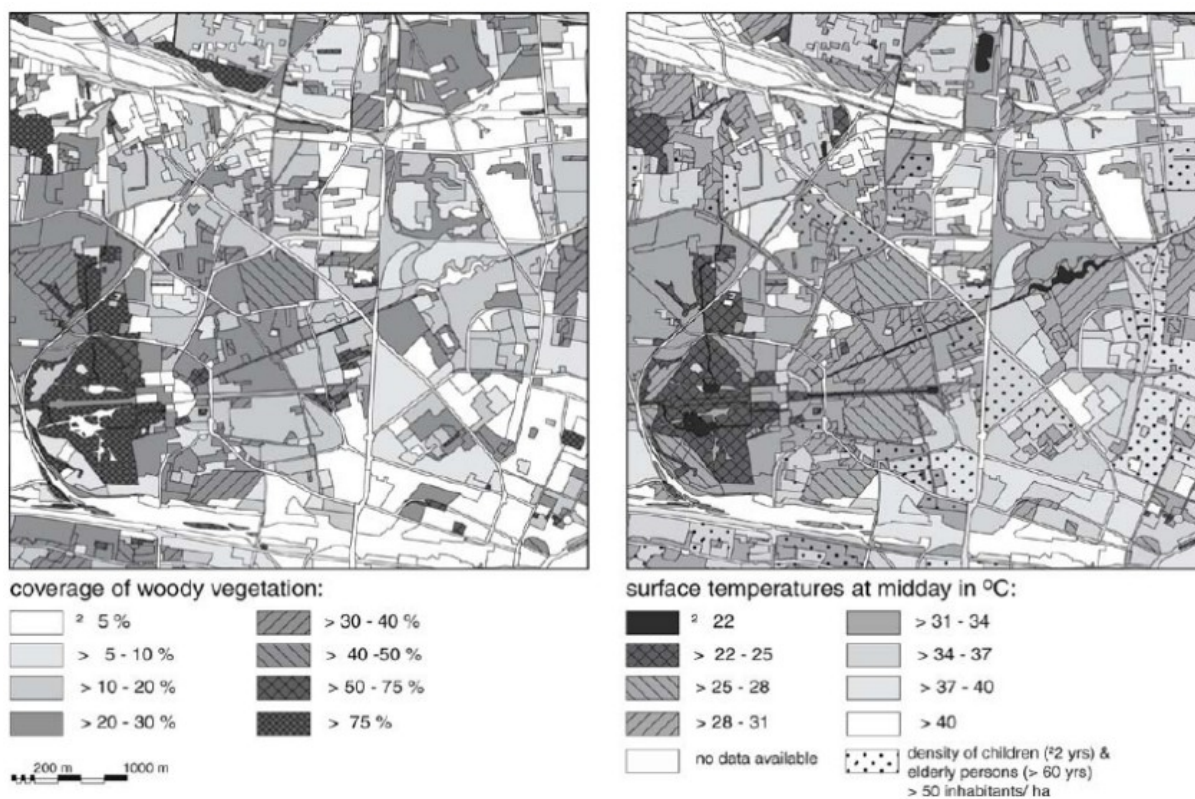


Fig. 6: Comparison of coverage and surface temperatures (Konijnendijk et al., 2005)

What vegetation does: reflects heat back to atmosphere; consumes some energy in process of photosynthesis; cools the air via transpiration; vegetation increases air humidity, that causes cooling of the air (increased humidity by 15 % causes decrease of temperature about 3,5 °C).

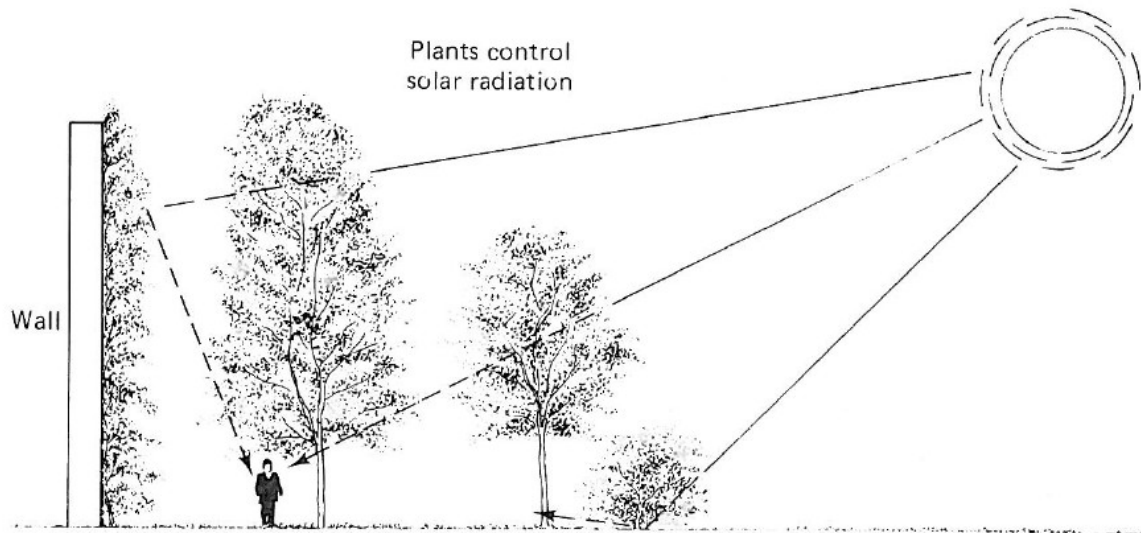


Fig. 7: Plants can be used to intercept, filter, or block solar radiation (Miller, 1997)

Trees can also act as very good air filters and cleaners. Significant reduction of free pollutants in the air. Evergreen species are able to filter off up to 25 % of dust particles. They limit and change wind, affect the temperature and humidity of city environment. They inhibit pollutants by incorporating them into their tissues. For example trees can reduce amount of  $\text{SO}_2$  &  $\text{NO}_x$  about approx. 4-5 %. Elevated temperature over the city causes effect called gradient wind. As the warmer air over the city streams up, colder wind from peri-urban areas flows into the city. Unfortunately, peri-urban areas are usually used as industrial zones, there are big communications, so this air flow drags a lot of pollutants and dust into city centre. This can be avoided by placing the trees into city (cooling of air) and as a green belt around (filtering of air). In addition, trees act as an acoustic barrier also, so the noise from transport and industry can be also decreased.

