

10. Conclusion

As cities continue to rapidly urbanise and densify, street trees have become a focal point in our community's aspirations to maximise ecological benefits and our connection with nature. Having one of the most compact and dense urban environments in the world⁶⁶, Hong Kong is particularly challenged to maximise street tree planting in the face of progressive development, unpredictable climate, and ageing street tree assets. Indeed, the effects of climate change in Hong Kong can already be seen by the increased frequency of extreme hot days and rainfall⁶⁷, and some of our ageing trees planted decades ago may not be able to adapt to these changes. Increasing temperatures due to urban heat and climate change are proven a threat to some tree species in other economies⁶⁸. Hong Kong needs to be prepared to ensure our urban forest is resilient, adaptable and sustainable to meet these changes.

This Guide proposes that roadside trees should be selected and planted under the principle of, "Right Tree, Right Place" to create an urban forest that can tackle the challenges brought about by future changes. To further future-proof this valuable asset, the 10-20-30 rule of plant diversity should be considered for wide application in new planting and replacement planting as far as practicable.

By increasing tree species diversity supported by CVCM, the on-ground outcomes of the Guide can contribute toward the reduction of risks associated with inadequate upstream life-cycle planning and design of street tree assets. Adoption of species diversity in urban city planting has been practised by international cities, with emerging landscape design re-imagining the traditional streetscape environment. The preparation and development of district-wide urban forest precincts or master plans are also recommended to better articulate landscape design themes, and more importantly to provide territory-wide cohesion of overall landscape strategy. The potential for design innovation is significant, as complexity demands creative solutions. This Guide offers designers in Hong Kong the unique opportunity to be at the forefront of streetscape design for compact and linear landscapes.

Professional advice from Landscape Architects, qualified Arborists, horticulturalists, and other relevant disciplines should be sought for further investigation on the suitability of species relative to the street type and design, in particular replacement planting of ageing tree assets. Proper hard and soft streetscape design with professional input from Landscape Architects is recommended across all work stages. This include, but not limited to, the allocation of sufficient planting space at the initial planning stage, proper designing of CVCM and supporting hard landscape elements such as tree pit details, structural soils or cells, drainage and irrigation requirements, specification of suitable planting media etc. at design stage, and selection of quality nursery stocks, and supervision of planting works to ensure proper workmanship etc. at implementation stage.

To consolidate a robust life-cycle inventory, the development of a holistic urban forest database with tree planting date, health condition, form, size and urban ULE, etc is strongly recommended to ensure continual assessment and review of tree species performance within different street types. Further studies into the propagation, procurement, growth characteristics and performance of tree and CVCM species, especially

⁶⁶ Wendell Cox Consultancy (Apr. 2018). *Demographia World Urban Areas 14th Annual Edition: 201804*. Retrieved from www.demographia.com/db-worldua.pdf.

⁶⁷ Hong Kong Observatory. (n.d.). *Climate Change in Hong Kong. What Is UV Radiation*. Retrieved 18 Jan. 2018 from www.hko.gov.hk/climate_change/obs_hk_temp_e.htm.

⁶⁸ Kendal, Dave, et al. (Nov. 2017) *Risks to Australia's Urban Forest from Climate Change and Urban Heat*. Clear Air and Urban Landscapes Hub, National Environmental Science Programme, The University of Melbourne. Retrieved from www.nespurban.edu.au/publications-resources/research-reports/CAULRR07_RisksAustralianUrbanForest_Oct2017.pdf.

Street Tree Selection Guide

native species are also recommended. With more experience gained in application and trial planting of the tree species in the shortlist, it will inform and enrich the updating of the species list in the Guide to maintain continual improvement of Hong Kong's urban forest stock. Supporting studies to modernise planting conditions include tree pit details, specification options of urban soils, drainage and planting practices will be required to minimise downstream tree management and maintenance risks. Tree planting along carriageways and pavements in the urban areas form an effective landscaped connector. However, other suitable locations for urban forestry planting not included in this Guide, such as man-made slopes, public parks, green spaces within government properties, etc., are equally as important. Apart from roadside planting, to explore planting opportunities at project planning stage to connect to the surrounding areas into a "Green and Blue System" network with eco-corridors as envisioned under the Hong Kong 2030+ is encouraged to multiply the landscape benefits.

