2. Challenges and Opportunities

2.1 Challenges

This Section seeks to tackle the key challenges encountered in the existing and future roadside urban forest of Hong Kong to achieve a self-sustainable, resilient urban streetscape design as part of the initiatives set out in CAP. Many of these challenges are shaped from the harsh urban environment. These include, but not limited to microclimate, soil conditions, overhead and underground space, social and functional uses and surrounding land uses. Other challenges arise from past planting practices, lack of knowledge on proper planting and maintenance, limited available data and experience. Listed below are the most common challenges currently faced in Hong Kong.

Declining Vegetation Diversity

Biodiversity refers to the variety and abundance of living species within the ecosystem. It can be simply partitioned into 2 components – species richness (the abundance of species) and species evenness (variety of species). [9]

From the recent data gathered, it was discovered that our roadside urban forest scored high in species richness but low in species evenness. (Refer to *Section 4*) This is mainly due to the planting practices in the past, where there was an over-reliance on a limited variety of species, of which many were exotic species. One of the risks of homogenous planting practice is that any pest or disease affecting a single tree species may cause a domino effect of dying or diseased trees for multiple streets or districts.

As discovered from the desktop research, much of the original vegetation in Hong Kong was removed to make way for rapid urbanisation, particularly in the new towns. [10] In the older districts, carriageways and pedestrian footpath widths were kept to the minimum to maximise space for the increasing population. This inherited shortage of large planting spaces has led to general a lack of large-size trees that could have been planted on urban streets. Also, existing large trees in the urban streets are often seen growing in unfavourable conditions.

These issues lead to stressful growing environment for street trees, resulting in reduced Useful Life Expectancy (ULE) for street tree species and the gradual decline in vegetation diversity in Hong Kong. If the situation continues, this may further lead to a decrease in their pest and disease resilience and adaptability.

Diversifying the vegetation mixes in our roadside urban forests will improve the soil condition, plant health and their immunity to pests and diseases, and hence the subsequent maintenance efforts. A healthy roadside urban forest can also enhance biodiversity through generation of healthy urban ecosystems. Moreover, roadside urban forests with age diversity have shown that they can support a wide range of urban wildlife, including rare or endangered species. By having varying tree life spans and growth rates within the urban forest, it ensures that trees within the streetscape will not decline or need to be replaced all at the same time, thus reducing possible visual impact.

[9] Magurran, Anne E. (2011). Measuring biological diversity. Blackwell.

[10] Environment Bureau, HKSAR Government. (2016). Hong Kong Biodiversity and Strategy Action Plan 2016-2021.

Ageing Tree Population

An ageing or senescent tree is a tree that is near the end of its ULE. Different from the concept of life-cycle which stands for a measure of the biological life of the tree, ULE is an estimate of how long a tree is likely to contribute and remain in the landscape based on health, amenity and environmental services, cultural contributions and risks to the community. When the maintenance cost of a tree outweighs its contributions and benefits, it is deemed to be the ideal time that the tree should be replaced.

An ageing tree is more vulnerable to diseases, pests and other environmental factors before their inevitable decline. Due to the stressful urban environment, many urban trees reach the end of their ULE faster than those planted in their natural environment or a park. Many roadside trees in Hong Kong's urban areas are reaching the end of their ULE, in particular those planted in the early-1900s and the fast-growing pioneer tree species, such as *Acacia confusa*, planted for the purpose of reforestation in the late-1900s and early development of new towns. Timely replacement is critical to reduce tree failure risk in high trafficked areas, ensure slope stability, maintain tree canopy cover and streetscape design intent. Streets that are symmetrical avenues need to be carefully managed to ensure visual consistency and community consensus are achieved for the replacement planting.

Replacing trees reaching the end of the ULE requires good urban forestry management and practices. An appropriate replacement plan, community collaboration and a comprehensive management and monitoring program are essential to set out the framework for urban street tree replacement and planting.

Urban Heat Island

Urban heat island (UHI) effect occur in areas where there is lack of shade and vegetation cover causing increased heat retention and absorption by paved surfaces, buildings and roads. In Hong Kong, the UHI effect is primarily a night-time phenomenon, where the high heat capacity in the urban area reduces heat release back to higher atmosphere at night. Taller buildings also minimise wind speed and evaporation, which further inhibits cooling. Thus, larger nocturnal cooling rate can indicate a lower UHI effect.

