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Correlations between garden design plant applications and climate change

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ABSTRACT

Possible effects of climate change means great challenges to landscape design professionals in Hungary. Our climate will shift towards the Mediterranean and we have to prepare for this with among others, choosing correctly the plants to be planted. Teaching garden design dendrology has not recognized yet the necessity and urgency of this matter. Quick measures are required due to the long life-time and slow development of woody taxons. This paper presents the double relationship between landscape design and climate change emphasizing the outdoor architectural methods of adjustment. Such techniques recognized abroad are presented like precipitation drainage by vegetation and extensive green roof. Finally the effects of climate change on ornamental plants application are presented together with the associated project started at the Corvinus University of Budapest in 2010.

LANDSCAPE DESIGN AND CLIMATE CHANGE

Relationship between landscape design as an engineering scientific field and climate change is double: on the one hand landscape design methods can help the protection of climate and on the other hand we have to adjust to the climate change. Regarding climate protection it is highly important to increase the spreading of CO_2 bonding vegetation by various landscape design methods: regulation plans can help changes among cultivation types, it can prescribe particular plantation of vegetation in outdoor architectural plans, it can improve the living conditions of the vegetation, for example by establishing water surfaces, landscaping. Garden design, garden planning are parts of landscape design. It is thinking in small steps therefore its role in climate protection is limited, its effects on the micro-climate and the urban meso-climate are more significant.

Today's tendency – from landscape architectural university training point of view – preference of intensive garden maintenance methods the essence of which is to maintain the state of the garden regardless of resources, time and costs even in the case of plans regarding no environmental conditions. Automatic irrigation systems using the public network or fertilizing are classified into intensive garden maintenance. It gave such a tool by today with which we could think we do not need to accommodate to climate change. This view is dangerous from several points of view: on the one hand we will have to accommodate to climate change sooner-or-later as intensive garden maintenance only delays and not solves the problem; on the other hand it is doubtless opposite to the climate protection efforts (energy wasting).

Intensive garden maintenance – mainly due to increasing energy prices – may get into crisis in future decades. In order to avoid it ecologic efforts supporting the effectiveness of natural processes, like permaculture should be incorporated into the Hungarian professional knowledge. This method pointing beyond eco-management hardly known in Hungary yet can be characterized so that it sets every element of management – including the flora and fauna, landscape conditions and buildings – into such a united ecological system in which productivity and applicability increase with the help of a connection network planned beforehand while necessary expenses decrease (BAJI, 2009).

OUTDOOR ARCHITECTURAL MEASURES OF ACCOMMODATION

From landscape architecture point of view the primary consequence of climate change are the rising of temperature, drying of the growing season, increasing frequency of heavy rains and decreasing frost risk. These are – except for the latter one – regarded to be negative changes, however, the changing of these factors mean purely new landscape architectural challenges to be solved that have to be not assessed but accommodated to. From settlement and outdoor design points of view important tasks are presented by the frequency of extreme precipitation (and in a smaller part the rising of temperature as well) the rest of the changes rather influence the applied plant species. In the following the outdoor architectural measures are presented that help accommodation to climate change.

In urban environment greatest problem is caused by the prevailing view that we would like to get rid of the precipitation falling suddenly thus it is drained into the public drainage network – generally managed in a joined system with the sewage – as soon as possible. Heavy rainstorms in recent years like in Budapest July 2006 and June 2009 revealed that the drainage network cannot drain precipitation water in every case. Therefore the target has to be set to leave as less precipitation water as possible and as slow as possible into the drainage network.

This can be achieved by establishing green roofs on the flat tops of buildings. Green roofs are planted by vegetation where insulation and gardening layers form a unit reducing the runoff velocity of precipitation and the water quantity entering the drainage network by the precipitation retaining capacity of the substrate, the vegetation and by evapotranspiration (evaporation and transpiration).

Further ecological advantages of green roofs apart from retaining the precipitation water are the moderation of the urban meso-climate (so called heat island effect), cleaning of the air and increasing biodiversity. It also has aesthetic values and secondary social effects (recreation function, job establishing power). Most important arguments, however, are economic ones: it improves the energy balance of buildings with its shading and heat insulating effects, protects the roof cover, filters the noise and the ultra violet radiation, as a whole it increases the value of the property. Two main types of green roofs are the extensive (shallow productive layer with small maintenance costs) and the intensive (deeper productive layer with greater maintenance costs) ones. The latter one is also called as roof garden if it is accessible and may function as a garden. Considering these, plantation of extensive green roofs can be recommended as it has less establishment cost, smaller maintenance expenses with significant power in improving the life standard in the settlement (SZABÓ, 2009).