We engage with the street every day, and given our streetscape can make up as much as 75% of our outdoor environment, its resilience, comfort, and safety greatly impact our perception of a quality city where the community can stay and enjoy. The importance and benefits of a healthy and resilient urban forest is an investment that should be more widely recognised. With the broader application of this Guide, it is hope that this investment in our urban forest will safeguard these valuable tree assets for passing on to our future generations.

References

Agriculture, Fisheries and Conservation Department, HKSAR Government. (2016). *Hong Kong Herbarium*. Retrieved from <http://www.herbarium.gov.hk/home.aspx>

Ann, P. J., Chang, T. T. and Ko, W. H. (2002). *Phellinus noxius* brown root rot of fruit and ornamental trees in Taiwan. *Plant Disease*, 86(8), pp. 820-826.

Architectural Services Department, HKSAR Government. (2017). *General Specification for Building*.

Architectural Services Department, HKSAR Government. (2007). *Guide on Green Roof Application in Hong Kong - Final Report*. Retrieved from https://www.archsd.gov.hk/media/11630/green_roof_study_final_report.pdf

Berghöfer, A., Mader, A., Patrickson, S., Calcaterra, E., Smit, J., Bignaut, J., De Wit, M. and Van Zyl, H. (2011). *TEEB Manual for cities: Ecosystem services in urban management*. The Economics of Ecosystems and Biodiversity, *Suiza*.

Bolund, P. and Hunhammar, S. (1999). *Ecosystem Services in Urban Areas*. *Ecological Economics* 29.2: 293-301.

Byrne, L. B. and Grewal, P. (2008). *Introduction to ecological landscaping: a holistic description and framework to guide the study and management of urban landscape parcels*. *Urban Horticulture*. 2016, 10.1201/b21180-3, pp. 3-32

Chan, Y. L. (2015). *The History of Landscape Profession of Hong Kong: A Collection of Interviews 1978-2015*. The Hong Kong Institute of Landscape Architects.

Cheung, M. S., Chan, H. S. and Tong, H. W. (2015) *Rainfall Projection for Southern China in the 21st Century using CMIP5 Models*.

City of Melbourne. (2011). *Urban Forest Diversity Guidelines*. Retrieved from <https://www.melbourne.vic.gov.au/SiteCollectionDocuments/urban-forest-diversity-guidelines.pdf>

Planning Development, HKSAR Government (n.d). *The Diverse Landscapes of Hong Kong*. Hong Kong Landscape. Retrieved from http://www.pland.gov.hk/pland/en/p_study/prog_s/landscape/e_executive_summary_hp/e_ch2.htm [Accessed April 2016]

Development Bureau, HKSAR Government. (2012). *Development Bureau Technical Circular (Works) No. 2/2012 Allocation of Space for Quality Greening on Roads*.

Development Bureau and Planning Department, HKSAR Government. (2016) *Hong Kong 2030+ Towards a Planning Vision and Strategy Transcending 2030*.

