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# Climate is changing: are we changing too?

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## Abstract

*Many problems in the urban landscape can be reduced or eliminated by proper plant selection and by maintaining trees healthy so that they can fully provide their benefits. In a climate change scenario possible adaptation measures include changes to establishment practices and tree management, better matching of species to site, both under current and future climates, and the planting of non-native species and provenances in anticipation of climate change. Current opinion is to encourage the planting of local provenances of native species, citing adaptation of provenances to local conditions, and the requirement to maintain biodiversity and a native genetic base. However, local provenances may not be able to adapt to a changing climate, particularly given the rate of change predicted. Sourcing planting stock from regions with a current climate similar to that predicted for the future may provide one option, although care must be taken to ensure that suitable provenances are selected which are not at risk from, for example, spring frost damage as a result of early flushing. In this paper we'll focused on the technical and practical solutions for the selection of trees that might be the best choice in urban environments for the next future, given differences in urban sites (infrastructures, climate, soils etc), species attributes, management requirements and climate..*

## Keywords

*Species selection, green infrastructures, urban areas, soil, native vs exotic.*



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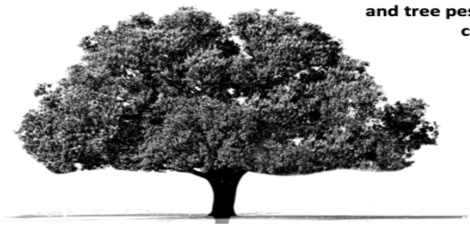
**Introduction**

It is known that the urban environment is quite different from the natural ecosystems where species naturally live and where they have evolved and/or adapted. It is therefore of paramount importance to know which are the effects of the urban conditions on tree physiology and growth and to adopt the best planting and management techniques which allow to increase plant growth and to improve and maintain a good health state, thus maximizing their effects both under current and future environmental conditions. Many factors affect tree growth in the urban environment, and they can be summarized in figure 1.
A number of factors must be considered in order to ensure that the proper plant is placed in a specific site in the specific time and when proper management techniques are applied. In general, these factors are divided into three major categories, which include design, site, and maintenance considerations. More specifically, factors to consider when selecting trees for city streets or park landscapes include pruning requirements and response, tree stability, drought tolerance, disease resistance, catastrophic insect pests, soil adaptation, complementary planting, shade or sun adaptation, provenance, and adaptive cultivars. As a matter of fact, while we are all aware of all the potential benefits of trees in the urban stands, only in the last ten years some efforts have been done to select plants for this kind of use. On the other hand, to meet all the expectations, we need to select trees that will tolerate the climate change which is predicted to result in altered rainfall patterns with an increase in the frequency and severity of summer drought across different areas in both Hemispheres and, probably, in extreme weather events (heavy storms, tornadoes, etc.). Drought is predicted to be most significant factor in the Mediterranean-like climates where it is usually combined with high irradiance and high temperature and this will strongly affect survival and growth of newly planted trees and will probably influence the development of diseases and tree pest resistance. Not only are the short-term effects on growth or survival in extreme years important, but also the long-term impacts have to be considered in selecting planting material. Prolonged hot and dry periods are becoming common in different part of the world, thus selecting trees that use water efficiently without the need for frequent watering or irrigation is the main way to make our green areas less subject to drought stress and more sustainable. With impending water shortages in many urban areas leading to prohibitions of irrigation or watering, planting trees that are more tolerant to drought conditions is the best long-term solution to a healthier, low-maintenance landscape.




## Main criteria for the selection of planting material in a global change scenario

As underlined by Benedikz et al. (2005), the production of high-quality planting material is the first link to establish a healthy urban landscape and its importance is obvious. Planting projects can fail because of poor quality plants and when the wrong species or variety/cultivar is planted.

Very often tree selection for urban planting doesn't take into considerations all the issues related to survivability and growth performance. Attractive trees can be selected from lists of tough, durable and ecologically appropriate trees, but aesthetic alone provides insufficient basis for selecting trees with high survival percentage and good growth performance.

