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Superb Fig *Ficus subpisocarpa*, 筆管榕 (Syn. *Ficus superba* var. *japonica*) on the Mui Wo Waterfront, Lantau Island. A self-seeded 'weed' that grew naturally out of a crack in the concrete, it is remembered as a bush 25 years ago and was saved from being chopped down by Fabian Pedrazzini of the Green Lantau Association.

It's one of the very few cool, shady spots where you can sit on the waterfront - for free. This solitary tree grew despite, not because of, the efforts of humanity yet repays our ingratitude with a multitude of services. It provides shade for sitting, picnicking, socializing and contemplating. It is a children's climbing frame, a haven for local bird life, and a welcome visual respite from the sad 'architectural' mediocrity that is the Mui Wo bus terminus.

Above all it is a silent teacher. We would all, especially professionals entrusted with designing the future environment, do well to heed its silent lessons!

Planting Futures Issue 2015

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The HKILA Publications Committee would like to thank the staff and students of the Division of Landscape Architecture, HKU, for all their help in putting this issue of Yuan Lin together.

Cover image

Jacaranda mimosifolia at Pacific Place 3, Star Street, Wanchai (Photo: Barnaby Smith)

Back cover image

Jacaranda mimosifolia in flower (Photo: Barnaby Smith)

Supplement cover image

New roadside planting at the junction of Jordan Road and Lin Cheung Road, West Kowloon (Photo: Mathew Pryor)

Supplement back cover image

GMP Planting at Star Ferry Pier, Central (Photo: Gavin Coates)

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President's Message

It is my great pleasure to welcome the publication of Yuan Lin 2015, the professional journal of The Hong Kong Institute of Landscape Architects, which serves as a platform for members and related professionals to share experiences, showcase projects and exchange views on matters related to landscape architecture.

This issue of Yuan Lin focuses on planting. The articles presented address the landscape architectural knowledge and technical skills pertaining to the design, implementation and management aspects of planting in a variety of local urban contexts.

I would like to take this opportunity to express my sincere thanks to the authors, Publication Committee, Editorial Team, members and landscape practitioners who have been involved in the production of this issue of the journal. On behalf of the HKILA, I would also like to warmly thank the many landscape material suppliers, contractors and organisations who, through their advertisements, have enabled the journal's publication. Without all these valuable contributions, Yuan Lin 2015 would not have been realised.

I strongly encourage members to submit articles, reviews, reports and other contributions for the next issue, on the theme of public space, so that we can increase the frequency of publication, and make best use of the journal to promote landscape issues in Hong Kong

Happy reading!

Tak WONG
President of HKILA
July 2015

Editorial

Planting is one of the fundamental arts and sciences of landscape architecture, and in many ways has come to define and identify the discipline. Landscape architects need to be knowledgeable and skilled in the design, implementation and management of planting, in different contexts and environments.

Trees, shrubs, climbers and grass provide greenery and visual ornament, create environmental comfort through shade and shelter, reduce the 'heat-island effect' and diversify ecology of high density urban environments. Plants can also have strong cultural, historic and symbolic meanings and values. There is an increasing body of research to show that urban planting substantially benefits the physical and mental health of city dwellers.

In high rise cities like Hong Kong, intense competition for space creates unique challenges for landscape architects in the establishment and management of planting. In contrast to the natural environment of our country parks, urban plants have to tolerate extreme deprivation just to survive, let alone thrive. Considering the impoverished physical environment that has typically been allowed for trees in our narrow streets, it is little wonder that their average life expectancy is less than 20 years. Landscape architects need to appreciate the inherent artificiality of urban planting and must work closely with property owners, managers, planners, architects and engineers, to ensure the provision of adequate growing space and conditions, and maintenance tailored to achieve the design intent in the long-term. We have a duty to ensure that planting designs emphasise integrated, sustainable, successional vegetation structures, and not focus merely on the immediate, the decorative, and the isolated specimen.

This issue of Yuan Lin has been dedicated to planting. A wonderfully diverse collection of reviews, articles and academic papers, collectively explore the different forms, scales, and contexts of Hong Kong's urban planting.

A few of the many meanings and values that society can give to plants and planting are discussed in the opening article 'On the symbolism of plants in the context of Hong Kong', and specific meanings are explored in the beautiful 'Landscape symbols and representations in the Tale of Princess Kaguya'.

In 'A return to Disney' three practitioners revisit the massive ornamental planting works they helped build for the HK Disneyland Resort, reminiscing on how it was all achieved, and assessing how the planting has fared over the last 10 years. 'A tree for all reasons' examines successful examples of greening in the highly contested streets of Wanchai, and highlights the impact that just a small number of individual trees can have on our urban environments. 'Weaving green fabric to a condensed city' looks at



the many successes of Development Bureau's 'Skyrise Greening' campaign in greening the city's vertical surfaces and rooftops.

