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Plant Species Selection and Community Configuration for Residential Areas Based on the Digital Technology

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Abstract

Sunshine is a key ecological factor for plant growth, development, reproduction and their community stability. The SOLWEIG model combined with ArcGIS and, AutoCAD software as a digital platform was used in this paper, and which focus on sunshine duration simulation by these digital technologies. Results show that the maximum sunshine duration is 10 hours, the minimum sunshine duration is 0 hours, and the average is about 4 hours in the sample points of the study area. The order from high to low is N>D>F>B>E>G>K>C>A>L>M (patches of planting area) in sunshine duration, the average highest value is 6 hours and the lowest is 1.6 hours for the 11 greening patches in this study. These results also indicate that the building height and layout is the major factor of influence in the change of sunshine hours when other parameters are stable. On this basis, the research combined with the standard system of sunshine requirements of landscape plants, an empirical analysis of plant selection and community configuration to show through a case of Tongxiang city in Zhejiang province, China. The value of this research is to provide a theoretical method for plant selection and community configuration in urban built-up areas.

Keywords: Solar radiation, SOWEIG model, GIS (geographic information systems), Landscape plant, Plant community

1. Introduction

Sunshine is an indispensable ecological factor for the photosynthesis of all green plants, therefore, it is equally important for the landscape plants. Specifically, the effect of sunshine on plants is mainly to determine their normal growth, development, reproduction and community stability (Teramura & Sullivan, 1994, Roderick, Farquhar et al., 2001). In general, when plants are selected for landscape construction, ecology or species protection in different areas, the basic ecological niche of the plants should meet as much as possible according to the local ecological conditions (de Siqueira, Durigan et al., 2009, Nagaraju, Gudasalamani et al., 2013). This is also the basic reflection of the "right tree, right place" in the ideal of plant cultivation (Li & Hao, 2008). In the field of modern city research and practice, especially under the premise of satisfying the housing space and traffic function requirements, the solar radiation and hydrological environment are showing a diversified trend. Therefore, the necessary ecological factors in the life process of plants are all affected to varying degrees. In addition, the ambient temperature, sunshine conditions (Bourbia & Awbi, 2004, Ahmed, Ossen et al., 2014), and the nature of soil (Jim, 1998; Negre, Zancolo et al., 2006), has also changed significantly.

In urban residential areas, building materials, height and pattern are the main factors that change the distribution of solar radiation. Related studies pay more attention to the problems of pollution, ventilation, and UHI (urban heat island) in cities (Shashua-Bar, Tzamir et al., 2004, Hang, Li et al., 2012, Ng & Chau, 2014), the impact of the changed sunshine on urban plants is less likely to discuss. The main reason for this phenomenon is that the hard landscapes, such as buildings, roads, squares and other infrastructures are generally the main body of construction in the process of urban planning. The landscape plant is often placed as an embellishment in the last link. In recent years, the active role played by landscape plants in cities has received increasing attention (Rai & Panda, 2013, Zhang, Lv et al., 2013). To ensure the survival of urban plants and maximize their ecological benefits in the city, the analysis of sunshine is particularly critical, especially in the selection of the best planting site for plant species.

As early as the 20th century, Chinese scholars have explored the impact of architecture on sunlight, and the research results have been used in the selection and application of landscape plants (Shao & Zhou, 1996). However, this research is limited by the performance of computers and lack of digital technology, there are no reports on the related application in the field of practice. Nowadays, advances in computers have greatly promoted the development of related digital software, and can meet the needs of research and practice for sunshine simulation. The digital simulation method is efficient and accurate compared to the experience-based methods, which can overcome the limitations of traditional methods, have become, and has become the first choice for the related simulation in architecture design and urban design (Besserud & Hussey, 2011, Maestre, Pérez-Lombard et al., 2013).

In recent years, china's software industry has developed rapidly, such as Sunlight, FastSun, SUN and other sunshine analysis software can better simulate the solar radiation, however, most of these are secondary development based on the AutoCAD platform. In the latest version of the ArcGIS system (ESRI), the Solar Analyst module is integrated in the spatial analysis toolbox, which can perform quantitative simulation of solar radiation based on the functional relationship of factors, such as altitude, latitude, slope, aspect, and viewshed in the study area (Fu & Rich, 1999).