This is particularly important in a global change scenario where, for example, the warmer microclimate of the densely built-up areas within the cities can be advantageous in the north of Europe, enabling the cultivation of less winter-hardy species in the cities and the choice of a wider range of exotic species and phenotypes than would not normally be expected for those climates. Conversely the improved microclimate can also cause early flushing or prolong the growing season, making the trees susceptible to late spring or early autumn frosts. Whereas in Southern Europe the higher temperatures and the reduced water-availability in paved areas can lead to drought conditions and may even curtail the species choice. The fact that the urban environment is a series of heterogeneous microclimates must also be taken into consideration. Therefore, successful planting is dependant on many factors. It is not only necessary to use the right type of plant of the highest quality, but it is essential to ensure that the site is suitable to the tree. Proper site assessment should precede plant selection if urban tree plantings are to be successful. The match up of site limitations with tree adaptability is commonly called the "right tree in the right place". Hence not only plant quality must be considered, but also the choice of species, their origins, cultivars and site amelioration.

The debate about the exclusive use of native plants for new planting or, in any case, their absolute priority towards allochthonous ones has become part of this context. However, there is no consensus regarding the term 'native' and its actual meaning; it is a 'fluid' word which needs a precise context to be fully understood and explained (Ferrini, 2011). Sternberg (1996) divides native plants in different categories, clearly distinguishing autochthonous plants, those originated and evolved in a precise site, from the indigenous that have been established a long time before in a site, but were introduced by natural

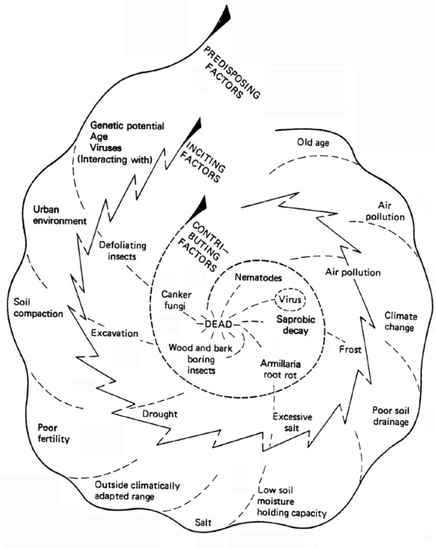



**Fig. 2** – Main criteria for species selection in urban areas (Sjoman et al., 2017).

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**Fig. 1** – Factors affecting tree growth in the urban environment.

diffusion and, finally, from those naturalized, massively introduced by man in specific sites where they became perfectly adapted. The question is "what's the meaning of exotic and native species in the actual urban environment?" As reported by Clark and Kjelgren (1989) there is no reason to assume that trees native to a locality are somehow inherently superior to exotic or non-native species for use in the cities. Both the physical environment and the management systems associated with urban areas are so different from natural conditions, even within a given geographic locale, that no logical jump from forest to urban site seems possible. In fact, even if the cities and towns are located within natural forest regions, trees from these forests have not adapted to the harsh environmental conditions of the city where meso – and microenvironment are markedly different from the general climatic conditions influencing the growth of local woodlands.

To this regard there is in Europe a debate revolving on the use of native broadleaved species for urban purposes because of their tolerance to the environmental conditions. Unfortunately, research on their use as urban trees has been inadequate, thus limited information is available throughout technical and scientific literature. Anyway, as we move forward into the 21st century there is an increasing interest about the use of suitable and reliable native or naturalized species to bring diversity to monospecific avenues and streets and to increase biodiversity (especially in periurban green areas) and the recreational value of the urban forests in our cities. To realize this reliable information on their ecology in the urban environment and their interaction with it is strongly needed.

However, while native species should be the first choice, we can affirm that the use of exotic species shouldn't be excluded *a priori* but, more simply, they should not prevail on autochthonous and indigenous ones and that their excessive use doesn't promote a sort of 'vegetal globalization' to the detriment of native species.