From a study conducted by Hong Kong Observatory (HKO) in 2010, the urban-rural temperature difference or UHI intensity in the urban centre of Hong Kong can be more than 10°C.[11] In general, urban areas are observed to have higher UHI with a noticeably smaller nocturnal cooling rate in summer. On the other hand, the rural areas have a higher nocturnal cooling rate and daytime warming rate (***Figure 2-1***).[9]

Elevated temperatures resulting from UHI can affect a community's environment and quality of life. Some of these impacts are:

- Increased energy consumption – With the decreased nocturnal cooling rate resulting in hot nights, an increased overall electricity demand for air- conditioning and other cooling methods.

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

- Increased air pollutants and greenhouse gases – Due to increased energy consumption, there is a greater demand for fossil fuel power plants which leads to increased air pollutants and greenhouse gas emissions. Additionally, some of these pollutants are temperature dependent and tends to form faster under warmer temperature, such as NOx and volatile organic compounds.

- Decreased human health and comfort – The elevated temperatures and increased air pollutants can cause general discomfort, respiratory difficulties, heat cramps, exhaustion, heat strokes and heat-related premature deaths.

Urban forests can become a key factor in combating UHI. Evapotranspiration and shade created from urban forests can cool the air to as much as 1°C to 5°C and reduce the production of temperature dependent pollutants.[12] Trees providing shade can contribute to regulate temperature extremes, and improve human health and comfort.

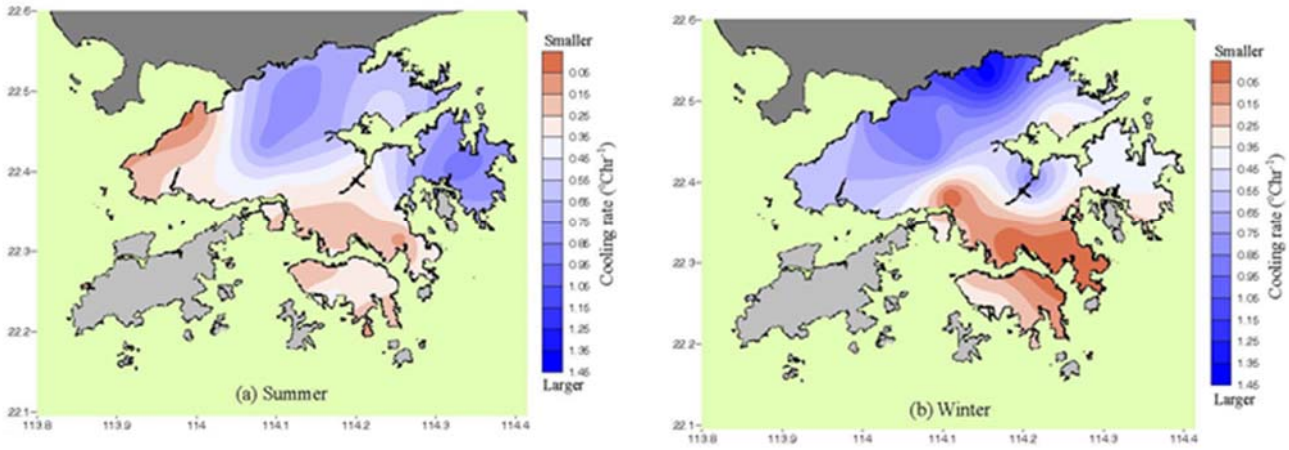

Figure 2-1 Urban Heat Island (UHI) in terms of Cooling Rate (CR). The CR of rural areas is higher than that of urban areas in general.[9]

Climate Change

> "Future proofing is about utilising and developing the capabilities of cities to respond to the risks associated with climate change, resource scarcities and damage to ecosystems in a way that catalyses inclusive urban development." – Future Proofing Cities [13]

Local climate extremes and UHI, both shown in studies conducted by HKO, are worsening. The frequency of temperature extremes, such as high hourly rainfall, hot days and nights, and extreme precipitation, has been increasing over the last hundred years. The annual number of hot nights

[12] Kurn, D. M., Bretz, S. E., Huang, B., & 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).

[13] Godfrey, Nick, and Roger Savage. (2012). Future Proofing Cities: Risks and Opportunities for Inclusive Urban Growth in Developing Countries. Epsom, Surrey, U.K: Atkins.

(days with minimum temperature of 28°C or above) has increased by twenty times and the annual number of cold days has decreased by 45% since the last 100 years. Extreme precipitation has become more frequent, with the hourly rainfall records increasing more than 60%, breaking past rainfall records at an unprecedented rate. HKO projected that the temperature and weather extremes will continue to rise due to global warming (refer to ***Figure 2-2***)[14]. Therefore, developing a long-term planting strategy will better equip Hong Kong to cater and withstand future local climate extremes.

It is also important to understand the future trends in climate change and how these might affect the future growth of the trees. As part of the planning strategy for Hong Kong's long-term vision of a sustainable and resilient landscape, tree species should be selected with due consideration to climate resilience.