Another digital model also performed well, like SOLWEIG model, this model from the urban climate group of Gothenburg University and is a program written in the Java and MATLAB language (Lindberg, 2008). By comparison, it has better stability (Hämmerle, Gál et al., 2011, Kántor & Unger, 2011), and has been successfully applied to the related research of urban environmental heat radiation (Lindberg, Holmer et al., 2008, Lindberg & Grimmond, 2011, Lindberg & Grimmond, 2011).

In this study, we adopted the SOLWEIG model as the technical platform, and established a standard system for plant selection based on existing research results. A residential area as a case verification in Tongxiang, Zhejiang Province China. The SOLWEIG model was used for quantitative evaluation of sunshine duration, and the spatial distribution and comparison relationship of sunshine hours were obtained. Accordingly, this research combined with sunshine requirements of landscape plant, and then gives reasonable suggestions for plant selection and community configuration.

2. Methodology

2.1 Technology Platform

The SOLWEIG model as a mainly technology platform for solar simulation, and the AutoCAD and ArcGIS software are also used in data processing and conversion.

2.2 Parameter Settings

In order to make the simulation results more accurate, we set relevant parameters according to the geographic location and site scale of the study area. The specific information is as follows (Table 1).

Table 1. Parameter settings for SOLWEIG model

No.	Name	Value	No.	Name	Value
1	Height	3 Meter	8	Time interval	image/5min and /30min
2	Time	04/16/2014	9	Grid and intersection	3M*3M; 978
3	Longitude	E 120.55°	10	Number of samples	356
4	Latitude	N 30.5°	11	Grid size of building	0.1*0.1
5	Altitude	50 Meter	12	Number of building grid	994596
6	UTC	+8	13	Building height	N*3.3M
7	Terrain	0 Meter			

2.2.1 Sun Altitude Angle and Sunshine Duration

Solar altitude is the angle of the sun relative to the earth's horizon, it determines the distance that solar radiation travels through the atmosphere. The solar altitude angle can be calculated by the following formula:

$$\alpha_{sun} = 90^\circ \quad (La \perp 23.5^\circ)$$

In the formula, α_{sun} refers to the altitude angle of the sun; La is the geographic latitude of the sun irradiation point; 23.5° is the latitude of the solar north-south tropic line. The study area is located in Tongxiang, Zhejiang Province, with a geographic latitude of 30°28'-30°47' north latitude. 30.5° is used as the calculation parameter now. Therefore, the solar height angles of the summer solstice, spring (autumn) equinox and the winter solstice is 83°, 59.5° and 36° in Tongxiang City, respectively. As SOLWEIG, the system automatically generates the solar altitude angle and calculates the sunshine hours based on the input of the simulation date.

2.2.2 Altitude and Sunshine Duration

Altitude has a certain influence on the sunshine duration, mainly reflected in the early sunrise and the late sunset. The main reason for this phenomenon is the refraction caused by the penetration of solar radiation into the atmosphere, and the light quality is mainly long-wave light such as red light or infrared light. Although this part of the solar radiation has small energy, it is of great significance for the photosynthesis of landscape plants. Therefore, it is also an important parameter. In the study, the altitude of Tongxiang City is set to 50 meters.

The reason why the simulated height affects the sunshine hours is that the shadow area formed by the building will decrease as the simulated height increases. For the selection and configuration of landscape plants in the study area, trees and shrubs can play a more important ecological value, and the economic cost is also high. The simulation of site conditions in this study focused on trees and shrubs. Therefore, the simulation point is set at a height of 3 meters above the ground.

2.2.3 Time Interval and Grid

SOLWEIG model is mainly used to simulate DEM-based sunshine hours, shadows and an average heat radiation. The spatial distribution of sunshine hours can be directly simulated, but the simulation of points needs to be generated separately. The simulation interval and the number of building DEM grids have a great influence on the running speed of the model. Improper setting will cause the running time to be too long or even crash. In this study, the above influencing factors were tested and compared several times before use.