Street Tree Selection Guide

- Department of Conservation and Natural Resources, Pennsylvania Government. (2018). *Plant Communities*. Retrieved from www.dcnr.pa.gov/Conservation/WildPlants/PlantCommunities/Pages/default.aspx.
- Drainage Services Department, HKSAR Government. (2018). *Stormwater Drainage Manual, Planning Design and Management*, 5th Ed.
- Dumroese R.K., Wenny D.L. and Barkley Y.C. (2001). *Plant your seedlings right*. Retrieved from <http://www.lri-lb.org/sites/default/files/Plant%20Your%20Seedling%20Right.pdf>
- Environment Bureau, HKSAR Government. (2016). *Hong Kong Biodiversity and Strategy Action Plan 2016-2021*.
- Environment Bureau, HKSAR Government. (2017). *Hong Kong's Climate Action Plan 2030+*.
- Environment Bureau, HKSAR Government. (2015). *Hong Kong Climate Change Report 2015*. Environment Bureau. Retrieved from <http://www.enb.gov.hk/sites/default/files/pdf/ClimateChangeEng.pdf> [Accessed April 2016]
- Fern, K. (2014). *Useful Tropical Plants*. Retrieved from <http://tropical.theferns.info/>
- Fini, A. and Brunetti, C. (2017). *Irrigation of Urban Trees*. Routledge Handbook of Urban Forestry, Taylor and Francis Group, pp. 419–432.
- Food and Agriculture Organization of the United Nations. (n.d.). *Planning a Tree Nursery*. Retrieved from <http://www.fao.org/docrep/006/AD228E/AD228E03.htm>
- Gilman, E. F. (2013). *680 Tree Fact Sheets: Trees by Scientific Name*. Retrieved from http://hort.ufl.edu/database/trees/trees_scientific.shtml
- Gilman, E. F. (2011). *An illustrated guide to pruning*. Cengage Learning.
- Gilman, E. F., Masters, F. and Grabosky, J. C. (2008). *Pruning affects tree movement in hurricane force wind*. *Arboriculture and Urban Forestry*, 34(1), pp. 20.
- Gillman, J. and Rosen, C. (2017). *Tree Fertilization: A guide for fertilizing new and established trees in the landscape*, University of Minnesota Extension. Retrieved from <https://www.extension.umn.edu/garden/yard-garden/trees-shrubs/tree-fertilization-guide/>
- Gómez-Baggethun, E., Gren, Å., Barton, D. N., Langemeyer, J., McPhearson, T., O'Farrell, P., Andersson, E., Hamstead, Z. and Kremer P. (2013). *Urban Ecosystem Services*. *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities*: pp. 175-251.
- Greening, Landscape and Tree Management Section, HKSAR Government. (2012). *List of Potential Suitable Plant Species for Skyrise Greening in Hong Kong*. Development Bureau.
- Greening, Landscape and Tree Management Section, HKSAR Government. (2015). *Guidelines for Tree Risk Assessment and Management Arrangement*. Development Bureau.

Street Tree Selection Guide

Greening, Landscape and Tree Management Section, HKSAR Government. (2013). *Skyrise Greenery - Pictorial Guide to Plant Resources for Skyrise Greenery in Hong Kong*. Retrieved from http://www.greening.gov.hk/en/green_technologies/skyrise_guide.html

Greening, Landscape and Tree Management Section, HKSAR Government. (2016). *Handbook on Tree Management*. Development Bureau.

Greening, Landscape and Tree Management Section, HKSAR Government. (2015). *Guidelines for Tree Risk Assessment and Management Arrangement*. Development Bureau.

Greening, Landscape and Tree Management Section, HKSAR Government. (2016). *Knowledge Sharing (Special Topics)*. Development Bureau. Retrieved from www.greening.gov.hk/en/knowledge_database/special_topics.html [Accessed Feb 2017]

Godfrey, N., and Savage, R. (2012). *Future Proofing Cities: Risks and Opportunities for Inclusive Urban Growth in Developing Countries*. Epsom, Surrey, U.K: Atkins.

Harris, J. R., Day, S. D. and Kane, B. (2008). *Nitrogen fertilization during planting and establishment of the urban forest: a collection of five studies*. *Urban Forestry & Urban Greening*, 7(3), pp. 195-206.

Hartman, J. R., Pirone, T. P. and Sall, M. A. (2000). *Pirone's tree maintenance*. Oxford University Press.

Highways Department, HKSAR Government. (2006). *Public Lighting Design Manual*. Highways Department.

Highways Department, HKSAR Government. (2013). *Structures Design Manual for Highways and Railways*. Highways Department.

Hitchmough, J. and Fieldhouse, K. (2008). *Plant user handbook: a guide to effective specifying*. John Wiley & Sons.

Hong Kong Observatory, HKSAR Government. (n.d.). *Climate Change in Hong Kong: Extreme weather events*. Retrieved from http://www.hko.gov.hk/climate_change/obs_hk_extreme_weather_e.htm [Accessed 21 Mar 2016]

Hong Kong Observatory, HKSAR Government. (n.d.). *Climate Change in Hong Kong. What Is UV Radiation*. Retrieved from www.hko.gov.hk/climate_change/obs_hk_temp_e.htm. [Accessed 18 January 2016]

Huang, Q., Swatantran, A., Dubayah, R. and Goetz, S. J. (2014). *The influence of vegetation height heterogeneity on forest and woodland bird species richness across the United States*. *PLoS One*, 9(8), e103236.