Different forms of planting are explored in several articles. 'Trials in succession woodland planting at SENT Landfill' reports on new approaches to establishing sustainable vegetation structures on reclaimed land, while 'Productive green roofs' examines the increasing use of roof spaces for the production of vegetable and fruit crops in high rise cities, and suggests that this might be the logical next step in urban farming and green roofs. 'Alternative way to green the city: Unplanned vegetation in Hong Kong' is an intriguing student research study that questions the standard approach to planting procurement, and suggests that a small shift in public opinion might lead us to more effectively co-opt nature to green the city on our behalf

Good planting design is based on detailed knowledge of plant growth habits and ecologies. To that end 'Amenity and sports turfgrass in Hong Kong' sets out the options for successfully growing lawns: always a challenge in Hong Kong's unforgiving subtropical climate. 'Aerial roots on *Ficus microcarpa*' reports on a research study investigating these remarkable features, typical of one of Hong Kong's most iconic tree species, and in particular the long-standing question of whether these roots can take up water from the atmosphere around them. Conversely 'Extreme trees' investigates how the tolerance of some mature trees to extreme physical damage has resulted in their commodification within the development process in southern China.

Successful urban planting requires good policy and management. The article on a 'Tree preservation ordinance for Hong Kong', looks back to the Territory's early history and provides an interesting footnote to the current discussion about the need for tree protection legislation. By contrast 'Tree management shortcomings in Hong Kong' examines some of the policy and management challenges in developing a healthy urban forest in the city today, and 'Establishing a framework for the recognition for local arboricultural practitioners' highlights some of the current difficulties faced by the profession in providing quality arboricultural services to the community in Hong Kong.

The centrepiece of the journal is reserved for a beautifully drawn educational illustration of the 'Tree of Landscape Design' (*Arbor propositum*), a planting-orientated, graphic metaphor of the landscape design process.

'During bad times, people of South China have the tradition of washing themselves with pomelo leaves. As this tradition goes, the citrus fragrance of the leaves washes away evil and bad luck. Perhaps what is needed for Hong Kong right now is a city-wide wash using this formula.'

Yin-lun Chan

On the symbolism of plants in the context of Hong Kong

Yin-Lun Chan

As an integral part of our landscape, plants play important functional and aesthetic roles in our everyday life. Plants that appear in our landscape are reflective of the climatic and cultural contexts of where we live, in other words, our identity of place. In the context of Hong Kong, we encounter symbolic imageries of plants from both Eastern and Western contexts. Through a selection of plant symbols and by looking specifically at the ways they are depicted in works of Chinese literature, the worldviews expressed through such metaphorical associations are described. In so doing, this paper attempts to explore how these plant symbols may be interpreted in a contemporary context.



'China the Flowery Land', from an old Chinese engraving (Source: Lehner & Lehner 1960: 104)

Introduction

Perhaps the most intriguing features about any discussion of symbolism in Hong Kong are the ideas of hybridity, juxtaposition, and contrast. This myriad of dichotomies include those of Chinese / Western, traditional / modern, native / foreign, elitist / popular. This list of pairings could be applied to analyse all sorts of cultural features of the city, and a proposal to review the symbolism of plants in Hong Kong based on this line of enquiry promises an interesting study. The floral emblem of Hong Kong, appearing on coins and flags, is the vividly-coloured flower of the Hong Kong orchid tree *Bauhinia x blakeana*. The Hong Kong orchid tree, a hybrid between *Bauhinia variegata* and *Bauhinia purpurea*, is a widely planted sterile hybrid with showy blossoms and brittle branches. Certain wags have been heard to wisecrack that these qualities do indeed make the Bauhinia a very apt emblem for Hong Kong.

The striking feature of Hong Kong's urban environment is its densely packed urban setting, a product of capitalist priorities and over-the-top commercialisation. Landscapes reflect a place's ideology and taste. The shiny giant skyscrapers, multi-lane highways, flyovers and underground tunnels in the city-centre of Hong Kong all combine to tell the story of modernity and efficiency – time is money, and money is king! Amidst this mechanistic worldview of a city, what is the place of plants?

Plants are indispensable elements in considering the city's *feng shui*. Urban gardens, allées of trees, decorative plants – there are indeed many traces of plants in contemporary urban lives – not to mention their processed forms such as food, fabric and others. They are considered a 'touch of nature' within the concrete jungle, something that 'softens' the harshness of built forms, something that relieves us from urban stress. Greening of the city is 'good'. Planting contributes to urban sustainability. Plants filter sound, dust, and produce oxygen. Trees are urban lungs. Plants save the world.