The results of preliminary experiments show that: time interval (≥1h), the simulation results cannot meet accuracy requirements for practice. The time interval is too small (<5min), although it is beneficial to practical application, but the software's running speed and data acquisition efficiency are limited. The simulation of the total sunshine hours in the study area adopted a resolution of one image every 5 minutes, which is used to analyze the spatial distribution of sunshine hours. Considering the speed of operation and the sensitivity of plants to sunshine hours for a single sample point, the study adopted a resolution of one image every 30 minutes. For the setting of simulated sample points, a 3M*3M grid is used to cover the planting area, and the sample points are selected from the intersections of the grids.

2.3 Selection Rules and Basis for Landscape Plants

In this study, the data on the sunshine demand and ecological habits of the plants are based on two Chinese monographs in botany (Bao, 2003, Zhuo & Chen, 2004).

2.3.1 Sunshine Hours and Landscape Plants

The effect of sunshine hours on plants mainly to adjust their photoperiod, and the mismatch of sunshine hours will lead to changes in the flowering period of plants (Jackson, 2009, Lee, Roh et al., 2013). For flowering plants, it can be divided into Long-day plants, Short-day plants, and Day-neutral plants based on their differences in the requirements of sunshine time (Whiting, 2011, Yeang, 2013). However, the requirements of long-day and short-day plants on the sunshine duration are not absolute, and the photoperiod can be broken by a certain number of hours of illumination or shading (Shin, Kang et al., 2008, Yeang, 2013)

2.3.2 Sunlight Intensity and Landscape Plants

Sunlight intensity affects the photosynthesis rate of landscape plants. The sunlight intensity needs to reach its Light Compensation Point (LCP) to accumulate dry matter. The photosynthesis rate increases with the increase in sunlight intensity until it reaches its Light Saturation Point (LSP) stops. Therefore, the landscape plant can be divided into the heliophilic plants, shade-tolerant plants and shade-loving plants based on the requirements of landscape plants for light intensity (Wei & Huang, 2015).

In this study, we selected the following plant species and summarized them according to their requirements for sunshine conditions. Details are shown in Table 2.

Table 2. Landscape plants and sunshine adaptability (Bao, 2003, Zhuo & Chen, 2004)

Sunshine conditions **Layer and scientific name**		**Hours (direct radiation)**			**Intensity (total radiation)**		
		Full	**Partial**	**No**	**Max**	**Medium**	**Min**
Trees	*Ginkgo biloba L.*	√	√		√		
	Taxus chinensis (Pilger) Rehd		√	√			√
	Pinus thunbergii Parl	√	√		√		
	Ficus benjamina L.	√	√		√		
	Magnolia grandiflora L	√	√			√	

	Koelreuteria paniculata Laxm.	√	√		√	
	Acacia farnesiana (L.) Willd.	√	√		√	
	Hibiscus syriacus Linn.	√	√		√	
	Taxodium distichum (L.) Rich.	√			√	
Shrubs	*Euonymus japonicus L.*	√	√		√	
	Monstera deliciosa Liebm.		√	√		√
	Fatsia japonica (Thunb.) Decne. et Planch		√	√		√
	Loropetalum chinense var.rubrum	√	√		√	
	(Malus Halliana Koehne) Begonia	√			√	
	Camellia japonica L.		√			√
	Michelia figo (Lour.) Spreng.		√			√
	Lagerstroemia indica L.	√	√		√	
	Chrysalidocarpus lutescens H. Wendl.		√			√
Vines	*Caulis Mucunae*	√	√		√	
	(Ficus pumila Linn.		√	√		√
	Hedera nepalensisvar.sinensis	√	√		√	
	Wisteria sinnsis	√	√		√	
	Morden cvs.of Chlimbers and Ramblers.	√	√		√	