Tree Density	Tree Cover	Measured Wind Reductions, % of Open <sup>b</sup>		Estimated Average Irradiance Reductions		Annual Energy Savings		
		Heat	AC	Heat	AC	Madison	Salt Lake	Tucson
none	0	22	22	10	8			
low	24	44	54	15	22	2	4	6
medium	67	60	67	25	40	8	12	20
high	77	66	75	30	50	9	17	23

<sup>a</sup>All values in percent.

<sup>b</sup>Heat indicates reductions in winter, the heating season, and AC indicates reductions in summer, the air-conditioning season.

Table 2: Measured wind reduction, estimated reduction of irradiance by tree shade, and estimated average energy saving in air-conditioned homes by tree in USA (Miller, 1997)

## Hydrology

Urban areas suffer with significant changes in water regime and hydro-

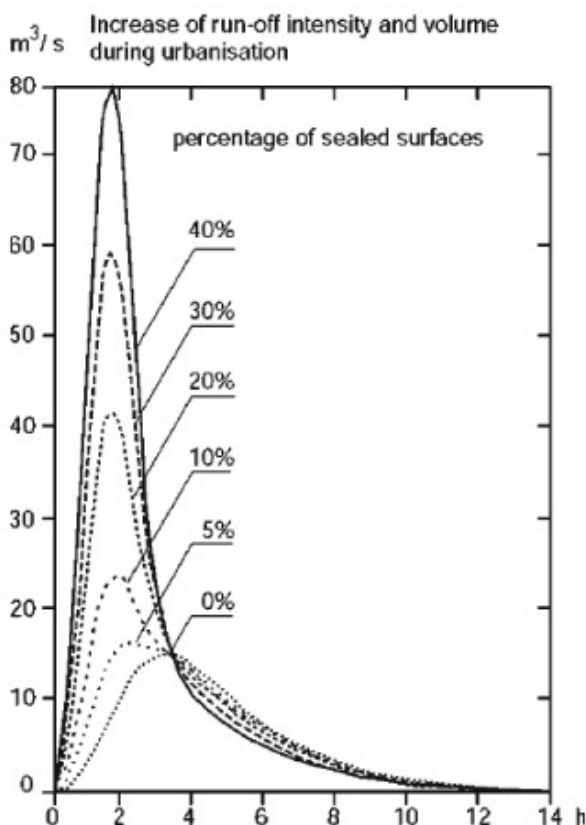


Fig. 8: Increase of run-off and volume of water (Konijnendijk et al., 2005)

logy. High rate of sealed surfaces, soil compaction and drainage leads to faster movement of water and thus to aridisation of the urban environment. Changed soil conditions and properties cause uneven water movement, the capillarity is changed, so a lot of trees and other plants suffer from drought.

Trees help to reduce stormwater runoff and improve water quality: stormwater runoff can be a big problem in urban environments. Large amounts of concrete and other impervious surfaces can force excess rainwater to pool in

streets and on properties faster than the sewer system can absorb it. The result can be flash floods and damage to properties. Trees can capture large amounts of rain through their root systems and canopies, which also help to filter some of the pollutants. The net result is the redirection of rainwater into the ground water supply, and the improvement of water quality.

Urban areas with high portion of green areas have advantage from this point of view. The water can soaked into the soil and is trapped on the trees leaves and stem surfaces, so it can cool and moisture the air instead of flow away through the drainage. Water capacity of such soils allows the water to be bound in the structure, thus, the water is slowed and stopped and cannot harm people or damage the property.

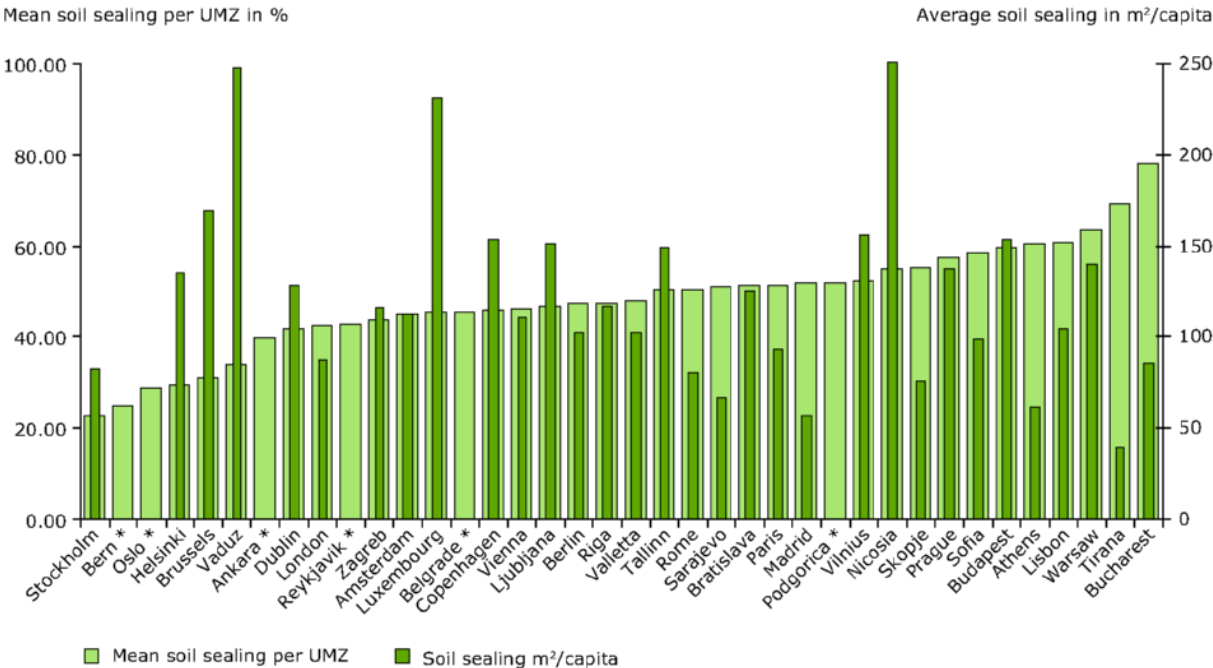


Fig. 9: Mean soil sealing in European capitals (UMZ – Urban Morphological Zone) and soil sealing per inhabitant. Available at <http://www.eea.europa.eu/data-and-maps/figures/soil-sealing-in-the-capitals>

**Carbon sequestration**

Very popular theme of our days is the carbon sequestration. Wide research has been done, a lot of finance were spent, to evaluate and quantify



the inhibition of carbon dioxide in living organisms. Trees help to improve air quality by mitigating air pollution & greenhouse gases. Most trees use photosynthesis to convert carbon dioxide (CO<sub>2</sub>) into nutrients and to the wood. The amount of fixed CO<sub>2</sub> in a tree can be really huge. The US Department of Agriculture has found that one acre of forest absorbs six tons of carbon dioxide and puts out four tons of oxygen. This is enough to meet the annual needs of 18 people.