Figure 1: Good example of a facade overgrown by woodbine in Budapest. (Photo: Ákos Bede-Fazekas 2010)

Establishing green facades is not widespread in Hungary in contrast to green roofs. They include greening outdoor walls by vegetation, wood species or mounted green facade elements planted into special wall holes. In a wider sense creepers climbing up the walls – with the help of a support network or not – are classified into green façade category as well. This latter seem to be the most sustainable system and in the drier climate of Hungary plantation of creepers is recommended to be supported instead of mounted green facades.

In a private garden we have to aim for retaining and infiltrating the total precipitation water quantity. This can be achieved by appropriate landscaping and plantations complemented by sedimentation and reservoir basins. Retaining precipitation water presents a larger challenge in an urban environment mainly due to the great ratio of covered surfaces. The aim in this case as well is to retain and infiltrate into the soil as much of the precipitation water as possible or to improve the micro-climate by evaporating the accumulated rainwater. Released precipitation shall be delayed from the public drainage network as long as possible and shall be drained separately from the sewage!

There are several ways to retain precipitation on the surface. One method is to form pervious cover that can be spread (rubble stone, pea gravel), composed of several smaller elements (dressing stone, cobblestone, pervious concrete mould) or continuous (drain asphalt, stabilized rubble stone, grass strengthen by turf grid). It is important to lay these covers on flexible bases to leave precipitation to infiltrate down to the subsoil. We also have to consider the danger presented by movements due to frost effect! A further solution is to accumulate and infiltrate surface precipitation by a drainage layer (subsurface drain well, desiccating ditch) that can be combined by vegetation as well. Drainage helped by vegetation is not widespread in Hungary yet, however, it is effective and aesthetic measure against precipitation runoff both in urban and in private garden environments. Several types of infiltration helped by vegetation are identified including filtering belt, grassy hollows, water retaining area, infiltrating plantation basin, rain garden (CSILLAG, 2009).

There are further landscape architectural measures to accommodate to the climate change that can be applied easily in both private garden an public area contexts. One of these is to establish multi-levelled, structured plantations. Combining perennial herbaceous plants, bushes and trees help the development of a more vaporous, cooler and more balanced micro-climate. The role of which is expected to rise significantly in our parks the following decades. Further aim is – again to improve the micro-climate – to increase surface and leafage cover. Covering the surface protects against greater precipitation falling suddenly and against associated erosion as well. Furthermore extended areas with vegetation cover mean greater evapotranspiration as well. Increasing foliage cover – that is the most apparent measure of protection against climate change – is accompanied by the change of view that urges the retaining of woody plants found in the area of outdoor design as much as possible – independent from their dendrological value.

Utilizing existing relief forms and changing them by landscaping can improve not only the rate of retaining precipitation water but micro-climatic conditions as well influencing at the same time wind movement and surface exposure moderating as a consequence the unwanted effects of climate change. A further measure to accommodate to climate change beyond the above mentioned is to apply appropriate plants as in the future plants of warmer climate will appear in our gardens as ornamental plants. Selecting the species, breeds recommended for plantation will be the great challenge for future decades demanding a conscious seeing into the future from landscape designer professionals. Relationships between climate change and application of ornamental plants are investigated in the followings.

APPLYING PLANTS AT THE TIME OF CLIMATE CHANGE

Hungarian climate is formed by dry continental, wet oceanic and Mediterranean climate effects from which the Mediterranean effects will advance in the forthcoming century this is why plants applied in our gardens and parks have to be changed. Due to the long lifetime of woody plants landscape designers have to think in advance thus the plants that will be in their peak thirty years later – planted today – have to be selected from species enduring drought, preferring warmth and enduring Mediterranean climatic effects. A part of these plants survives difficultly the current severe winters (winter cover and frost protection help) but the risk of freezing will decrease gradually in the forthcoming decades. Ornamental plants originated from southern areas are termed frequently as frost sensitive that is used generally parallel to warmth demand, however, using the terms as synonyms is misleading and may deter people from planting them. Therefore, frost sensitivity is recommended to be regarded as a temporary problem solved easily in good garden conditions.