	Parthenocisus tricuspidata	√	√	√		√	√
	Vitis vinifera L.	√			√		
	Trachelospermum jasminoides	√	√		√		
	Campsis grandiflora (Thunb.) Schum.	√	√		√		
Ground covers	*Oxalis corymbosa DC.*	√	√			√	
	Zephyranthes candida	√	√			√	√
	Orychophragmus violaceus		√	√			√
	Ophiopogon bodinieri	√	√	√		√	√
	Acorus tatarinowii			√			√
	Zoysia japonica Steud.	√	√		√		
	Zoysia matrella (L.) Merr.		√	√			√
	Lycoris radiate		√	√			√
	Dichondra repens Forst.		√	√			√

2.4 Research Process and Steps

This research requires a variety of digital software to process the data, format conversion and data statistics. It mainly includes the establishment of building database, sample grid settings and statistics, drawing of the planting area and the establishment of planting database, sample points setting and the establishment of databases, and the simulation of sunshine hours. The process and steps are as follows.

2.4.1 Processing of Building Data

According to the preliminary master plan (.dwg format), the vector data of building plan are established through ArcGIS (ESRI), and complete the corresponding attributes based on the floor height and the number of individual buildings. Due to the analytical needs of the

SOLWEIG model, it is necessary to convert the data format of building from the vector into raster. In this study, the raster size of the building is set to 0.1*0.1, and the floor height is used as the DEM (digital elevation model) value of the building.

2.4.2 Sample Grid Settings and Statistics

The SOLWEIG model simulates the sunshine hours with 2.5D characteristics of spatial distribution, and the system cannot be divided and displayed according to grades. Therefore, it needs to be processed in the ArcGIS software environment. In this study, the grid spacing is set to 3M*3M, and there is a total of 978 grid intersections distributed in the planting areas.

2.4.3 Planting Area Extraction and the Establishment of a Plant Database

This study adopted editing function of ArcGIS to sketch a file in the catalog according to the overall plan of study area, due to the large number of sample points, the planting area is divided into A, B, C, D, E, F, G, K, L, M and N, a total of 11 planting patches was established. At the same time, each sample point is numbered in ArcGIS, this information is recorded, such as the sunshine hours, relative coordinates, height from the ground, time interval and simulation date.

2.4.4 Sample Point Setting

In order to facilitate the simulation, statistics, calculation, and to guide practice, 356 intersection points of the grid are selected as the simulation samples in this study, these points come from 978 intersections based on the method of interval selection.

2.4.5 Simulation of Sunshine Hours

We use the SOWEIG model to simulate the sunshine duration, parameter setting adopted the values in Table 1.

3. Results of Sunshine Simulation and Planting Strategies

3.1 Analysis of Sunshine Hours

3.1.1 Spatial Distribution

The format of building data was transformed in the toolbox of ArcGIS, and then the data is loaded into the SOLWEIG model, set the model parameters according to the values in Table 1. The spatial distribution pattern of sunshine duration in the study area is as follows.

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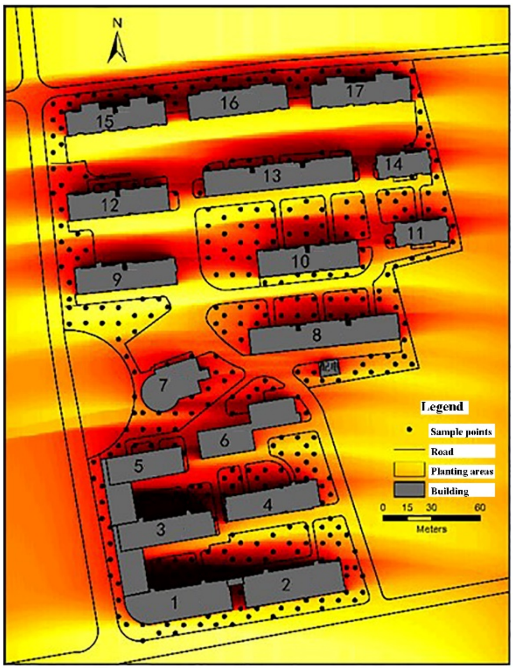

Figure 1. Spatial distribution of sunshine hours

The simulation results (Figure 1) show that planting areas with insufficient sunshine hours are mainly concentrated in the area enclosed by block 1 and 3, and block 3 and 5. The north side of block 15, 16, and 17 is also an area with less sunshine. Block 1 and 2 have sufficient sunshine hours due to no construction on the south side. The south side of block 9 is far away from block 7 and this building is lower. Therefore, it has a larger sunshine area and sufficient sunshine hours.