The fact that plants are associated with a broad range of cultural meanings have long histories in both Eastern and

Western contexts. Trees and flowers have long been subjects of poem, literary and poetic imageries, and painting. In fact, the artistic lineage of the term 'landscape' seems to share common roots as artistic subjects in both the East and West. The various Chinese translations for the term 'landscape' can be quite problematic. However, *shan-shui* (山水), literally mountain and water, as the term relating to Chinese landscape painting is a rather straightforward one in relation to the European tradition of oil landscape painting. Given this background, the study of plant symbolism in the context of contemporary Hong Kong might allow us to get a better glimpse of the identity complex inherent in the urban landscape of Hong Kong. As such, this paper intends to provide an updated interpretation of some of the traditional plant symbols in the contemporary, desacralized and commercialised popular context. I argue that landscape architects should take on a more active role in incorporating our cultural attachment to plants into the design and interpretation of everyday landscapes.

Encountering urban plants

Let us take a mental inventory of the plants we encounter in the contemporary landscape of Hong Kong.

1) Flowers: Including both cut flowers and potted plants.

2) Street planting: From the traditional street trees to the 'street gardens' which are becoming more common under 'beautification' schemes, and those strange little planters hanging off the railings of heavy trafficked roadsides.

3) Food: Markets, community gardens, nurseries, roof-top farms.

4) Other functional uses of plants: The first one that comes to mind is the ubiquitous bamboo scaffolding used for works on building façades. This category would also include all the timber used in building construction, furniture, and interior decoration. Not to forget paper, fabric, and other 'processed' forms of plant materials.

5) Gardens: Stepping into the scope of classic landscape architectural practice.

Tamed renditions of natural landscape, so to speak.

6) Countryside: Country parks, farmlands (former rice fields), coastal areas (mangroves), uninhabited areas of 'wilderness'.

7) Copies and metaphorical existence: Have you not come across any plastic plants lately? Flower trellises for wedding ceremonies, fake lawns, landscape paintings hung on walls – these are the maintenance crews' favourite!

Although Hong Kong may be a fairly built-up city, plants are still major components of our landscapes. They infuse all aspects of our daily lives. As urban dwellers, we seem to be losing our connections to nature, which is reflected in our seemingly decreasing physical contact with living plants. But this is not quite true, no matter how advanced our technology, we still need plants to survive. In fact, we encounter plants all the time, if not symbolically and metaphorically. Now let us revisit some of these plant symbols and for a moment indulge in an exercise of over-interpretation. We start with the rose.

Rose

Rose is one of our favourite florals symbol of all time. Its flamboyant redness embodies images of blood and passion. It has been one of the most frequently used symbols in literary codes. Anecdotally, the author's primary school was of the name 'Rosaryhill' and many mornings would start with the reciting of the Hail Mary, which formed part of the Rosary prayers.

The vibrancy of the rose is symbolic of St. Valentine's Day as with other festive plants such as Christmas trees and Halloween pumpkins. Plants associated with festivities reflect the seasonal habits of plants and aspirations of cultures. Hong Kong hosts many festivals, including both Eastern and the Western. This is a reflection of the city's colonial history, Chinese heritage, and metropolitan nature.

The rise and fall of the popularity of festivals is a subject of cultural and folklore studies. It can also be analysed in the context of contemporary commerce. There are institutional and commercial aspects related to this. One

aspect is whether a festival is associated with a public holiday. The choice of public holidays can be political, as seen for example in the replacement of the Queen's Birthday by the First of July at the turn of 1997. The other aspect is the workings of capitalism, whether the festival can be translated into commercial profit. The danger of commercialised festivals may result in symbols that no longer contain any cultural or religious content. In this case, all cultural symbols degrade into pure symbols of commerce. This is the way they appear in shopping mall foyers, reflecting pure consumerism. This means Christmas and Easter without church, Halloween without harvest, Ching Ming without ancestors, Winter Solstice/ Thanksgiving without family, Labour Day without Socialism. One concern about how a festival survives is its ability to involve children, so that there is generational continuity. Only when a festival is embraced by children and the younger generation can it remain part of an active culture that is continually renewed and evolving, rather than a dying culture requiring protection and preservation. In this respect, consumerism may be doing something that is at the same time good

and bad.

Let us return to roses, which are nowadays perhaps best associated by Hong Kongers as associated with St. Valentine's Day. Outrageously expensive flowers, the crucial day of profit for flower shops, the day for men and women to make romantic gestures. Within this commercial phenomenon, the symbolic associations of roses are coupled with colour and numerology, exemplified in the table below taken from a commercial website where each line is emblazoned with the hyperlink, 'Purchase Romantic Roses!'

