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Impression of the global climate change on the ornamental plant usage in Hungary

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Abstract: The climate modeling, which has adequate spatial and temporal resolution, shows that the future climate of the Carpathian Basin will be much more arid and hot than nowadays. The currently used and taught assortment of the ligneous ornamental plants should be urgently revised. It is aimed in my research to collect the species which will probably be introduced in the future. They can be gathered from the Hungarian botanical gardens and research centers and from the spatially analogous territories. The collected taxa should be examined with GIS software if they will really suffer our future climate.

Keywords: dendrology, ornamental plant, adaptation, climate modeling, distributional range, Mediterranean pines

1. Introduction

A few years ago the fact of the global climate change was disputed. Nevertheless, the existence of the climate change is acknowledged by the academic level nowadays. The question is just about the extent of anthropogenic origin. Even though the landscape may plays a role in mitigation (land use regulation, afforestation), small-scale open space and garden design, however, may help especially in adaptation [6]. The debate on the origin of climate change is irrelevant from this perspective.

The landscape architecture can contribute to adaptation with a number of tools, including the green roofs, green facades, landscaping, attainment of dense tree stratum and land cover, the development of complex stands, sustainable management of surface rainwater and use of drought-resistant plants. [7, 8] Researches focus on the latter.

The climate modeling, which started around 1946-54, now produces surprisingly accurate results, including spatial and temporal resolution. Accordingly, regional models have also been made for the area of the Carpathian Basin [7, 11, 12]. These are based on the IPCC SRES scenarios, named A2 and B2, and cover the period until 2100. By the end of the century the average temperature of the summer season rise 3.7 to 5.1 ° C [2], while the maximum temperature rise 4.0 to 5.4 ° C. The frequency of extreme rainfall indices are expected to increase during the warmer half of the year, while the average rainfall decreases in summer and autumn [1]. Such a level of drying is cannot be tolerated by the plants commercially available in Hungary or included the dendrological curriculum of the landscape architect students. It is therefore necessary to get to know our future climate at least 30-40 years into the future, because so much time is needed for the selection, cognition, propagation and raise of trees to be in their prime 30-40 years later [4]. Annuals and perennial plants can spread rapidly, so my research has been concentrated to the ligneous plants.

2. Materials and Methods

According to the predictions for the period 2011-2040, spatially analogous territories can be found in South Romania, North Bulgaria, Serbia, Macedonia and North Greece [10]. It is therefore necessary to know the assortment of ornamental plants of these regions. The expectable alteration of the Hungarian ornamental plant assortment can be inferred from the comparison to the assortment of the spatially analogous territories. This requires the establishment of an international research team. Sapientia-Hungarian University of Transylvania and Corvinus University of Budapest started cooperation, as a first step. We should turn not just the southeastern direction, but the north, because the actual climate of Hungary will be shifted towards the territory of Poland in the next 30 years [9]. Thus, we could provide proposal for our Polish landscape architect colleagues to enlarge, transform their assortment of ornamental plants.

It is not necessary to travel to distant lands for the sake of recognize the new species, because some of the indigenous research centers and botanical gardens have a great deal of experience about the introduction of species require warm temperature. Among these, the arboretum of Pécs, Badacsonytomaj and Sopron (old plantations), the botanical garden of Somogyvámos (juvenile plantation), the private arboretum of Csákvár, the garden of the International Dendrological Research Institute, Budakeszi, and the new plantation in the old arboretum of Pannonhalma should be emphasized (*Fig. 1*). Most of the accumulated experiences are unpublished or, at least, they cannot reach the practicing landscape architects [3]. It is aimed by me to collect, systematize, reconcile with the landscape architecture demands, and spread this knowledge. Therefore, in the course of my former research, I collected more than two hundred taxa little-known in Hungary, but verified in the Hungarian climate. Of course, an insignificant part of them are commercially available.

Figure 1: There are a numerous of rare, frost-sensitive, old trees planted in the Folly Arboretum of Badacsonytomaj, Hungary. In the foreground *Pinus armandii* can be seen. The photo was taken by the author in July, 2010.

The plants taking part in my research are often referred as warm-like or frost-sensitive. These attributes are not synonyms; however, for the most of the taxa, they are acceptable. The demand of warm temperature will clearly be appreciable as benefit, whilst the frost-sensitivity will present a problem only in the first few decades. The axiom of sustainability is often asserted nowadays, which, for the garden designer, should mean the reinterpretation of the concept of intensive maintenance. From the point of view of the frost-sensitive plants this means that the cost of the watering should rearrange to defend the plants from the wintery frost. The heap of the stem, the frost and light protection of the trunk, the shelter of the crown from the pressure of the winter moisture, and the cover of the whole plant from the frost are such instruments of garden maintenance, which are, in case of the young plants, easily and cheaply realizable (*Fig. 2*).

Figure 2: The shelter of the trunk and the binding of the crown of a recently planted *Pinus pinea* in Pannonhalma, Hungary. The photo was taken by the author in January, 2011.