Comprehensive analysis shows that when the latitude, longitude, simulation time, and altitude of the study area are constant, the sunshine hours of the regional Micro-environment are only affected by the height of the building, the spacing, and the building layout. By reducing the height and enclosure of the building, increase building spacing, the sunshine hours of the Micro-environment can be effectively increased. Instead, the sunshine hours will be reduced. This study did not consider the influence of terrain factors on the sunshine duration, and future studies will further explore this content.

3.1.2 Comparative Analysis

In order to select plant species and design plant communities for planting areas, the study calculated the values and specific distribution of sunshine hours at 356 sample points (Figure 2), and compared the average sunshine hours in different planting areas, which is A, B, C, D, E, F, G, K, L, M and N, respectively (Figure 2).

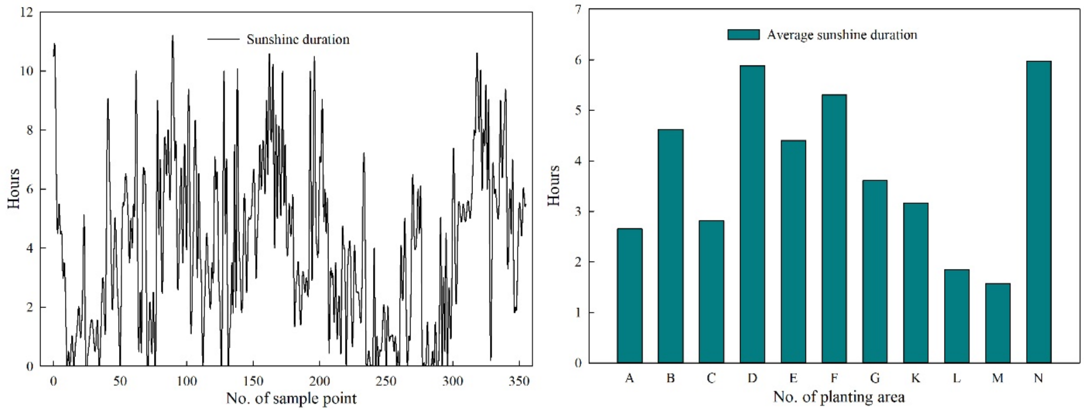

Figure 2. Comparative analysis of sunshine hours (Left. comparison of sunshine hours in 356 sample points; and Right. comparison of average sunshine hours in different planting area)

The result shows (Figure 2) that the highest value of sunshine hours in the study area reaches 10.5 hours, and the lowest is 0 hours. The sunshine hours vary greatly with the location of the sample points.

Comprehensive analysis shows that the number of samples with high sunshine hours in the study area is relatively small, while the proportion of samples with medium sunshine hours, insufficient sunshine hours and serious shortages is larger. It can be seen that the buildings have a greater impact on the spatial changes of sunshine hours. Under the premise of diversified sunshine radiation, when selecting plant species, we should pay more attention to their adaptability to sunshine.