The main criteria for species selection in urban areas have been recently explained by Sjoman et al. (2017) and summarized in figure 2:

1. Bioecological (hardiness, tolerance to anoxia, tolerance to soil compaction, tolerance to drought, disease resistance, low risk to become an invasive species, being a food source for local fauna, tolerance to shade, tolerance to soil pollution and anomalies).
2. Functional (low maintenance cost, reduced conflicts with human activities and health, growth rate, longevity, improving urban climate and pollutants reduction, tolerance to root manipulation, conflicts with sidewalk, pavement, etc., suscep-

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**Fig. 3** – Decline disease spiral (Manion, 1991).



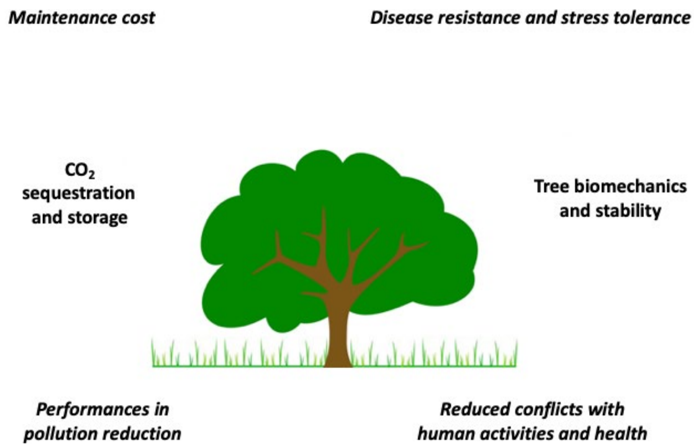
tibility to frequent pruning in relation to possible interferences with traffic and services, branch breakage potential, easy to transplant and to manage).
3. Technical (production method, smaller or bigger trees, morphological traits).
4. Aesthetical (deciduous or evergreen species, trunk, leaves and flowers colour, density and texture, growth and habitus uniformity, canopy height and shape in relation to street dimension).

Considering all these criteria is key for the development of successful tree planting program to take into account the intrinsic characteristics of the urban environment and the setting up of a regular program for a long-term management.

The selection of resilient species able to deal with the main biotic (species resistance) and abiotic (species tolerance) stresses is considered to be the most efficient and long-lasting control method for trees growing in urban and metropolitan areas (Santamour, 1977). The first step in selecting species for urban planting is to analyse the sensitivity of the different species to global change. The assessment should identify whether global change could cause significant negative impacts on tree growth and physiology. If a species appears to be unsensitive to climate change, city planners and arborists should move on the next step, that is site assessment and modification (if needed) and planting. If a species appears to be sensitive to climate change, there will be a need to select potential alternative species. Research is strongly needed all around the world to develop trees that can tolerate these stresses. A breeding and selection program to develop trees for artificial ecosystems needs to take cultural practices into account.

According to Shurtleff (1980) we can distinguish five steps to get better trees into the urban landscape:

1. mass field selection to discover sources of resistance. This involves testing of many thousands of individuals collected over a wide geographical area;
2. vegetative propagation of likely candidates. But there is a need to reduce this number quickly to get a breeding program down to a manageable size;
3. trial plantings over a wide area and under highly variable conditions;
4. evaluation of test selections with certification (if feasible) of the best individuals to build up clone numbers;
5. distribution to commercial growers. This process will be money and time consuming, but the results can be highly beneficial for the future of our cities.




People who work in the field of arboriculture are aware of the uniqueness of tree biotic and abiotic problems and the challenges to face when the trees are located near large human populations. Already in 1977, Wilson reported that one disruptive force (in our case the climate change or the construction of building and infrastructures) can set into play a chain of successive changes. These changes can proceed to a point where certain species no longer can survive in that ecosystem because it becomes unfit for the existing vegetation.

Manion (1991) proposed a similar idea but placed more emphasis on the temporal sequence of factors and their interaction; his conceptual model was illustrated through a decline disease spiral that depicted the series of events that culminated in tree death (fig. 3).