Vegetation in urban areas bonds < 1 % C produced, but allows to lower carbon use indirectly, by lowering of energy consumption for air-conditioning etc.

Two examples:

Sacramento (CA) population of trees ~ 6 mil. This population means approximately 238 000 tonnes of fixed C and every year decrease of production of CO<sub>2</sub> is estimated to 75 600 t.

Liverpool – areas with good tree cover fix up to 0,13 t C per ha (double of free areas). On areas with big population of fully grown trees up to 17 t of C can be stored per ha, on free areas it is less than 1 t/ha. (after Konijnendijk et al., 2005)

### **Biodiversity**

The loss of biodiversity is one of the major problems of recent world. Urban trees are very valuable habitats and refuges due to their dimensions and specific regimens. Many species of fungi,

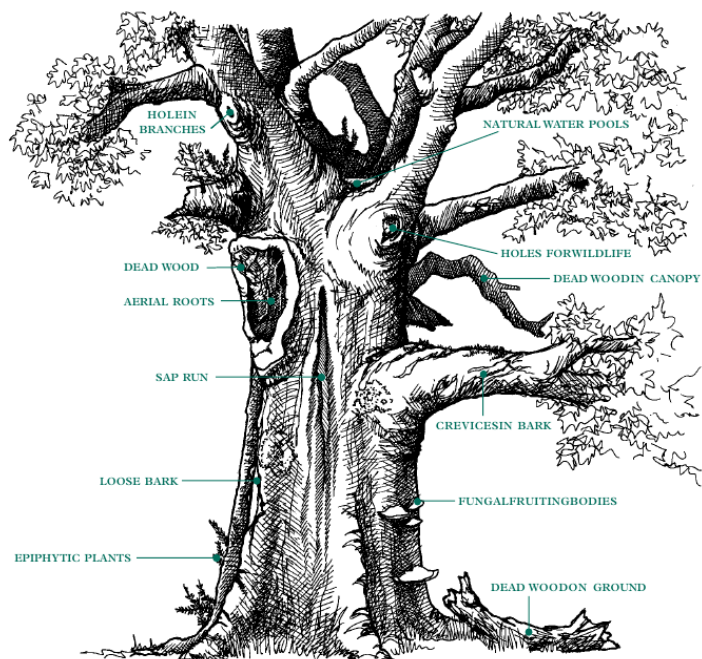


Fig. 10: Typical biologically valuable features of veteran trees (Fay, 2011)

higher plants, insects, birds and mammals are tightly bonded on those trees. As the forests with productive function tend to be homogeneous, usually with one or two dominating species, of the same age, and as the age when they are felled is short, the habitats for many organisms disappeared.

For example *Cerambyx cerdo* (great capricorn beetle), highly protected species in Czech Republic, is bonded to the old oak trees, over 100 years old. In smaller trees the larvae are not able to finish the development. Standard European forests do not offer to many trees of such dimension. In cities, on the other hand, the population of those old big trees is relatively higher. Trees are protected and thus some features like deadwood, cavities etc. can be found easier than in the landscape.

There are many species of fungi, insects, vertebrae and mammals, that need trees for feed, for shelter, for protection. Urban forests and urban trees with longer presence on the site than forest trees, and with faster development of biologically attractive features are very valuable source.

We shouldn't forget, that this gives opportunity to people to meet those organisms. This educational benefit is almost of the same importance like the



Fig. 11: A table from Kew Gardens showing the richness of wildlife bounded to the trees (foto L.Praus).



biological one. Children, but adults also, can thus build strong relationship to nature.

### ***Economic value***

Trees provide many material benefits, starting with their fruits or fruits of accompanying organisms, wood (often of big dimensions and attractive species. Increase of land and estate price is significant also. The USDA Forest Service has found that mature trees add an average of 10 percent to a property's value.

Businesses do better on tree lined streets: A 2004 study found that consumers overwhelmingly preferred business areas with well-planted canopy-covered streets and suggests a link to the amount of time that shoppers are willing to spend in stores.

Trees can reduce heating and cooling costs for buildings: When placed strategically around buildings, trees can reduce cooling costs by 30 percent, and heating costs by 20-50 percent. By providing shade and a barrier to wind, trees cool buildings during hot weather, and limit snow accumulations during cold weather. Economically this is beneficial as it can reduce the fuel costs associated with heating and cooling.

Crime rates tend to be lower in areas with trees: Research presented at the American Association for the Advancement of Science conference (AAAS) in Chicago socio-cultural benefits showed that the presence of trees could cut crime by as much as seven per cent.

## **POLICY AND PLANNING – EUROPE, CR 20P.**

Theoretical conceptualization of urban forestry and urban forestry policy

Design of urban forest ?

Comunication and partnership

Involving people

Urban conditions

Plant selection

## **PRACTICAL PART 20P.**

### **Management of urban forest**

The key to healthy and valuable population of urban trees, where the benefits will prevail the drawbacks, is inventory and evaluation of trees. This is the first step of successful tree management.

#### TREE INVENTORY

Inventory is the first step to the evaluation and management. Every tree is located, marked and basic dendrometric parameters are measured. There is a lot of systems around the world used by various companies. The system, that is successful in Czech Republic is based on division of urban area to basic areas. These basic areas are smaller areas with reasonable number of trees. The basic area should be of one greenery type.

For every BA the occupation value and safety state value can be estimated. Occupation value gives information about presence of potential targets that can be hit by the tree. The main groups of targets are: pedestrians, movable property (e.g. cars), and real estates. The higher frequency of pedestrians, cars and price of buildings, the higher the importance of the BA. Safety state value describes the state of the growth on the site, if there are young trees old it is a old growth, if the trees are managed in good way or if there is lack of care, if there are many trees with danger of fall or not. These two values together helps us to find the basic areas with high priority (many valuable targets, bad tree population condition). Such an evaluation is easy to do and at least it offers information for reasonable use of means available for tree management and care.