And of course, to be consistent with capitalist logic, the more expensive it gets, the more sincere you are and the more powerful the spell! But to many city managers, roses are best kept in their 'safe' cut-flower and bouquet forms. For urban street plantings, roses grow too fast and often appear unkempt. Viewed from a governance perspective, roses represent passion, which requires heavy maintenance and must be controlled.



Roses (Photo credit: Ziva & Amir, <https://www.flickr.com/photos/125619820@N03/18185550873/>)

Colour Meanings

Red Roses: Love & Respect
Dark Pink Roses: Appreciation & Gratitude
Light Pink Roses: Admiration & Sympathy
Yellow Roses: Happiness & Friendship
White Roses: Innocence, Purity, To Honor, Remembrance
Purple Roses: Enchantment & Enthralment
Orange Roses: Enthusiasm & Captivation

Number Meanings

1 Rose – Love at first sight
2 Roses – A common love between both parties
3 Roses – I love you
6 Roses – I devoted to you; I want to be yours
7 Roses – I'm taken with you
9 Roses – Everlasting Love
10 Roses – You are perfect
11 Roses – You're the one that is most important in my life
12 Roses – Be my sweetheart
13 Roses – Secret friend
...
99 Roses – I will love you forever
100 Roses – Remaining devoted to you
101 Roses – You are my only love
108 Roses – Marry me
365 Roses – Can't stop thinking about you
999 Roses – Eternal Love
(Extract from rosemeaning.net)

One of the most important eras for construction industry in Hong Kong is the planning and development of the Rose Garden Project in the 1990s involving the new Chek Lap Kok airport, the Tsing Ma Bridge, container terminals, and major railway and highway extensions. Presented as a way to 'soften' the tone of massive infrastructure, and to paint a 'rosy' picture of Hong Kong's future, 'Rose Garden' conjures quite contrasting imageries to the actual massive scale movement of dirt and pouring of concrete. But this was quite adept at describing the bubble economy of the 1990s. To many, it is remembered as an era of good times, a golden, rosy, voluptuous era; an era of excess.

Peach

Also in the rose family is the peach. As with the Japanese cherry blossom *sakura*, the Chinese peach blossom is loaded with meaning in traditional symbology. In Chinese literature, the peach is the classic imagery of an escapist utopia. This came about by the fable told by the Jin dynasty poet Tao Yunming, 'The Peach Blossom Spring'¹. The story starts with a beautiful description of a forest of blossoming peach trees:

晉太元中·武陵人·捕魚為業·緣溪行·忘路之遠近；忽逢桃花林·夾岸數百步·中無雜樹·芳草鮮美·落英繽紛；漁人甚異之。
(《桃花源記》陶淵明)

One year in the Jin dynasty, there was a fisherman, who strolled along a stream, without noticing how far he had gone. Suddenly, he encountered a forest of blossoming peach trees, extending a few hundred feet from the bank. There was not a single other species within the grove. Smelling of sweet fragrance, colourful petals swirled in the breeze. The fisherman became curious. ('The Peach Blossom Spring' by Tao Yunming, translated by the author)

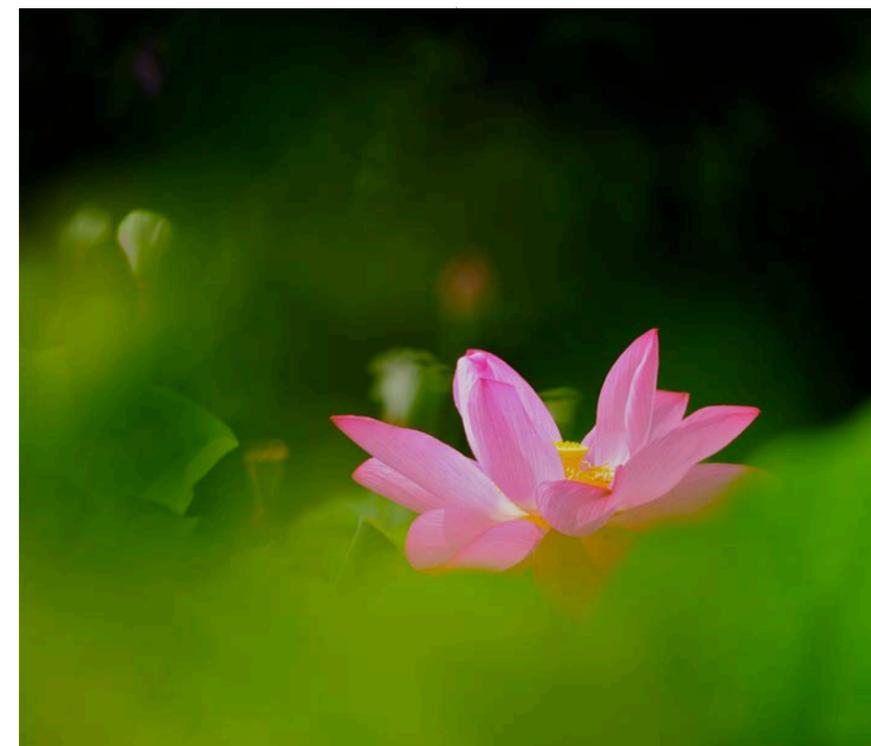
The fisherman proceeded along the stream and entered a utopian village that had been shielded from the warfare and misery of the outside world. The villagers were people who, having escaped the tyrannical rule of the Qin dynasty, formed a 'commune' in the mystical woods that the protagonist found only once but not when he returned a second time. This escapist attitude is in fact quite typical of Chinese scholars who get weary of bureaucratic power