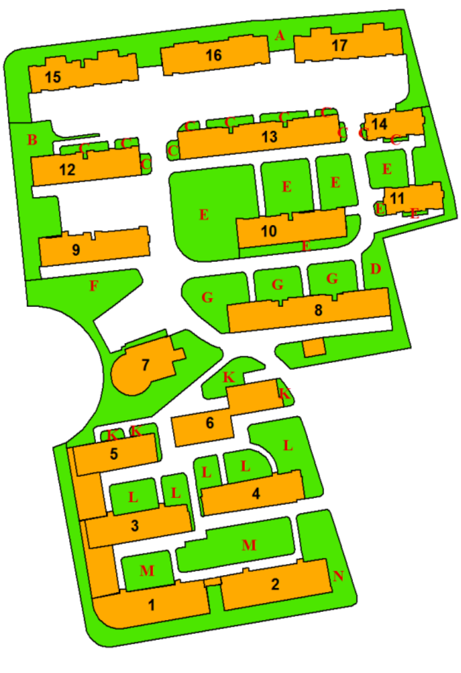

Figure 3. Distribution of planting site in the residential area

The average sunshine hours of planting area from A to N is 2.7 hours, 4.6 hours, 2.8 hours, 5.9 hours, 4.4 hours, 5.3 hours, 3.6 hours, 3.2 hours, 1.8 hours, 1.6 hours and 6.0 hours, respectively. The sunshine hours of the 11 planting sites are sorted from high to low: N>D>F>B>E>G>K>C>A>L>M (Figure 3).

3.2 Plant Selection and Community Configuration

3.2.1 Selection of Key Tree Species and Backbone Tree Species

The core and base tree species can be used for street greening and viewing. The planting strategy can be solitary planting, opposite planting, row planting, cluster planting or group planting. These tree species reflect local climate conditions, regional culture and characteristics. As the key plant species, most of them are trees, so there should not be too many species, 3-5 species are more suitable.

Suitable tree species in deciduous plant can be selected: *Ginkgo biloba L.*, *Liquidambar formosana Hance*, *Koelreuteria paniculata Laxm.*, *Liriodendron chinensis (Hemsl). arg*, *Acer buergerianum*.

Evergreen trees can be selected: *Cinnamomum camphora (L.) presl*, *Pinus thunbergii Parl.*, *Michelia chapensis*, *Magnolia grandiflora*, *Elaeocarpus decipiens Hemsl.*, *Osmanthus fragrans*.

3.2.2 Vertical Structure Design for Trees, Shrubs, and Ground Cover Plants

To select suitable trees, shrubs, and ground covers for the construction of vertical structures, is an important design strategy for planting in landscape architecture, which can maximize ecological value and artistic effects. According to the climate conditions of Tongxiang City, Zhejiang Province, combined with simulation results of the sunshine hours in this study, the following species combination is provided as a vertical structure design. The details are as follows (in the form of tree - shrub - ground cover):

- *Ginkgo biloba L. + Cinnamomum camphora (L.) presl + Pinus thunbergii Parl. —— Viburnum macrocephalum + Rhododendron Simsii Planch. + Aucuba japonica var.variegata D'Om-Brain —— Ophiopogon bodinieri.*
- *Cinnamomum camphora (L.) presl + Michelia alba DC. —— Pittosporum tobira + Gardenia jasminoides Ellis + Amygdalus triloba (Lindl.) Ricker —— Oxalis corymbosa DC.*
- *Pinus massoniana Lamb + Quercus variabilis Bl. + Liquidambar formosana Hance —— Kerria japonica. + Swida alba Opiz —— Iris tectorum Maxim.*
- *Osmanthus fragrans + Michelia chapensis —— Aucuba japonica var. variegata D'Om-Brain + Rhododendron mucronatum (Blume)G.Don + Rhododendron pulchrum Sweet —— Acorus tatarinowii.*
- *Koelreuteria paniculata Laxm. + Albizia julibrissin Durazz. —— Gardenia jasminoides Ellis + Hypericum monogynum L. —— Farfugium japonicum (L. f.) Kitam.*
- *Acer buergerianum + Liquidambar formosana Hance + Sapium sebiferum (L.) Roxb. —— Hydrangea macrophylla + Viburnum macrocephalum —— Reineckia carnea (Andr.) Kunth) Lucky Grass.*

- *Osmanthus fragrans* + *Michelia maudiaeDunn* —— *Mahonia bealei* + *Nandina domestica* —— *Nandina domestica*.