Next step is mapping of single trees or group of trees (where individual trees can't be localised easy). Every tree is located using some suitable method ranging from simple marking the tree into suitable map to precise location using geodesy. Aerial location is also possible. We should choose the method according to the wanted precision and available sources. Even the simple location using maps can be

precise enough, especially now, when high quality aerial pictures are at disposal. As an example the reader can visit [page checktrees.com](http://checktrees.com).

Localisation is very important. It is important identification of a tree and also it

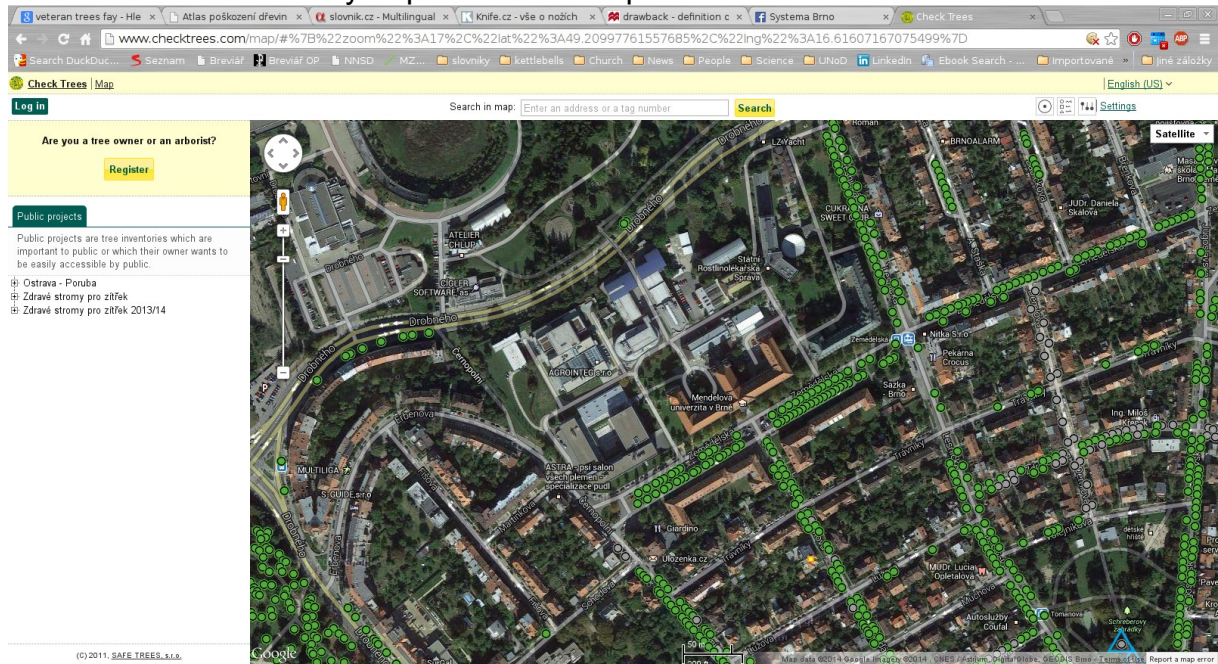


Fig. 12: Screenshot of MENDELU surrounding on the checktrees.com portal. gives information about the right owner (in the Czech law the owner of the land owns the trees also). Therefore it must be done as precisely as (reasonably) possible.

Located trees can be marked with tags of different types – aluminium signs with



Fig. 13: Arbotag system marker (<http://www.signumat.com/>) numbers, special tree tags with bar code, QR code markers or even RFID chips. This is important where the localisation id difficult or the area is not providing an easy survey. Marked tree can not been mistaken with other.

Last step of inventory is measurement of basic parameters – tree height, diameter, crown dimensions.

## HAZARD TREE ASSESSMENT

After inventory, the tree care can be planned. To do that, one needs to know the state of the trees. In urban forestry and arboriculture, the leading parameter is tree safety and stability. There are other factors, of course, that can be taken into account, and their importance depends on the purpose of the survey. If we are interested in reconstruction of the park, we will build on a different set of parameters. In standard situations, the safety of citizens is on the first place.

Hazard tree assessment is a very wide area. Those who are interested refer to almost the classical book in arboriculture – *The Body Language of Trees* by Claus Mattheck and Helga Breoler. The book aims at tree biomechanics and evaluation, our information will be just brief.

Trees are objects with a double nature – they are living organisms and they can be seen as cantilever beams. These two aspects show what we should evaluate: a biological parameter, called vitality or vigour, and a biomechanical parameter – stability and health status.

Vitality is a parameter describing the physiological capacity of a tree. It is highly dynamic and fast changing as the conditions of the site change. It is estimated by these parameters:

- defoliation
- malformation of primary branches



Crown defoliation indicates reduced tree vitality. From the left to the right degree of defoliation (the loss of needles): no defoliation 0-10%, slight 10-25%, moderate 25-60%, and severe >60-99%.

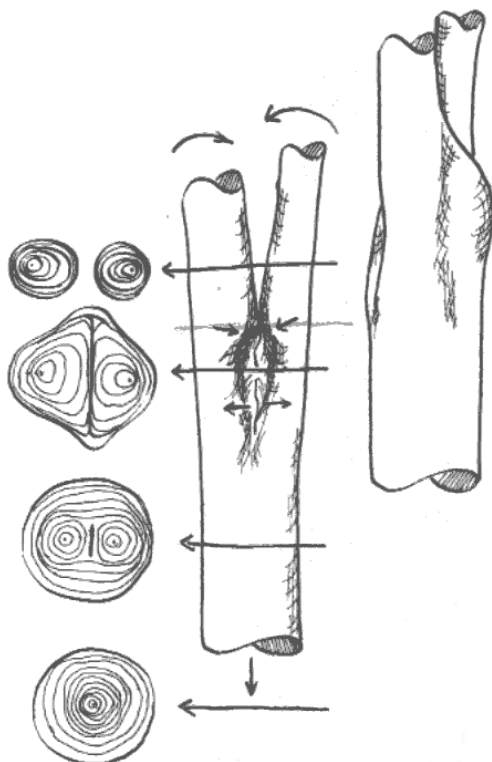
Fig. 14: Defoliation of spruce (from [www.metla.fi](http://www.metla.fi))

- growth rate
- secondary shoots growth

Importance of this factor is a measure of reaction of the tree. Only vital tree can react on the changing environment and have enough of sources to heal damages etc.