It is necessary to identify species and breeds that cope well with today's climate conditions as well (enduring frost and winter). Unfortunately there are only a few example on selection of taxa originated from areas of warmer climate regarding frost endurance, on multiplication, presentation and spreading of selected species and breeds in Hungary. Botanic gardens (and arboretums) where older plants of these warmth demanding exotic species can be found and plant keeping experience is present may have special role. Such collections in Hungary are in Pécs, Sopron, Badacsonyörs, Csákvár, Budakeszi and Somogyvámos. Most warmth demanding species are from the Mediterranean, western shores of North America and the Far East.

Figure 2: The Folly Arboretum in Badacsonyörs is the home of old plants of several rare warmth demanding species. In the foreground a Chinese juvenile cone can be seen. (Photo: Ákos Bede-Fazekas 2010)

Domestic garden design dendrological literature deals with very few warmth demanding taxa, although the list could be extended significantly on the basis of species and breeds found in Hungarian botanic gardens. Several cypress, pines and evergreen oaks could be applied in the changed climatic conditions, however, numerous other species would worth trying them like *Abies bracteata, Abies cilicica, Abies lowiana, Abies pardei, Acer kawakami, Aesculus californica, Berberis morrisonensis, Carpinus turczaninowii, Celtis bungeana, Cephalanthus occidentalis, × Chitalpa tashkentensis, Cupressus bakeri, Cupressus gigantea, Cupressus goveniana, Cupressus pigmaea, Cupressus torulosa, Elaeagnus bockii, Ephedra equisetina, Fontanesia fortunei, Helwingia chinensis, Ilex latifolia, Juniperus deppeana, Juniperus pseudosabina, Kalopanax pictus, Ligustrum lucidum, Mahonia fremontii, Melia chinensis, Phillyrea angustifolia, Picea koyamai, Pinus bungeana, Pinus gerardiana, Pinus palustris, Pinus pinaster, Pinus sabiniana, Prunus lusitanica, Quercus faginea, Quercus libani, Quercus trojana, Rhamnus alaternus, Sequoia sempervirens, Tilia maximowicziana, Torreya jackii, Viburnum wrightii, Yucca baileyi, Zanthoxylum alatum* (BEDE-FAZEKAS 2009).

Figure 3: Himalayan real cypress in the Arboretum in Buda (photo: Ákos Bede-Fazekas 2010)

It is not enough, however, to give lists of new species as such lists are subjective based on only a few domestic individuals. It is important therefore to predict in objective ways based on controllable scientific methods what taxa (maybe limited to species due to the lack of data) are expected to advance in our gardens in the future. In contrast to botanists for the landscape designer not the future distribution area of the given plant is interesting but rather whether the plant founds good life conditions in good garden conditions or not. Thus in contrast to area shift it is much easier and more accurate to estimate and model which areas will meet the climate demands of the selected species in the future. Demand of the plant can be determined accurately based on its current distribution area and the meteorological data sets of past centuries. Considering this, research has been initiated in the Corvinus University of Budapest to model the shifting towards the north of areas appropriate for species demanding warmth, mainly Mediterranean pines. Predictions to the period between 2011 and 2100 were prepared based on various climate scenarios.

As an example the preliminary map showing the maritime pine is given. Dark grey indicates the continuous distribution areas found in the Euforgen database (Atlantic and Mediterranean shores) based on which the climatic demands of the species are estimated using the monthly average temperature and monthly average precipitation of meteorological data sets from 1960–1990. Light grey colouring indicates areas that would have been suitable for the plant in the last decades (Greece, Italy, Spain and extended areas in France beyond those mentioned above) while middle grey indicates areas where the species will be possible to be planted securely between 2011 and 2040 according to the climate model. Most significant advancement of the studied taxon is expected in the northern areas under the effect of the Gulf stream, however, results interesting for Hungary are also presented in the preliminary research. As can be seen the southern Transdanubia will be suitable for maritime pine to be planted in forthcoming decades a few of which can already be found in Hungarian botanic gardens but unfortunately only a few steps have been taken for its multiplication, distribution, presentation and securing its acceptance by professionals. The presented model species is only one of numerous taxa the names of which were left out of Hungarian dendrological textbooks and tree nursery price lists!