4. Conclusions

The principle of "right tree, right place" has long been recognized in the cultivation practice of landscape plants. Sunshine is one of the most important ecological factors, compared to other factors, such as temperature, moisture and nutrition, it is relatively stable in the same location. Therefore, researchers and practitioners in the field of landscape architecture can select appropriate plant types based on the sunshine data provided by the meteorological department. However, few studies have explored the microenvironmental state of the planting area, despite the great difference in sunshine due to the diversity of buildings and topography. This study adopted SOLWEIG model combined with the ArcGIS and AutoCAD software, to simulate the sunshine hours for the planting area. Then, suitable plant species and communities are provided according to the sunshine conditions of the planting area, thereby realizing the ideal of "right tree, right place" on the technical level.

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References

Ahmed, A. Q., Ossen, D. R., Jamei, E., Manaf, N. A., Said, I., & Ahmad, M. H. (2014). Urban surface temperature behaviour and heat island effect in a tropical planned city. *Theoretical and Applied Climatology*, 1-22.

Besserud, K., & Hussey, T. (2011). Urban design, urban simulation, and the need for computational tools. Ibm Journal of Research and Development, *55*(1&2), 13-29. https://doi.org/10.1147/JRD.2010.2097091

Bourbia, F., & Awbi, H. B. (2004). Building cluster and shading in urban canyon for hot dry climate Part 2: Shading simulations. *Renewable Energy, 29*(2), 291-301. https://doi.org/10.1016/S0960-1481(03)00171-X

de Siqueira, M. F., G. Durigan, Junior, P. M., & Peterson, A. T. (2009). Something from nothing: Using landscape similarity and ecological niche modeling to find rare plant species. Journal for Nature Conservation*, 17*(1), 25-32. https://doi.org/10.1016/j.jnc.2008.11.001

Fu, P., & Rich, P. M. (1999). Design and implementation of the Solar Analyst: an ArcView extension for modeling solar radiation at landscape scales. Proceedings of the 19th annual ESRI user conference. SanDiego, USA.

Hämmerle, M., T. Gál, Unger, J., & Matzarakis, A. (2011). Comparison of models calculating the sky view factor used for urban climate investigations. Theoretical and Applied Climatology*, 105*(3-4), 521-527. https://doi.org/10.1007/s00704-011-0402-3

Hang, J., Li, Y. G., Sandberg, M., Buccolieri, R., & Di Sabatino, S. (2012). The influence of building height variability on pollutant dispersion and pedestrian ventilation in idealized high-rise urban areas. *Building and Environment, 56*, 346-360. https://doi.org/10.1016/j.buildenv.2012.03.023

Jackson, S. D. (2009). Plant responses to photoperiod. *New Phytologist, 181*(3), 517-531.

https://doi.org/10.1111/j.1469-8137.2008.02681.x

Jim, C. (1998). Urban soil characteristics and limitations for landscape planting in Hong Kong. *Landscape and Urban Planning, 40*(4), 235-249. https://doi.org/10.1016/S0169-2046(97)00117-5

Kántor, N., & Unger, J. (2011). The most problematic variable in the course of human-biometeorological comfort assessment—the mean radiant temperature. *Central European Journal of Geosciences, 3*(1), 90-100. https://doi.org/10.2478/s13533-011-0010-x

Lee, A. K., Roh, M. S., & Suh, J. K. (2013). Growth and flowering responses of Anigozanthos hybrids influenced by plant age, temperature, and photoperiod treatments. *Horticulture Environment and Biotechnology, 54*(6), 457-464. https://doi.org/10.1007/s13580-013-0104-0

Lindberg, F., & Grimmond, C. (2011). The influence of vegetation and building morphology on shadow patterns and mean radiant temperatures in urban areas: model development and evaluation. *Theoretical and Applied Climatology, 105*(3-4), 311-323. https://doi.org/10.1007/s00704-010-0382-8

Lindberg, F., & Grimmond, C. (2011). Nature of vegetation and building morphology characteristics across a city: Influence on shadow patterns and mean radiant temperatures in London. *Urban Ecosystems, 14*(4), 617-634. https://doi.org/10.1007/s11252-011-0184-5

Lindberg, F., Holmer, B., &Thorsson, S. (2008). SOLWEIG 1.0–Modelling spatial variations of 3D radiant fluxes and mean radiant temperature in complex urban settings. *International Journal of Biometeorology, 52*(7), 697-713. https://doi.org/10.1007/s00484-008-0162-7

Maestre, I., L. Pérez-Lombard, Foncubierta, J., & Cubillas, P. (2013). Improving direct solar shading calculations within building energy simulation tools. *Journal of Building Performance Simulation, 6*(6), 437-448.