Stability is estimated probability of failure. Evaluated parameters are:

- defects (e.g. compression forks, )
- damages



- secondary shoots presence
- cavities, fissures,
- cracks
- presence of tree decaying fungi

Sometimes the safety of a tree is evaluated. It differs from the stability, because it reflects the target value also and can be described as quantified risk of harm.

Health status of a tree is very similar to the stability. It also built on parameters as the

Fig. 15: Compression fork (Mattheck, Breoler, 2003)

stability, but it looks more on the presence and extent, how the integrity of tree is eroded and does not reflect the tree will fail or not.





Fig. 16: Tree with poor health status, but high level of stability



Fig. 17 Tree crown structural changes (Roloff, 2001)



Fig. 18: Damaged tree base

## ***Arboricultural practices***

### PLANTING

Urban trees are usually planted they do not grow from seeds on the site. Planting is the first stem of tree care and is very important. Any mistakes during the planting period can cause significant problems later.

Before planting, the site evaluation should take the place. What to control:

- Slope (it affects technology of planting)
- Soil Type (affects the species selection)
- Exposure (affects the species selection)
- Amount of light (affects the species selection)
- Drainage (affects the regime after planting)
- Space or size (affects the species and material selection)
- Soil pH/Nutrient availability (affects the species selection)

Species selection: not all species can be planted everywhere. Every species has its ecological amplitude and should not be planted in conditions out of its range. Nice example is planting a water demanding tree species (e.g. maples) in cities. They usually suffer from drought. We should also respect final tree dimension. Place London planes into narrow street is not a good idea. So check following:

- Tree life span
- Regionalisation
- Final tree dimension
- Species suitability
  - environmental resistance

- Influence on environment

A suitable city tree: a species with wide ecological amplitude, resistant to the drought, to the salinity, to the emissions. In cities we can look for species more disposed to the environment, in the landscape, the native species should be preferred. Invasive plants species must be avoided.



Fig. 19: Barefoot stock

Not only the species, but also type of stock must be chosen carefully. We have two basic types:

- Bare root stock - Suitable for forestry and landscape planting, small, compact, easy to manipulate, must be planted ASAP.
- Balled and Burlapped (with root ball, in containers...), better in cities, they have significant dimensions, so the effect of planting is immediate.



Fig. 20: Stock with ball

To choose proper dimension is also very important. To big material is expensive, small plants can be damaged easily, and the effect on site is small.

Planting procedure – in few steps we will describe the procedure of planting a tree.

- Control or digging of planting hole - Minimum 1,5 times bigger then root ball  
Theoretically 0,75 m<sup>3</sup> of root volume to every 1m<sup>2</sup> of crown ground area, but at least 8-16 m<sup>3</sup>. Optimum dimensions are 3-5 times wider than the root ball  
Tricks and tips:



- Mixing the substrate – it helps the roots to become used for worse soils, much worse than in nursery



Fig. 21: Smaller, but still big balled stock

- Erode the planting hole walls, so the roots can not rot around the hole walls

- No organic substrate in the deeper layers – it can decompose, the bacteria will use the oxygen and the roots will suffer from hypoxia



Fig. 22: Very big tree can be planted

- Control of the seedling, ball treatment, - Remove dry and damaged roots, application of growth regulator is possible, roots must be protected from drying.

Remove the wrapping material, spread the roots. The tree must be handled with care and through the root ball, not the stem, or the small tiny roots can be damaged.

- Pruning - Planting procedure causes loss of roots up to 90 – 95 %. To mitigate the effect of root loss stress, the balance between transpiration and water absorption have to be re-established. This can be done by the pruning of the planted tree up to 1/3 - 1/2 of original volume. Next effect of this pruning is the establishment of new crown structure, removal of damaged branches and support of the leading shoot etc.
- Tree set up, stakes installation, watering system installation
- Burying of the tree, stabilisation - Root system of the newly planted tree can not provide mechanical support. Anchoring protects newly formed roots from tearing and the tree from uprooting. There are various types of anchoring:
  - Underground – the root ball is anchored
  - Overground – the tree stem is anchored

The stakes can damage the tree if mounted improperly!

The stem have to be protected from the light.

### **Pot effect**

Occurs where there is significant difference between soil quality in the ball (container) and the site. The root do not leave the palnting hole and the tree became unstable, with poorely developed root system.

Different nutrient richness

Different mechanical properties of soil

- Watering (1/2 during planting – cca 30 - 50 l, 2/2 at the finish)

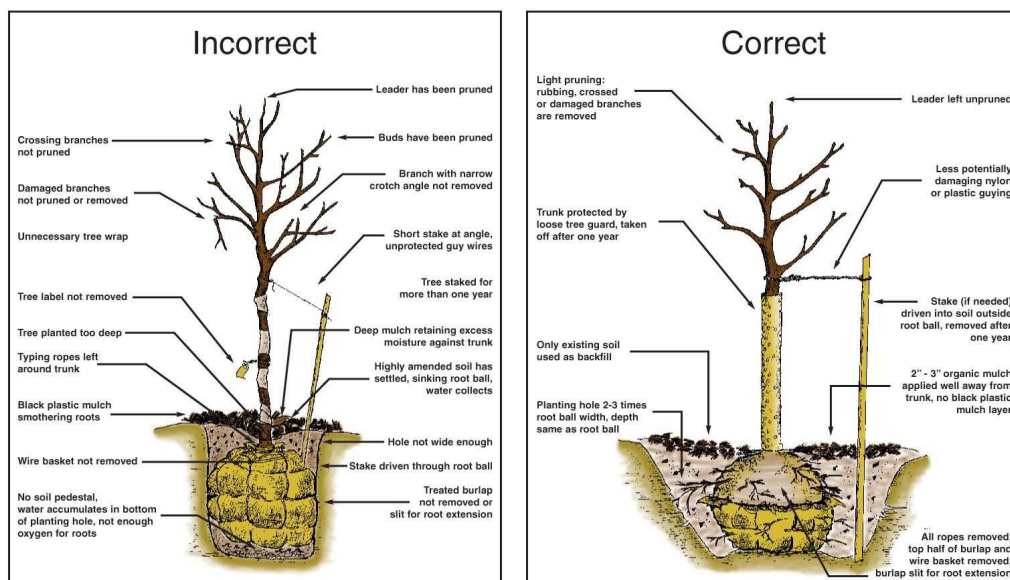
The care does not stop after planting. The tree is demanding in its first years, while the root system is not developed well and the tree needs to acclimatise to new stand. The care consists from:

- Watering and fertilizing
- Pruning
- Stakes control and removal
- Protection of the root space
  - Soil aeration
  - Removal of weed
  - Mulching



## Tree Planting

To ensure healthy trees, start with Right Tree/Right Location.  
Once you select a tree suited for your site and its microclimate, be sure to plant the tree correctly!