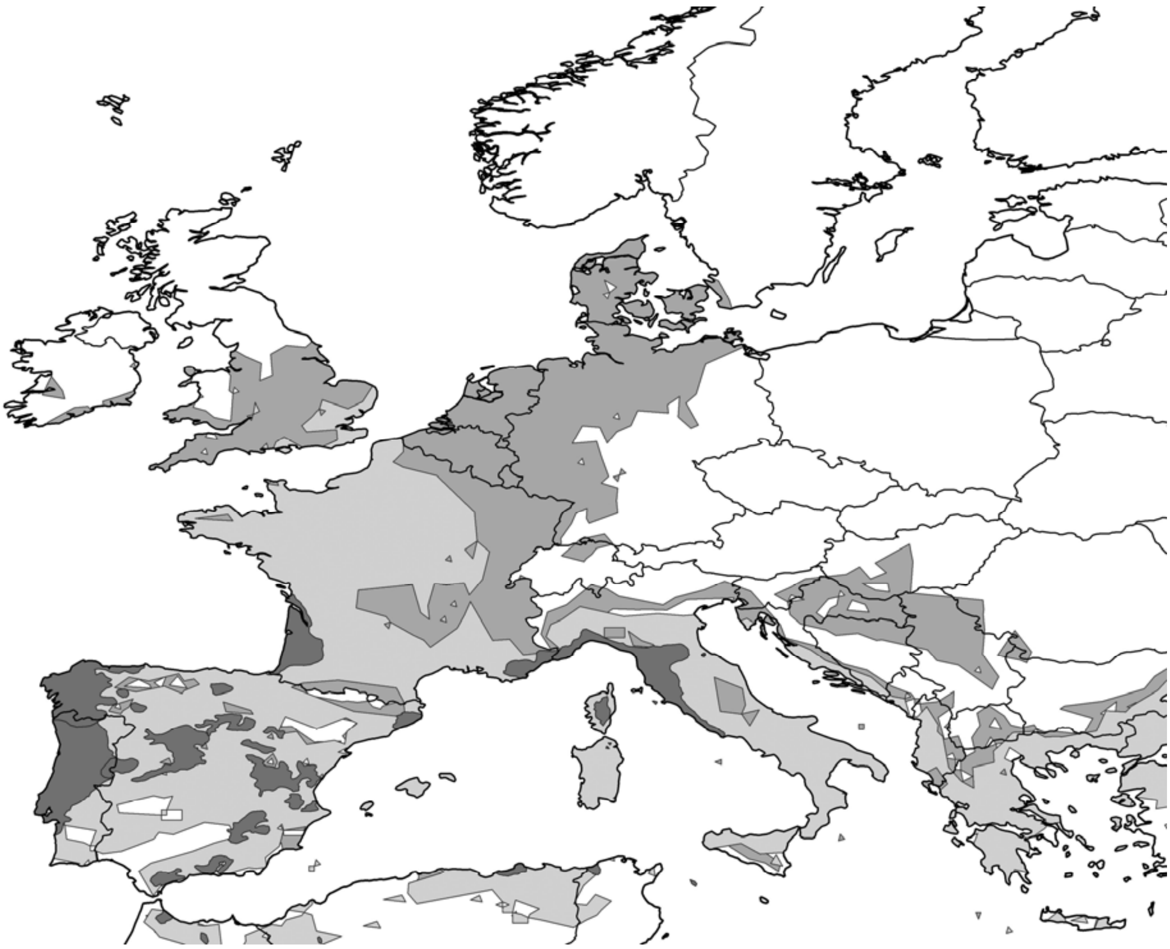

Figure 4: Distribution area and climate demand of maritime pine reflecting the climate change (the map was constructed by the author based on the Euforgen area database)

The research described above is suitable for tracing not only species advancing into the area of Hungary but those leaving it as well as some of the indigenous taxa (or planted regularly nowadays) are expected to find not even the minimum conditions of plantation in Hungary due to the effects of climate change. The last few centuries brought continuous extension of plant offer for garden design dendrology, however, climate change may reverse this tendency. Further development of the research – the aim of which is to predict the changes in the real distribution area – could be achieved by searching functions approaching well the current area, however, this requires significant mathematical and programming backgrounds.

SUMMARY

In its report the Climate Change Intergovernmental Board urges for preliminary plans for the changed climatic conditions based on the scenarios modelling climate change. Considering garden dendrology this means the finding of taxa that could be applied successfully by garden design in Hungary in future decades. Woody plants originated from warmer climate proved themselves several times in Hungary: more-and-more species in increasing number of locations prove their warmth and drought endurance.

My highest aim with my presentations, research and publications is to call the attention of landscape designers to the importance of accommodating to climate change and to help to take the initial steps to reduce the apparent backlog of the profession to climate change.

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