A CASE FOR CLIMATE-RESPONSIVE LANDSCAPE DESIGN

FROM SCIENTIFIC KNOWLEDGE TO INDUSTRY PRACTICE

City dwellers of today are no strangers to rising temperature in the urban environment, brought about by the combined effects of climate change and the urban heat island (UHI) effect. While some turn to mechanical cooling (e.g. air conditioning) as a convenient mitigation strategy, many others look into environmentally-friendlier solutions such as passive design strategies involving natural ventilation and reducing temperature with greenery.

Greenery, in particular, has become an integral component of contemporary urban design. Few

can deny the aesthetic qualities of urban greenery and its effectiveness in softening the harsh urban landscape. Yet, there are even lesser people who truly appreciate their potential to improve thermal comfort in the urban environment.

Introducing greenery to the built environment is not a new concept. Those Green Fingers and Green Lungs artfully envisaged by the Housing and Development Board (HDB) for the latest Built-To-Order (BTO) public housing precincts have their origins rooted in Ebenezer Howard’s Garden City of To-Morrow, a vision conceived more than a century ago. How interesting is it to note then, that in a hundred years, we have not progressed beyond the
rudimentary allocation of ‘green’ spaces in built up areas? With ample literature validating the benefits of urban greenery and identification of specific plant traits that can provide such benefits, it is only rightful for this body of knowledge to be incorporated into the practice of landscape design.

As we work towards building cities of the future, it is also important to also ponder on landscapes of the future and how they can function both as an integral aspect of urban design as well as a force for improving the cityscape climate. Herein lies the question: How can the process of landscape design be optimised to improve livability in the urban environment?

To answer this question, we have to look into how landscaping and landscape design are currently being evaluated. The local government has adopted a “the more the merrier” approach to landscaping. This is evident in policies such as the Landscaping for Urban Spaces and High-Rises (LUSH) Programme, where developers have to replace 100 percent of the greenery lost from the site due to development with greenery in areas within the development. In the BCA Green Mark scheme, the addition of greenery is also strongly encouraged: up to six points are allocated for achieving a green plot ratio of four and above. Both initiatives justify the allocation of greenery as a means to lessen the UHI effect in cities. These initiatives are implemented with the assumption that:

1. All plants are equally competent at reducing temperature.
2. Plants can be placed anywhere for cooling effect.
3. Having more plants will equate to a greater cooling effect.

While the industry is currently operating under such assumptions, research into actual plant cooling potential has progressed tenfold in the last decade. Although there is merit in having more plants around, it is understandably more effective if they are strategically chosen and placed in areas where cooling can be maximised. Currently, there exists a significant gap between actual findings in the scientific realm and what is being translated into industry practice.

Part of the reason for the gulf between academics and practitioners is due to the fact that both parties speak very different languages and operate under a very different set of rules. On one hand, scientists tend to focus solely on very specific aspects of plant study and findings, while scientifically robust, may not necessarily make logistical or economical sense in actual practice. Take studies on rooftop greenery, for instance. There is ample literature validating the benefits of rooftop gardens and sky terraces. However, practitioners are not able to discern the impact of adding rooftop gardens into their design in terms of how much temperature it can reduce, simply because there is no convenient way for them to evaluate their design in view of greenery and its effect on temperature. Scientific studies also tend to be too technical to be fully understood by industry practitioners in a short amount of time. The result is a piecemeal approach to greenery implementation that
seldom goes beyond basic requirements of aesthetics and maintainability.

In recognising the disparity between science and practice, scientists are now working towards the formulation of a framework that incorporates meteorological as well as site conditions as prerequisites for landscape planning. The Department of Building in the National University of Singapore, in particular, has conducted extensive research on climate-responsive landscape planning.

**DESIGNING WITH SCIENCE**

Recent advancements in scientific research on the cooling effect of plants have shown that plants react differently when exposed to varying ambient conditions. In particular, the cooling effect of plants will vary according to their physical traits, as well as physiological attributes such as plant evapotranspiration rate and reflectivity. Using this data, as well as information from related research, a simple framework is established.

The underlying strategy is to produce a map that displays resultant thermal conditions arising from the landscape proposal (Figure 1). In this manner, landscape planners will be able to visualise the impact of their design and make amendments without infringing on their design autonomy. To illustrate how a climate-responsive landscape planning method will work, consider the following scenario:

Four design iterations have been conducted for an area slated to be park space. Simulation is conducted with software that is readily available in the market. In Iteration 1, trees with small canopies (5 m diameter) are placed at locations...
Figure 1. Landscape planning with temperature maps

designated by the landscape planner. In Iteration 2, trees with larger canopies are assumed (15 m diameter) at the same spots. Radiant exposure reduces drastically near the trees. In Iteration 3, more trees (20 m diameter canopy) are added to areas that are anticipating larger pedestrian flow. As a result, thermal conditions of these areas are shown to have improved significantly. In Iteration 4, thermal effects of shrubbery are factored into the radiation map.

A visual comparison of all four iterations reveals the immense positive impact of tree and shrub allocation using the proposed landscape planning framework (Figure 2). The proposed landscape design framework allows designers to understand the impact of their choice of plant selection and allocation before eventually committing to a final decision. This can help to minimise undesirable outcomes such as lack of shading provision at prominent locations or inadequate light provision for plants due to excessive overshadowing from adjacent buildings.

CONCLUSION

Objective plant selection and placement are important factors in landscape planning. In the proposed framework, scientific objectives are proposed to lend sophistication to the landscape design process. It is easy to appreciate the importance of context and locality with the temperature map. Adjacent buildings can affect solar exposure significantly, thereby influencing the plant placement process, dispelling the common myth that plants can improve the environment by cooling temperature indiscriminately.

The proposed iterative framework for landscape planning seeks to more effectively realise the cooling potential of greenery as an urban heat mitigation technique and to optimise urban greenery as an ecosystem resource. Through the use of this climate-responsive landscape design framework, landscape planners and designers can do their part to improve thermal conditions in the urban environment.

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