## PRUNING



Fig. 24: Wrong anchoring, must be removed.

A book could be written about pruning. But it is not in the scope of this text to describe it in deep details. In addition, systems and technologies are not united through the Europe, so it is difficult to offer the system of technologies. What we can do, is to set the main and basic rules for pruning, that works everywhere.

The pictures had been taken from Czech Arboricultural standard for tree pruning.

Why the trees must be pruned? There are some reasons for pruning:

- Constitution of crown in young trees – this is the cheapest way of tree care, but the most effective. Majority of defects can be repaired by pruning of young trees, not later.
- Care for crowns of adult trees – to maintain them safe and nice
- Shaping of trees – sometimes from safety reason or aesthetich reasons the tree is shaped.
- Safety – some technologies of pruning serves to set the stability., to decrease the loading acting on branches or the stem.
- Boost of aesthetic function (blooming etc. )
- Wood quality improvement – branches removal causes the wood less knotty, better in properties.



Fig. 25: Underground anchoring

- Adjustment of root/shoot ratio – as has been mentioned above.

How to prune a tree – how to cut a branch. Usually, the branches are cut at the branch collar - the cut is made on the edge of stem and branch wood. If done properly, only the branch wood is attached.

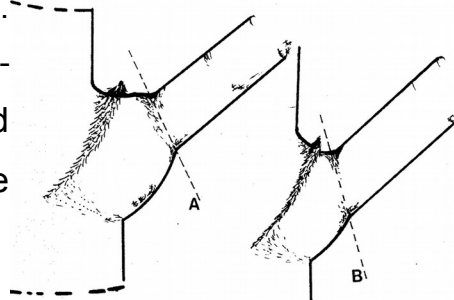


Fig. 26: Position of branch collar

But we should be aware what branch can be cut. The bigger is the wound, the worse is the healing. One third rule sets the maximum dimension of cut– cut branch should not be thicker than 1/3 of the mother branch diameter.

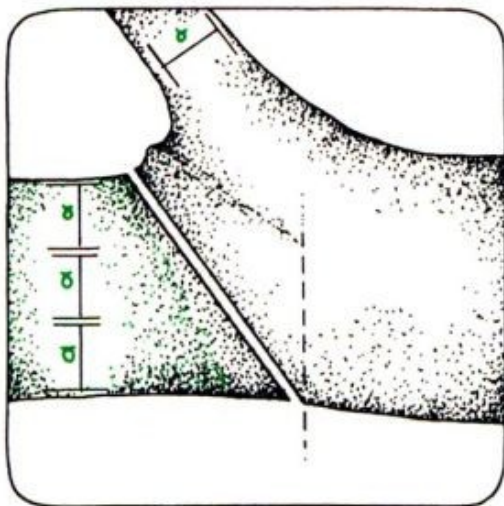


Fig. 27: One third rule scheme

If the cut is done to suppress a branch, remaining leader should have diameter at least 1/3 of the cut branch.

Sometimes it is difficult to cut a branch, it is heavy and as it falls, strip of bark is torn from the tree. Three-Step Pruning cut – heavy branches, where is a risk of bark ripping, and it is not possible to hold it in the hand, the cut should be done in three

steps. The first cut undercuts the limb one or two feet out from the parent branch or trunk (approx. 1/4 to 1/3 branch diameter). The second cut is the top cut which is usually made slightly further out on the limb than the undercut. The third cut is to remove the stub, while preserving the branch collar and branch bark ridge.

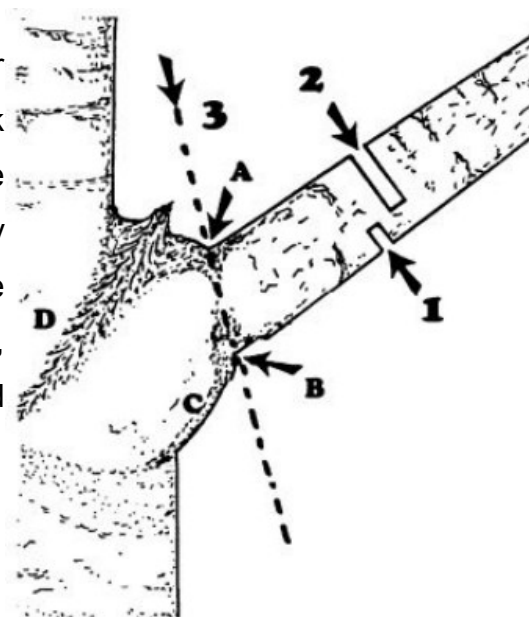
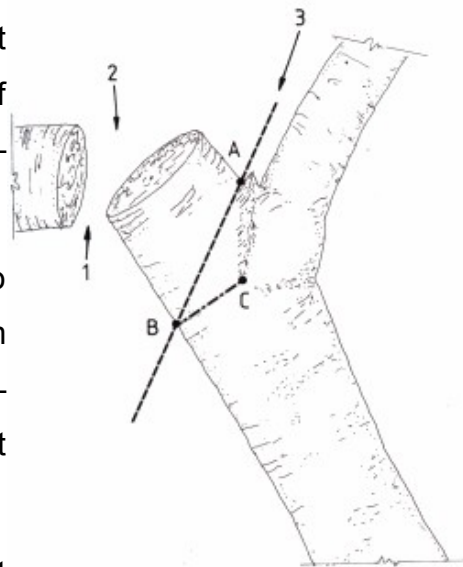


Fig. 28: Three\_Step pruning scheme



Drop-Crotch Pruning: If the reduction of the leader is needed, the so called Drop-Crotch Pruning is applied. Drop-crotch pruning is the cutting of limbs back to their point of origin or back to a lateral branch capable of sustaining the remaining limb and assuming apical dominance of the limb.

One of the most frequent defects is so called compression fork. It arises mainly from co-dominant branches. To remove these co-dominant branches is made by cutting one branch at the proper angle in relation to the crotch.