In the urban stand pollution is a factor to be seriously taken into consideration and we are becoming aware of air pollutants that may have profound effects on disease and insect problems of urban trees. Possibly the direct air pollutant damage to trees is small compared to the predisposing effects of these disruptive agents to other tree problems and there is an endless array of disease complexes that can be conceived for urban tree diseases.

In the past decades many cities have planted, especially in Northern Europe, not only trees of a selected species, but even a selected clone on their streets. It is obviously nice to see a wide avenue made of identical trees belonging to the same species, but unfortunately, as recently stated by Bassuk et al., (2002) the appeal of same species plantings is ultimately outweighed by disadvantages. Even if aesthetics was the only consideration, the fact that unhealthy or dead trees are unattractive, makes the need to diversify unavoidable. For example, a rapid review of disease and pest problems in street tree populations reveals numerous cases of devastation due to over-planting or the exclusive planting of a single species throughout a community. Some of the most notable examples include the American elm (Dutch elm disease), American chestnut (chestnut blight), Honey locust (honey locust plant bug), Norway maple (giant tar spot and verticillium wilt) London planetree (canker, anthracnose) and crabapple (scab, fireblight, cedar apple rust, and powdery mildew). Still according to what stated by Bassuk et al., (2002) to avoid similar problems in the future, it is clear that uniform plantings of a limited number of species must be avoided. But, is it possible to gain the practical advantages of diversity without giving up the aesthetic advantages of uniformity? Fortunately, the answer is yes. Through careful selection and grouping of plants, communities of trees can be created which, despite their genetic diversity can satisfy our desire for visual uniformity. By breaking down the visual characteristics that distinguish one species or cultivar from another into basic categories, it is possible to select criteria for putting trees into aesthetically compatible groups.

So, the key against adversity is increasing biodiversity and keeping a good species diversity in plantings is always a wise management decision. As new pests and diseases inhabit our woody landscapes, species diversity may be a critical key to minimizing their impact. A suggestion can be to seek out pioneer species i.e. those plants that colonize open fields or newly formed land surface left behind such as ex-industrial areas, coal or gravel mines. Pioneer species can change accordingly to the site but, at least in Europe and North America, they generally belong to genera like *Populus, Celtis, Ulmus, Cornus, Crataegus, Salix, Acer, Betula*.

**Conclusion**

The selection of trees for future plantings can only be successful if many single criteria are considered. These criteria must be chosen keeping in mind that trees are long-lived beings and accordingly to the limited degree to which adoption to changes can occur, it will be increasingly necessary to consider the impact of changes on urban trees and on urban forest management plans, including species and site selection. Apart from improving site condition through a precise assessment of the intrinsic and extrinsic factors, it is important to take into account all the possible changes to be expected in the future. After planting, urban tree management practices also need to be considered when estimating the net effect of urban trees on atmospheric carbon dioxide (Nowak et al., 2006). These should not only be aimed toward maintaining trees as much healthy as possible and to limit carbon emission (via fossil-fuel combustion) (Nowak et al., 2002). Urban tree management must meet these challenges and the role of research must be promoted and funded. Increased emphasis should be placed on selection and/or breeding trees for environmental stress tolerance, such as drought and temperature stress. Tolerance or resistance of trees to environmental stress will result in healthier trees that are not only able to resist disease but will notably improving the quality of the urban environment (Boland et al., 2004).

It is our opinion that the main strategy for protecting trees from the adverse effects of climate change and for maximizing their benefits on the urban environment and on human well-being, consists in developing long term management and replacement programmes which will ensure a balanced age range and a good tree health.

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Clearcut #1, Palm Oil Plantation, Borneo, Malaysia 2016. photo(s) © Edward Burtynsky, courtesy Admira Photography, Milan / Nicholas Metivier Gallery, Toronto.
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Decision makers, policy makers, city planners as well as stakeholders should be aware of the impacts that global change will have in our life and of the paramount importance of urban vegetation to mitigate these impacts and to improve the quality of our cities.

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