Under the "Right Tree, Right Place" principle, we will not only need to select trees that can thrive in the existing Hong Kong climate, but also in the expected changes in future weather patterns until the end of its ULE.

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

Figure 2-2 – More Extreme Weather in Hong Kong

Community Concerns

Most Hong Kong citizens like trees. On the other hand, they have some reservations or concerns of varying degrees in particular trees planted in urban street environs. These concerns include:

- Trees attract animals, causing nuisances like droppings and possible diseases passed from birds
- Trees cause a mess by dropping leaves, flowers or fruit
- Trees may block views
- Trees attract unwanted insects, such as mosquitoes
- Trees block footpaths and cause paving upheaval
- Trees may be dangerous

Currently, the government is educating the community on the benefits of trees and proper tree planting, maintenance and management procedures, through talks, exhibitions and advertising to ease most of the public's concern. However, it is equally important for the community to realise that trees are living organisms and eventually do age, die and need to be replaced. With appropriate life-cycle planning and planting under the principle of "Right Tree, Right Place", accompanied by proper urban forestry management and practices, it is possible to maximise a tree's ULE.

Spatial Constraints

According to the research conducted by The Centre for Urban Forest Research (2004), large trees have more positive impacts on urban ecology and our living environment than small trees in terms of conserving energy, reducing stormwater runoff, mitigating urban heat island effect, improving local microclimate, improving soil and water quality, enhancing visual attractiveness and promoting health and well-being. Although planting large trees may require a higher upfront cost from a long-term perspective, the considerable benefits brought by established mature large trees outweigh the cost of planting a group of small trees within the same space.

However, with a high density urban area and narrow streetscape, planting space in Hong Kong is largely constrained by various functional requirements and complex site situations, such as underground utilities, pedestrian and carriageway width requirements, barrier-free access requirements, building regulations, etc. Flyovers, building line extensions, advertising signboards, traffic headroom and street canopies in older neighbourhoods further compete with the existing trees for overhead growing space. Existing trees are sometimes scarified and extensively pruned to satisfy these functional requirements. Planting or replanting of trees that can reach large mature sizes may not always be possible.

Also, high-rise skyscrapers not only cast large shadows on the ground, but also create wind corridors and wind shields which may have negative impacts on trees. This situation increases the difficulty of selecting the right species for the right places.

Urban Environment

Many researches have proven the benefits of planting large trees in urban landscapes in terms of creating more shaded areas, absorbing more gaseous pollutants, reduced vulnerability to vandalism, cleaning the air and releasing oxygen. However, trees require more space and more years to grow and mature, and maintenance for these trees is essential and relatively expensive.

In urban area, restrictions on the time and frequency of certain horticultural maintenance operations may be imposed to some planting areas as in the case of the central median planters to minimise traffic disruption. This has rendered difficulties for a thorough maintenance services to be carried out to these planters. Understanding that the possibility of human injury and property damage from tree failure in urban areas is significantly higher than the rural areas because of the higher quantity of possible targets and frequent foot traffic, tree selection must balance between maintenance cost / requirements and the tree benefits including social, environmental, visual amenity, etc.

2.2 Opportunities for Hong Kong

Under CAP, Hong Kong 2030+ and BSAP, a strategic framework has been set out to guide Hong Kong into becoming a sustainable and resilient city. One of the strategies is to formulate an urban forestry management strategy. The first step is to formulate a baseline to the current situation and a basis for ensuring biodiversity within the urban forest as part of the management strategy. A sustainable, resilient urban forest will require selecting the most appropriate tree species to deal with current and future challenges.

The next step is to select the appropriate tree species for the location, and to further develop and implement an urban forest management programme that is committed to work in a tree life cycle and provide a better street environment for urban trees to grow. For example, the management programme should be able to allow the selection of appropriate tree species to replace ageing street trees or high-risk trees to form new, potential green corridors within the existing urban framework. Blue-green drainage concept can also be considered in the early planning stage for new streets and for replacement planting where the existing planting area can be improved, as blue-green drainage infrastructure could reduce surface runoff, water pollution, heat island effect, carbon footprint and energy consumption, and blend the natural water environment into the city.[15] These will all require close coordination and input across multi-disciplines to form an integrated and holistic approach that takes into consideration the planning, landscape design, engineering, economics, environmental and general community requirements. With the concerted efforts from different disciplines and professionals, our urban forests will be sustainable, resilient and healthy for passing on to the future generations.

[15] Drainage Services Department, HKSAR Government. (2018) *Stormwater Drainage Manual, Planning Design and Management*, 5th Ed.