Nagaraju, S. K., R. Gudasalamani, N. Barve, J. Ghazoul, Narayanagowda, G. K. & Ramanan, U. S. (2013). Do Ecological Niche Model Predictions Reflect the Adaptive Landscape of Species?: A Test Using Myristica malabarica Lam., an Endemic Tree in the Western Ghats, India. *Plos One, 8*(11), 1-13. https://doi.org/10.1371/journal.pone.0082066

Negre, M., Zancolo, S., Malusa, E., & Piccone, G. (2006). Fertilisation of an urban park soil with municipal solid waste compost. Effects on soil properties and plant growth. *Fresenius Environmental Bulletin, 15*(3), 200-206.

Ng, W. Y., & Chau, C. K. (2014). A modeling investigation of the impact of street and building configurations on personal air pollutant exposure in isolated deep urban canyons. *Science of the Total Environment, 468*, 429-448.

Rai, P. K., & Panda, L. L. (2013). Dust capturing potential and air pollution tolerance index (APTI) of some road side tree vegetation in Aizawl, Mizoram, India: an Indo-Burma hot spot region. *Air Quality, Atmosphere & Health*, 1-9. https://doi.org/10.1007/s11869-013-0217-8

Roderick, M. L., Farquhar, G. D., Berry, S. L., & Noble, I. R. (2001). On the direct effect of clouds and atmospheric particles on the productivity and structure of vegetation. *Oecologia, 129*(1), 21-30. https://doi.org/10.1007/s004420100760

Shashua-Bar, L., Tzamir, Y., &Hoffman, M. E. (2004). Thermal effects of building geometry and spacing on the urban canopy layer microclimate in a hot-humid climate in summer. *International Journal of Climatology, 24*(13), 1729-1742. https://doi.org/10.1002/joc.1092

Shin, J. H., K. J. Kang, Seoul, W. O., & Kim, K. S. (2008). Night interruption and cyclic lighting promote flowering of long-day plants under low temperature. *Hortscience, 43*(4), 1122-1123.

Teramura, A. H., & Sullivan, J. H. (1994). Effects of UV-B radiation on photosynthesis and growth of terrestrial plants. *Photosynthesis Research, 39*(3), 463-473. https://doi.org/10.1007/BF00014599

Wei, H. Y., & Huang, Z. D. (2015). From Experience-Oriented to Quantity-Based: A Method for Landscape Plant Selection and Configuration in Urban Built-Up Areas. *Journal of Sustainable Forestry, 34*(8), 698-719. https://doi.org/10.1080/10549811.2015.1033555

Whiting, D. (2011). Plant Growth Factors: Light.

Yeang, H. Y. (2013). Solar rhythm in the regulation of photoperiodic flowering of long-day and short-day plants. *Journal of Experimental Botany, 64*(10), 2643-2652. https://doi.org/10.1093/jxb/ert130

Zhang, Z., Y. M. Lv & Pan, H. T. (2013). Cooling and humidifying effect of plant communities in subtropical urban parks. *Urban Forestry & Urban Greening, 12*(3), 323-329. https://doi.org/10.1016/j.ufug.2013.03.010

Bao, M. (2003). *Floriculture (花卉学)*. Beijing, China Agriculture Press.

Li, J., & Hao, R. M. (2008). The scientific connotation of "planting trees on the suitable sites condition in the urban landscape. *Journal of Nanjing Forestry University (Natural Science Edition), 32*(2), 151-154.

Shao, H., & Zhou, D. Y. (1996). Building’s Shade Effection and Its Influence on the Greening. *Journalof Beijing Forestry University, 18*(2), 37-44.

Zhuo, L., & Chen, L. Q. (2004). *Landscape Arboriculture (园林树木学)*. Beijing, China Agriculture Press.