struggles and leave for the countryside. The story of the 'Peach Blossom Spring' has been suggested as a metaphor for Hong Kong, which thanks to its unique political status, avoided much of the chaos that has characterised the modern history of the Chinese Mainland. As such, despite having interacted with foreign cultures for many years, Hong Kong is still the foothold of many traditional pre-Republic Chinese cultures, having escaped the ravages of civil war and the Cultural Revolution.

But perhaps more important to the common Hongkonger is what peach blossom represents in Chinese fortune-telling, that of spring, vitality, and good relationships. The peach is thought to embody much vitality because it blossoms before coming into leaf.

The Peach, *t'ao hua*, plays an important role in Chinese symbolical art. The blossom, one of the heralds of Spring, favoured season for weddings, is an emblem of Matrimony.²

In bookshops or newspaper stands, you can find many *feng shui* books that teach you how to attract good



Lotus (Photo credit: Jennifer, <https://www.flickr.com/photos/jennifer-kecl/4725272095/>)

fortune in relationships, with reference to peach blossom, arranging furniture and wearing particular gemstones. During Chinese New Year, families carry home soon-to-blossom peach trees (like Christmas trees) and later have young men and women walk around the blossoming tree in circles wishing for good relationships in the upcoming year. As the social pressure for men and women to get married continues, this tradition is likely to endure, especially given the current gender imbalance of Hong Kong. Fortune tellers and *feng shui* books emphasise the good fortune benefits of peach blossom, perhaps with therapeutic effects.

Lotus

The *Prunus* flowers are colourful, vibrant blossoms. They are emblematic of energy and youthfulness. On the other hand, Confucius and Buddhist wisdom professes a beauty which is more subdued, quiet, and tranquil. The lotus flower epitomises such characteristics, as described in the following excerpt:

One of the most revered plants with a deep-rooted, religious significance is the lotus flower, a member of the tropical water lily family (*Nymphaeaceae*)...Held sacred by the

ancients in the Near and Far East since the beginning of religious beliefs, it has an uninterrupted symbolic history of over 5,000 years...The eight-petaled lotus, *Lien* in China, and *Hasu* in Japan, is also the emblem of the Past, the Present and the Future, since buds, blossoms and seed-pods can be seen simultaneously on the same plant. The lotus is furthermore considered the symbol of beauty, perfection and purity, because the beautiful blossom grows clean and untouched by the sullied water of the muddy pools from which it rises.³

In this respect, plants are often used to depict preferred lifestyles and images of ideal ways of life. Many classical Chinese literary figures speak of alienation. They write about teachings and metaphors of how a person should live virtuously amongst chaotic societies and corrupt governments. Using the lotus flower as a metaphor, the following piece gives advice on life, on how to live righteously, and to maintain purity even when surrounded by dirt and mud.⁴

水陸草木之花·可愛者甚蕃·晉陶淵明獨愛菊；自李唐來·世人盛愛牡丹；予獨愛蓮之出淤泥而不染·濯清漣而不妖·中通外直·不蔓不枝·香遠益清·亭亭靜植·可遠觀

而不可褻玩焉·予謂菊·花之隱逸者也；牡丹·花之富貴者也；蓮·花之君子者也·噫！菊之愛·陶後鮮有聞；蓮之愛·同予者何人；牡丹之愛·宜乎眾矣·(《愛蓮說》周敦頤)