Mok, H.Y., Wu, M.C. and Cheng, C.Y. (2010). *Spatial Variation of the Characteristics of Urban Heat Island Effect in Hong Kong*. Hong Kong Observatory.

IH, A. E. S., Koriesh, E. M., Moghazy, E. I. and Hefni, M. M. (2013). *Comparison Between Two Methods of Fertilizer Applications and Fertilizer Rates for Young Urban Tree Ficus retusa, Linn. Implanted in Sandy Soil*. *Hortscience Journal of Suez Canal University, Hort. Dep. Suez Canal University*.

Street Tree Selection Guide

Jeff, C. and Carl, R. (2000). *Tree fertilization: A guide for fertilizing new and established trees in the landscape*. University of Minnesota Extension. Retrieved from <https://www.extension.umn.edu/garden/yard-garden/trees-shrubs/tree-fertilization-guide>

Jim, C. Y. (2008). *Multipurpose census methodology to assess urban forest structure in Hong Kong*. *Arboriculture and Urban Forestry*, 34(6), pp. 366-378.

Jim, C. Y. (2000). *Trees in Major Urban Parks in Hong Kong - Volume 1-4*. Leisure and Culture Services Department.

Jin, S., Guo, J., Wheeler, S., Kan, L. and Che, S. (2014). *Evaluation of impacts of trees on PM_{2.5} dispersion in urban streets*. *Atmospheric Environment*, 99, pp. 277-287.

Kendal, D., Farrar, A., Plant, L., Bush, J., Threlfall, C.G. and Baumann, J. (2017) *Risks to Australia's Urban Forest from Climate Change and Urban Heat*. Clear Air and Urban Landscapes Hub, National Environmental Science Programme, The University of Melbourne. Retrieved from www.nesurban.edu.au/publications-resources/research-reports/CAULRR07_RisksAustralianUrbanForest_Oct2017.pdf.

Koeser, A. K., Gilman, E. F., Paz, M. and Harchick, C. (2014). *Factors influencing urban tree planting program growth and survival in Florida*, United States. *Urban forestry & urban greening*, 13(4), pp. 655-661.

Krishnan, P. R., Kalia, R. K., Tewari, J. C. and Roy, M. M. (2014). *Plant Nursery Management: Principles and Practices*.

Kurn, D. M., Bretz, S. E., Huang, B. and Akbari, H. (1994). *The potential for reducing urban air temperatures and energy consumption through vegetative cooling* (No. LBL--35320). Lawrence Berkeley Lab., CA, United States.

Magurran, A.E. (2011). *Measuring biological diversity*. Blackwell.

Mbora, A., Lillesø, J.B. and Jamnadass, R. (2013). *Good Nursery Practices: A Simple Guide*. Establishing a tree nursery. TECA, World Agroforestry Center. Retrieved from teca.fao.org/read/7808.

Morel, J. L., Chenu, C. and Lorenz, K. (2015). *Ecosystem services provided by soils of urban, industrial, traffic, mining, and military areas (SUITMAs)*. *Journal of Soils and Sediments*, 15(8), pp. 1659-1666.

Penn State College of Agricultural Sciences. (2017). *Herbicides (Introduction to Weeds and Herbicides)*. Retrieved from <http://extension.psu.edu/pests/weeds/control/introduction-to-weeds-and-herbicides/herbicides>

Planning Development, HKSAR Government. (n.d). *Analysis of the Hong Kong Landscape*. Hong Kong Landscape. Retrieved from http://www.pland.gov.hk/pland_en/p_study/prog_s/landscape/tech_report/ch5.htm [accessed April 2016]

Planning Department, HKSAR Government. (2015). *Hong Kong Planning Standards and Guidelines*. Planning Department.

Street Tree Selection Guide

Plants for a future. (2012). *Database Plant Search Page*. Retrieved from <http://www.pfaf.org/user/Default.aspx>

Roddick, C. and Hanson, B. (2007). *The Tree Care Primer* (No. 186). Brooklyn Botanic Garden.

Roloff, A. (2016). *Urban tree management: for the sustainable development of green cities*. (Ed.) John Wiley & Sons.