How big wounds are acceptable? It depends on the species. Some of them can do a

Fig. 29: Drop-Crotch pruning

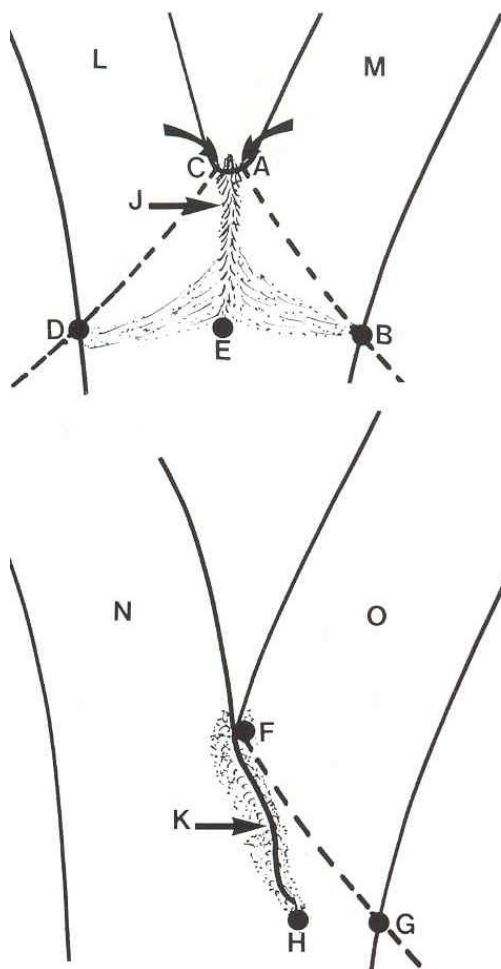


Fig. 30: Correcting Co-Dominant Branches

good job when dealing with infections, some of them not. The tree fights decay by closure of it inside the stem. The process is called compartmentalisation. Some species have good ability to compartmentalise, others not. The smaller the wound is the better. Many small wounds is better than one big. The wound diameter should respect the species – ability of compartmentalisation.

GOOD ABILITY: max. 10 cm

BAD ABILITY: max. 5 cm

After pruning treatment

If a cut a branch, should I do anything else? Should it be covered with some painting or so? These are often questions we hear. We can set following rules:

- Painting – it is not bad, but it is not needed.
- If provided, no toxic or leakproof painting or coating should be used.
- Painting has mainly aesthetic function

Czech Arboricultural standard for pruning contains groups of technologies of pruning:

- Constitutional pruning
  - This type of pruning is carried out on young trees.
  - The main goal is to establish and retain healthy and stable crown structure.

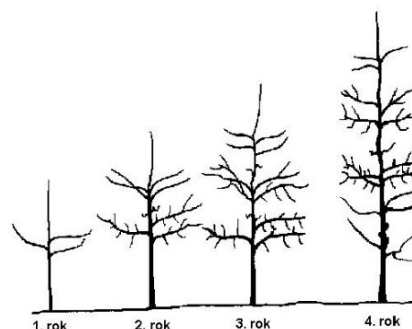


Fig. 31: Crown development

- Habitual defects like V crotches can be solved in this stadium.

- Maintenance pruning (safety pruning, local reduction, sprouts pruning, sanitary pruning) - These technologies aims on maintenance of tree safety, natural habits, functionality. They are repeated regularly, according to the species and state of the tree.



- Stabilising pruning (reduction, topping, crown reconstruction) - These technologies aim on the tree stability by the removal of the crown mass to lower the area, the centre of gravity

Fig. 32: Heavy stabilising pruning, on the edge of damage. Can be used just on poplars and willows

height and thus decreasing of arising wind load. No more than 30 % of the crown mass in one step should be removed. In some cases very heavy reduction is acceptable. For poplars and willows in older stages this is the main kind of pruning.

- Shaping pruning (pollarding, hedgerows) - regularly short cycle repeated pruning, that should be constituted during the youth of a tree.

### *Tree conservation*

Valuable trees with ecological or historical value are usually carrying a lot of defects, like cavities, cracks, and they must be stabilised and conserved, if they should not be felled down. Tree conservation are special treatments that are provided to stop the breakdown of the tree structures and to secure the tree safety.

We can distinguish two types:

- pre-emptive, - the are provided as a prophylactic treatments, where failure is suspected. Dynamic cabling is an example of such a treatment.
- Consecutive - as the name says, these are treatments that have to repair and reset the broken state of the tree. As an example we can point out static cabling.

In recent years, concept of tree surgery was prevailing philosophy of these treatments. This approach was based on removal of all “bad” features on a tree. Rigid cabling and construction were made to make the tree stiff and strong. Nowadays this concept is abandoned. The tree is understood with all its functions, holistically. The guidelines are now:

- Acceptance and understanding of natural processes is stressed up
- Natural mechanisms of healing and stabilisation are supported
- Minimisation of interventions is demanded

This type of treatment aims mainly on old, veteran trees.

We should know, that it is almost impossible to avoid colonisation of old tree stems by fungi. This is natural process, improved in the billions of years of mutual coexistence of trees and wood decaying fungi.

This kind of treatment is very demanding and thus very expensive. To decide whether do it or not, one should take into account:

- Assumed effect of treatment
- Up-to-date state of the tree
- Presume the stability of the tree AFTER the treatment
- What technologies are available

### **Fresh wound treatment**

Superficial layers of phloem and wood are damaged and the tree is open to infection. We need to boost natural healing processes. The wound must be cleared and smoothed without excessive deepening. The wound should be covered to keep the moisture. Wrapping the stem to protect the wound can help healing processes. The wrapping mustn't be impermeable – no latex, resins etc. That favours fungi<sup>9</sup>.

### **Cavities**

Cavities are natural part of tree life. Trees over 1,5 m of diameter can be reasonably suspected to be hollow. The tree is not in danger, if sufficient rest wall is kept.

Conservation of cavities includes three kinds of treatment:

- mechanical (removal of debris and decayed wood, drainage of cavities...),
  - huge mass removal is not recommended
  - no living tissue should be damaged

Very often, the cavity sealing was used in last era of arboriculture. For sealing, various materials had been used: bricks, stone, concrete, epoxies, etc. The effect can be negative, because:

- Water condensates on the material. It favours the fungi.

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<sup>9</sup> Any coverings, that keep the wound closed, without air movement but wet favourite fungi. Even if you put a layer of latex over the wound, there is a small room under the tough surface, where fungi friendly micro-climate is created.