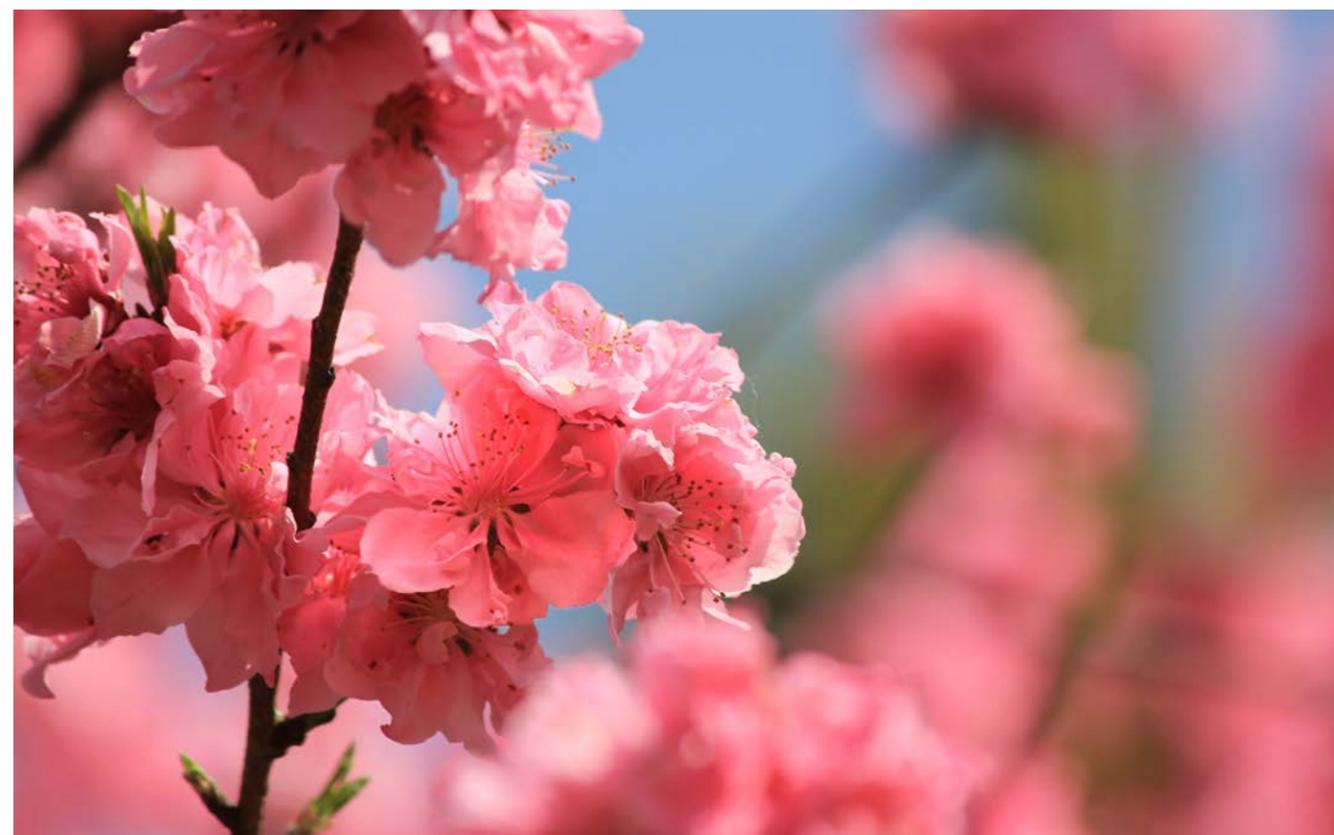
There are many admirable flowers among land and water plants. The Jin dynasty scholar Tao Yunming particularly loved chrysanthemum. Since the Tang dynasty, people have enjoyed peonies. Contrary to popular preference, I love lotus for its purity even though it rises from mud. I love it for its elegance standing amidst water ripples. It stands upright, its fragrance spreads afar, it deserves much respect! I say, chrysanthemum is the hermit of flowers; the peony, the wealthy flower; lotus, the most noble of flowers! Alas! There are few who loved chrysanthemum after Tao. And I guess there is no one who loves the lotus as I do. The Peony is the popular choice. ('The Love of Lotus' by Chou Tun-i; translated by the author)

Compared to the escapist, utopian peach, the metaphor of the lotus speaks of an attitude to life that is more worldly. It speaks to the idea of standing upright within a corrupted world. Rather than retreating from the world altogether, the lotus metaphor asks us to stay within society, but maintain our purity, be honest, and live a righteous life.

Ficus

No matter what your sense of time is, whether you conceive the image of a flower as representing the infinite universe, a flower is just a flower. The beauty of flowers stems precisely from the fact that they blossom and they wither; their very essence lies in their ephemerality. Large trees, on the other hand, are to us like elders; there since the beginning of time, and their canopies extend way beyond human reach. One of these, the fig tree is of cultural significance in many cultures.