In the vegetation period just a few respects must be considered furthermore: the frost-sensitive plants call for another way of watering, fertilizing and pruning than others. The frost-sensitivity, which causes a little, but resolvable problem in the beginning, does not indicate trouble later. However, these plants will suffer our future climate better than the ones introduced nowadays [4].

The perceptions explained previously were verified only by experimental methods. A more exact and expressive vision of the change of our ornamental plant assortment will be provided by modeling the future distribution of the species. In 2010, at the Corvinus University of Budapest a new research started to determine the species, which will probably be spread in our country. The research is built upon the data of existing climate models. It examines the period of 2011-2100. The software used for the research is ESRI ArcGis, a geographic information system application.

Although the current distributional range of plants can be determined well, a description of the plant demand, with an exact formula, is necessary to demarcate the future area. It is not available for us, however, is not so much important in the respect of landscape architecture. The range of the future introduction is rather interesting. It can, from a climatic point of view, be mapped with the potential distributional range.

The method of the research can be dissociated to some main steps. Firstly, the environmental (climatic) demands of the examined plant are queried from the actual distributional range and the climate data records of the reference period (1961-1990). This time deviation (20-60 years) is not significant, because of the slow change of the climate in the past decades. On the other hand the trees, which possess the distributional range nowadays, germinated decades before. The map of the area can be originated from several source; for the yet accomplished research the Euforgen digital area database have been used. In the next step the future time period is selected, which the introduction area of plant should be scanned in. The period of 2011-2040 was modeled in the research accomplished yet. Finally, those regions are filtered, which is overlapped by the demands of the plant. The result of filtering can be displayed in a map [5].

The aim of our research is, beyond the others described before, to determine the parameters, which approximate the demands of plants most of all. Though the microclimatic and soil conditions are not examined, the range, in which the plant can be introduced, can be determined well. The reason for this is that the parameters beyond the macroclimatic factors can be influenced easily with the instruments of landscape architecture. Maybe the high trees with special soil demand can cause some problems.

3. Results and discussions

The results of the recently started research are spectacular; however the selected period (2011-2040) is nearest to the reference period. The periods chosen afterwards (2041-2070, 2071-2100) will probably show a more expressive shift. It is, however, necessary to be noted, that for the later periods the selection of the parameters, which describe the demands of plant well and give a range large enough to interpret, is more difficult.

The yet accomplished research has suggested that the various indices of aridity do not give suitably interpretable results. The future maps based on Pálfai Index (*Fig. 3*) and Ellenberg Index show such a large territory, that they are undesirable to scrutinize further. The formula considering the temperature and precipitation data of the twelve months of the year is too strict. This is why it covers an insignificantly little area. Between the two utmost points two methods were tested. One of them does not examine the moisture, just the temperature of the twelve months is taken into consideration. The second method considers, besides the monthly temperature data, the rainfall of the vegetation period. On account of the express relation between the distributional range of plants and the precipitation and the claim to display a satisfactorily large territory, it can be declared, that from among the tested methods the most adequate is the one, which calculates upon the rainfall of the vegetation period (*Fig. 4*).

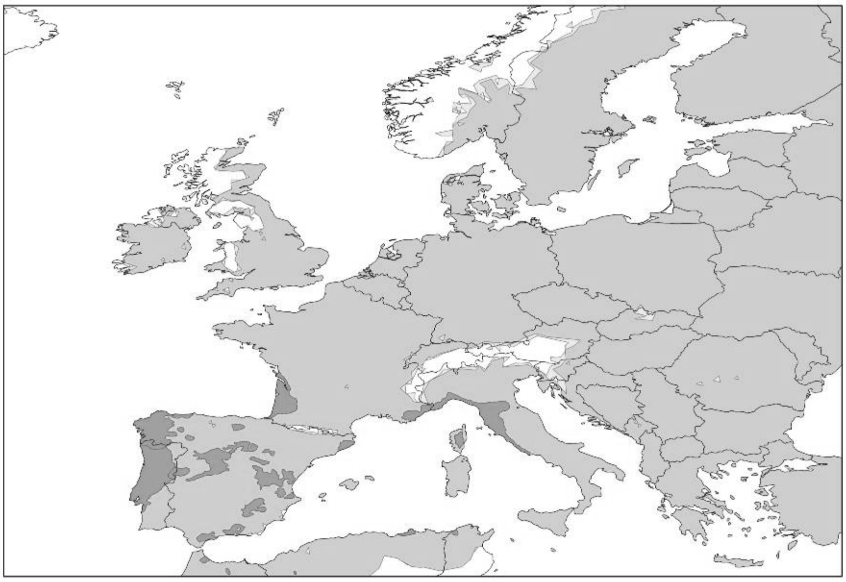

Figure 3: The distributional range (deep-gray), the potential distributional range (middle-gray), and the range where the examined taxon (*Pinus pinaster*) could be introduced in the period of 2011-2040 (light-gray) according to the Pálfai Index. The map was created by the author with the help of the Euforgen digital area database.