Salmond, J. A., Tadaki, M., Vardoulakis, S., Arbuthnott, K., Coutts, A., Demuzere, M., Dirks K.N. , Heaviside, C., Lim, S. , Macintyre H., McInnes, R. N. and Wheeler, B.W. (2016). *Health and climate related ecosystem services provided by street trees in the urban environment*. *Environmental Health*, 15(1), S36.

Santamour, F.S., Jr. (1990). *Trees for urban planting: diversity uniformity, and common sense*. Proceedings of the 7th Conference of the Metropolitan Tree Improvement Alliance, pp.57 – 65.

Starbuck, C. J. (1999). *Fertilizing shade trees*.

Tallis, M., Taylor, G., Sinnett, D. and Freer-Smith, P. (2011). *Estimating the removal of atmospheric particulate pollution by the urban tree canopy of London, under current and future environments*. Retrieved from <https://www.sciencedirect.com/science/article/pii/S0169204611002349> *Transport Planning and Design Manual*. Transport Department, HKSAR Government.

Transport Department, HKSAR Government. (2013). *Transport Planning & Design Manual*.

Tree Care Industry Association, inc. and American National Standards Institute. (2004). *American national standard for tree care operations: Tree, shrub and other woody plant maintenance-- standard practices (fertilization)*. Manchester, N.H: Tree Care Industry Association, Inc., Secretariat.

Webb, R. (1991). *Tree Planting and Maintenance in Hong Kong*. Standing Interdepartmental Landscape Technical Group, Government Information Services, Hong Kong Government.

Urban Forest Ecosystems Institute at California Polytechnic State University. (1995). *SelecTree: A Tree Selection Guide*. Retrieved from <https://selecttree.calpoly.edu/>

Vince, S. W., Duryea, M. L., Macie, E. A. and Hermansen, A. (2004). *Forests at the wildland-urban interface: conservation and management*. CRC Press.

Vogt, J., Hauer, R. J. and Fischer, B. C. (2015). *The costs of maintaining and not maintaining the urban forest: a review of the urban forestry and arboriculture literature*. *Arboriculture & Urban Forestry*, 41(6), pp. 293-323.

Wendell Cox Consultancy (2018). *Demographia World Urban Areas 14th Annual Edition: 201804*. Retrieved from www.demographia.com/db-worldua.pdf.

William, E. (2005). *Pruning Landscape Trees*. Retrieved from <http://extension.psu.edu/natural-resources/forests/urban-community/publications/pruning-landscape-trees>

Street Tree Selection Guide

Williams, K. (2014). *A Dozen "Must Have" Plants for Backyard Habitat*. New Jersey Audubon. Retrieved from www.njaudubon.org/SectionBackyardHabitat/ADozenMustHavePlantsforBackyardHabitat.aspx

Wu, Z., Raven, P. and Hong, D. (2013). *Flora of China*. Beijing: Science Press Ltd.

Zavestoski, S. and Agyeman, J. (2015). *Incomplete Streets: Processes, Practices and Possibilities*. Routledge.

Zhang, H. and Jim, C. Y. (2014). *Contributions of landscape trees in public housing estates to urban biodiversity in Hong Kong*. *Urban forestry & urban greening*, 13(2), pp. 272-284.

蔡福貴 (1995). 臺灣自然觀察圖鑑 3 - 木本觀賞植物(一). 臺北: 渡假出版社

蔡福貴 (1997). 臺灣自然觀察圖鑑 8 - 木本觀賞植物(二). 臺北: 渡假出版社

薛聰賢 (2001). 景觀植物實用圖鑒 第 7 輯 - 精選 木本花卉 196 種. 北京: 北京科學技術出版社

薛聰賢 (2004). 景觀植物實用圖鑒 第 14 輯 - 補遺 · 新品種 178 種. 北京: 北京科學技術出版社

香港園藝學會、中國科學院華南植物園 (2006). 香港古樹名木. 香港: 天地圖書.

廣州市園林科學研究所 (2008). 華南園林植物 (喬木卷). 貴陽: 貴州科技出版社

呂福原、歐辰雄 (1997). 臺灣樹木解說. 臺北: 行政院農業委員會

周琳潔 (2010). 華南鄉土樹種與應用. 北京: 中國建築工業出版