The common fig tree (*Ficus carica*), native to the Smyrna region in Asia Minor was one of the most widely revered sacred trees of antiquity. Among the ancient Hebrews the fig tree was a symbol of peace and



Peach blossom (Photo credit: tanakawho, <https://www.flickr.com/photos/28481088@N00/8629149917/>)

abundance. It was a sacred tree to the early Christians because Jesus desired to eat figs on the way to Bethany...There are several hundreds of species of fig tree, revered nearly everywhere as the Tree of Life and Knowledge, from Central Africa 'where the natives believe that the spirits of their ancestors live in fig trees, to the Far East where the Buddhist reveres the pipal, a fig tree, because Gautama found wisdom under it.'⁵

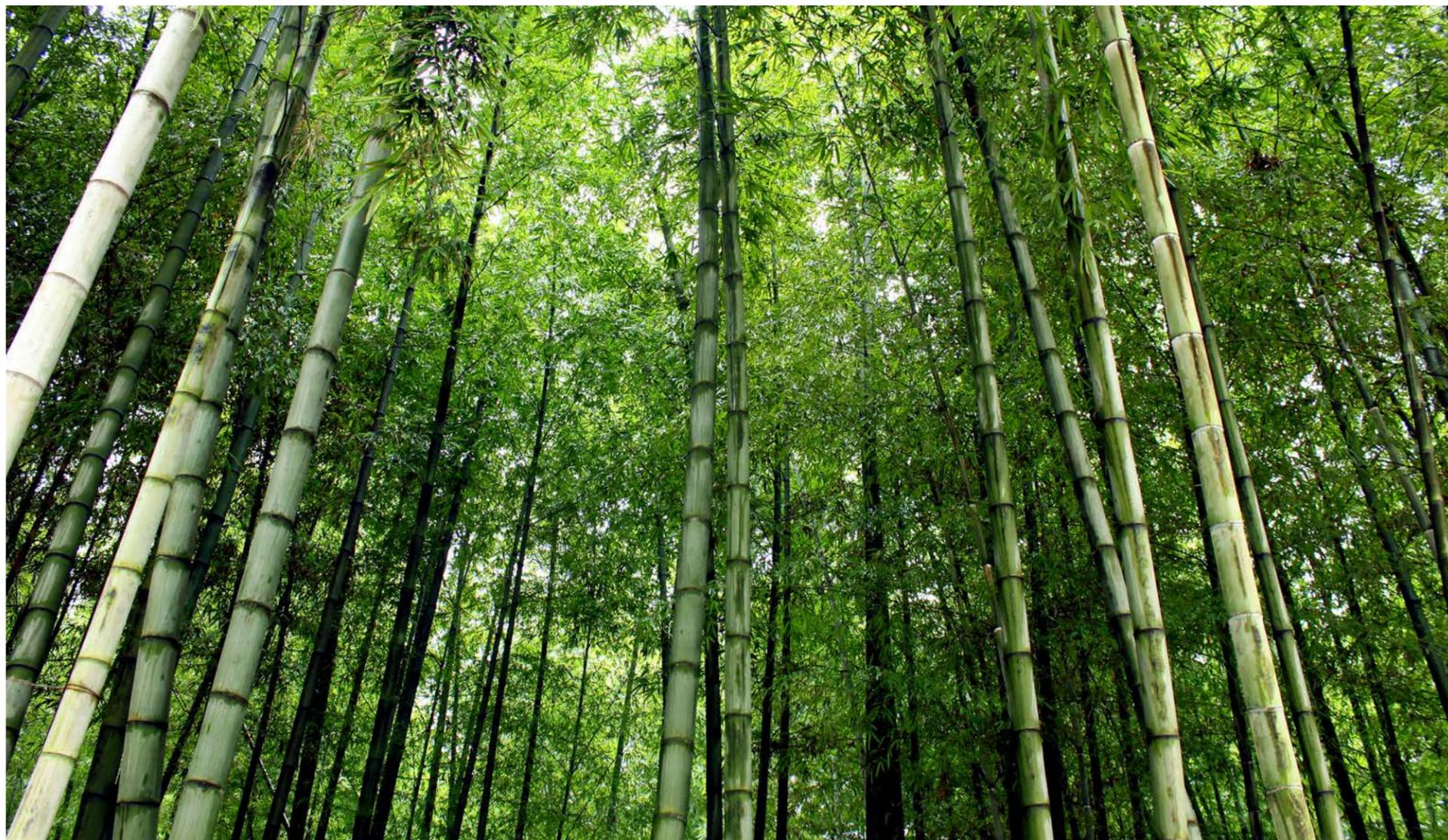
Our local fig tree, *Ficus microcarpa*, is also called the Chinese banyan or the curtain fig. In Kam Tin, there is a famous ficus tree that has over the years devoured an entire abandoned village house. For many Southern Chinese villages, the village tree stands for the well-being of the entire clan, and the public square under the tree is the centre of the village, where gatherings and other activities like storytelling and performances are held.