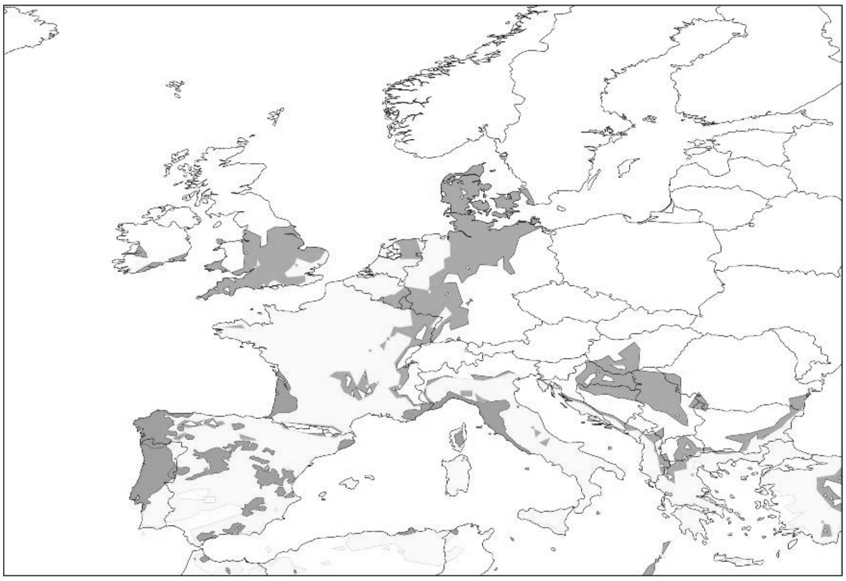

Figure 4: The distributional range (deep-gray), the potential distributional range (light-gray), and the range where the examined taxon (*Pinus pinaster*) could be introduced in the period of 2011-2040 (middle-gray) according to the most adequate formula. The map was created by the author with the help of the Euforgen digital area database.

The selection of species is not too simple. In the long run it is an explicit aim, that continually more species to be initiated into the research. For the present the research of the Mediterranean trees and shrubs of Europe has been started, the selected taxa are shown in *Table 1*.

Table 1: The selected taxa for the research

Abies borisii-regis	*Phillyrea latifolia*	*Quercus canariensis*
Abies bornmuelleriana	*Pinus brutia*	*Quercus coccifera*
Abies cilicica	*Pinus eldarica*	*Quercus faginea*
Abies pardei	*Pinus halepensis*	*Quercus × hispanica*
Acer heldreichii	*Pinus peuce*	*Quercus ilex*
Acer sempervirens	*Pinus pinaster*	*Quercus rotundifolia*
Juniperus oxycedrus	*Pinus pinea*	*Quercus trojana*
Juniperus thurifera	*Pistacia terebinthus*	*Rhamnus alaternus*
Phillyrea angustifolia	*Prunus lusitanica*	*Ulex europaeus*

The maps of *Quercus suber*, *Pinus nigra* (reference), *Pinus pinea*, *Pinus pinaster*, *Pinus halepensis* and *Pinus brutia* are finished yet. I allege *Pinus brutia* among them to explain the results of the research (*Fig. 5*). The continuous distributional range that can be found in the Euforgen digital area database is displayed with a dark-gray color. On the basis of this it is attempted to determine the climatic demands of the species with the help of the meteorological data records (monthly temperature and precipitation) of the reference period (1961-90). The light-gray colored territory shows the range which the plant could be potentially distributed to. It is much larger than the real area of the taxon. The middle-gray color shows the range where the pine can be introduced in the period 2011-2040. It can be seen that this area is shifted to the north direction, and, in the example of *Pinus brutia*, a large part of Hungary is included. It means that the future climate of, for example, Budapest, Hungary is as sufferable for this taxon as its original distributional range was in the reference period. This pine species is just one of the several, which could be introduced in the future climate of Hungary. The names of these taxa are almost unknown to the landscape architects of the country.

Figure 5: The range of distribution and potential introduction of *Pinus brutia*. The various regions are described in the text. The map was created by the author with the help of the Euforgen digital area database.

4. Conclusion

The landscape architects of Hungary should awake to the realization of the necessity of transformation, refresh of the ligneous ornamental plant assortment taught and used nowadays.

It is undeniable that the climate change is in the better position is this race. If we do all, what the adaptation to the climate change requires us, as urgently, as possible: it is late. We should grow familiar with our future climate, which is well determined by the regional climate models (several scenarios were taken into consideration, the special and temporal resolution is good enough). We must adapt to the more arid and hot future climate of Hungary. It is obvious that partially it means we must forget some of the ornamental plants used nowadays and become acquainted with the new, Mediterranean, drought-tolerant species. The intensive garden maintenance is ostrich policy, which is not worthy of the landscape architecture. A profession, that is proud of its intensive connection with the nature…

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