- Air circulation is stopped. It favours the fungi.
- The mass of sealing can cause damage of the lower stem parts
- Any control of sealed cavity is impossible
- chemical (application of pesticides and fungicides to inhibit the activity of biotic agents). The main rule is, that any -cide agent must not come into contact with living tissues of tree. Before we decide to apply insecticides, we should be sure that no protected species of insect does not colonise the tree.
- special (roofs, supporting constructions, lightning protection etc.). To protect the tree against abiotic and biotic factors (including human), special constructions are built. Various types of supports, roofs are made to save the tree. Such a treatment should be reserved for the most valuable trees.

### **Crown cabling**

If there is a danger of breakage of the branches or tree fall, the tree can be secured by installation of cables. We can divide them into groups according to three main features:

- Rigidity
  - rigid (statical) and
  - elastic (dynamical) cabling is made.

The difference is in the material properties of the ropes. Statical are tough and should be installed as pre-loaded. They can not absorb any movement, so there is high risk of dynamical breakage if installed improperly. Dynamic cables allows movement of tree parts and only in case of failure the can catch the falling part and save the targets underneath. Movement is very important, because the cambium is stimulated and the tree can growth.

- Destructiveness
  - destructive
  - non-destructive

The difference is in the way of mounting of the cabling system on the tree. Non destructive systems are preferred.

- Mechanical function
  - pre-loaded
  - elastic

Preloaded system serves as strengthening systems. If there are damaged parts of a tree, like compression fork with crack, it could be only stabilised by the adding of artificial strength. So the defect is screwed together to avoid any movement. Such a system must be pre-loaded. Elastic systems can not be preloaded, because the material has high tendency to creep. The carry no load until the tree failure.

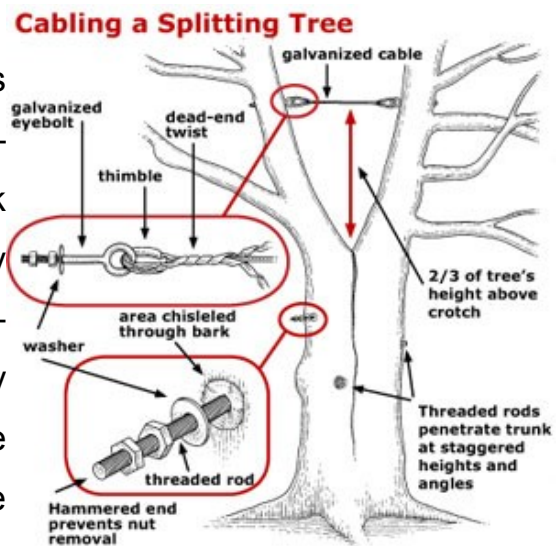


Fig. 33: Rigin pre-loade cabling system.



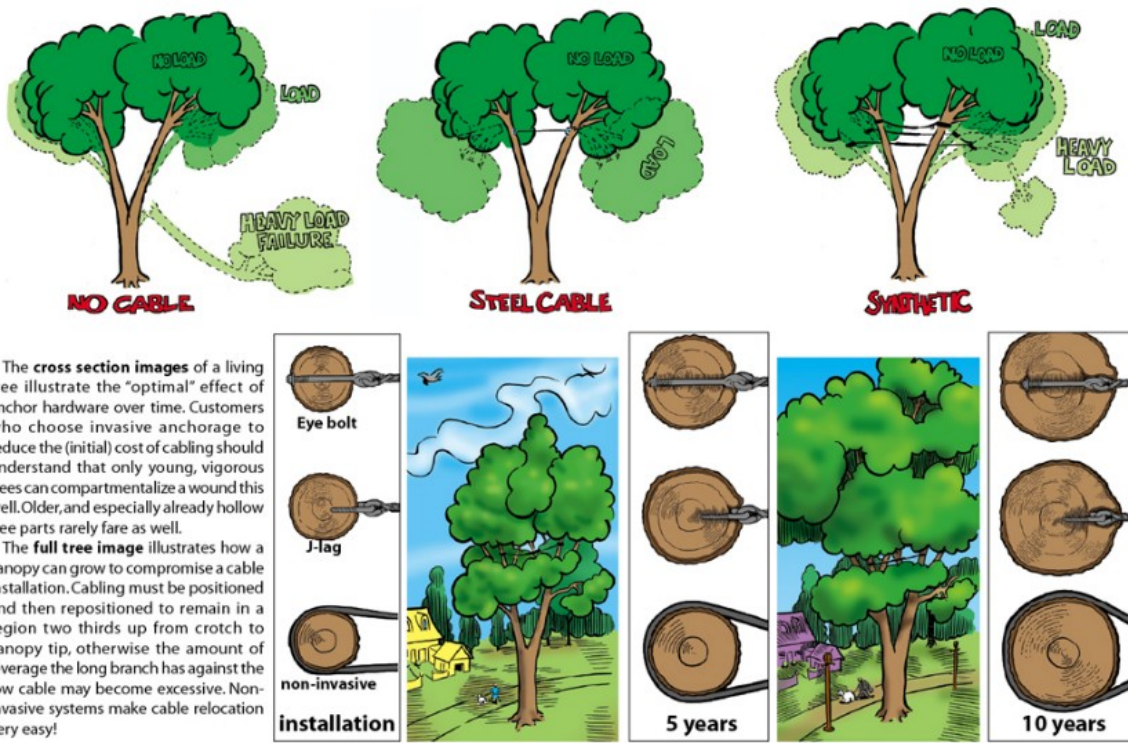


Fig. 34: Various cabling systems (<http://www.arborct.com/>)



Fig. 35: Dynamic cabling system Cobra (P. Ledvina)





Fig. 36: Steel pre-loaded cabling system (P.Ledvina)



Fig. 37: Old system from steel members.

## References

Costello LR (1993) Urban forestry: a new perspective. *Arborist News* 2:33–36

Duvigneaud P (1974) *La synthèse écologique: populations, communautés, écosystèmes, biosphère, noosphère* (The ecological synthesis: populations, communities, ecosystems, biosphere, noosphere)

Miller RW (1997) *Urban forestry: planning and managing urban green spaces*, 2nd ed. Prentice Hall, New Jersey

NUFU (1999) *Trees and woods in towns and cities. How to develop local strategies for urban forestry*. National Urban Forestry Unit, Wolverhampton

Fay, N. (2011) *Veteran Trees: A guide to risk and responsibility*. Available at <http://publications.naturalengland.org.uk/publication/75036>.