Another feature that is rather unique to the landscape of Hong Kong is the presence of retaining wall trees, growing from within the cracks of stonewalls. They are integral to the structure of the wall and at the same time provide shade and comfort to the urban streetscape. They are perfectly adapted to the hilly topography of Hong Kong Island, an example of the integration of natural topography, built structures, and ecology.

Bamboo

Bamboos are grasses. They grow quickly but maintain structural integrity. Here is a basic physics question asked of children, 'Does bamboo or a huge tree withstand stronger wind?' As the answer goes, although bamboo is much thinner in girth and easily bends, it can withstand much stronger wind precisely because of its flexibility that dissipates the force of the wind. The greatness of bamboo as a construction material is similarly because of this flexibility but at the same time its ability to withstand longitudinal compression.

Bamboo epitomises the functionality of plants within the urban landscape. Often it reminds us of our connections to the rural landscape. In the dense urban environment, with little space



Bamboo forest (Photo credit: JFXie, <https://www.flickr.com/photos/jfxie/7988632041/>)

between buildings, we often see these matrices created by the structure of this plant material at close quarters. Baker, in writing about his first encounter with bamboo scaffolding⁶, exclaims:

How soon one accepts! When I first set foot in Hong Kong one of the first marvels that registered with me was bamboo scaffolding. On close inspection it could be seen to be held together only by short lashings of reed, and when the workmen moved around on it the flimsy poles creaked alarmingly. How could it rise so high and remain so strong? Yet, a short while later I was showing a newly arrived friend around, and I walked straight past some scaffolding without thinking to comment. It was only when he stopped to wonder that I even noticed. (Baker 2011: 169-170)

Let us for a moment move away from this urban imagery and visit another one of my favourite secondary school texts. The following is Huang's breathtaking description of the bamboo forest⁷:

說是竹鄉，並不是沒有別的植物，不過實在太少，而竹子之多，給你的印象似乎是，那裏除了竹，其他便甚麼植物都不存在了。其實不是沒有而是看不到。遠望去一連幾座山頭，從山麓一直到山頂，不，從平地開始就全鋪著竹，一層又一層的，不但分不出竹枝、竹幹和竹葉，連房子、小徑和小橋流水都看不到，彷彿全被竹的海洋淹沒了。當一陣風吹過的時候，竹海上湧著暗浪，一浪推著一浪，一直湧到很遠，你很難知道那一片嫩青色和墨綠色的竹海有多深，只是你看竹浪的起伏和它的氣勢，就意味著它是非常深沉的。(《竹林深處人家》黃蒙田)

To say this is the home of bamboo, is not to say that there are no other plants, but there are very few. On the other hand, the sheer amount of bamboo gives you the impression that there are no other plants even though they are present. Looking across the rolling hills, from the ridges to the hilltop, no, starting from the flat areas it is already all covered in bamboo. Layer after layer. There is no way to distinguish among culms, branches, and leaves. You could not even identify the houses, paths, they are all covered in a sea of bamboo. The wind creates waves across the bamboo sea, the waves press on, one after another, to a distance away. It is impossible to tell how deep are the patches of light and dark green, but by admiring the greatness of the rising and falling bamboo waves, you figure it must be of great depth. ('Within

the Depths of a Bamboo Forest' by Huang Meng-tian, translated by the author)

Between the hermetic, withdrawn utopia of the Peach Blossom Spring and the self-righteousness of the lotus, bamboo describes an additional dimension of rural and urban connections. The narrator describes his visit to a friend living deep inside the bamboo forest, and how he admired simple rural life. To the urban dweller, connections with rural imageries are crucial in maintaining a healthy mind. The sight of bamboo in the urban landscape is perhaps one such icon that evokes rural imageries in our minds.

Incense Tree

The incense tree is closely tied to the name of Hong Kong. According to Baker,

It has been suggested that the name of Hong Kong does not mean 'fragrant harbour', as it is normally translated, but rather 'incense port'. Apparently in the Ming dynasty there was a thriving trade in incense through the village port of Hong Kong on the south side of the island. The incense came from plantations of trees which grew particularly well in this area.⁸

This tree mentioned by Baker is the incense tree, *Aquilaria chinensis*. The incense tree has many uses, but its high value stems from its resin which is the fragrant element of agarwood. The resin is formed in response to fungal infection or external wounding, which can be turned into expensive Chinese medicine or an aromatic substance. Agarwood is also of religious importance. The burning of resin-rich agarwood is part of Buddhist and Taoist ceremonies, and it can also be used to make joss sticks that are used in the worship of gods:

The worship of the divinity by the lighting and offering of incense goes back to the remotest times of Chinese history, and existed more or less as practiced at the present day, or at least in the form of aromatic substances burnt in honour of the gods. We read that in very early times, the emperors Yao, Shun and Yü, offered burnt offerings to the Supreme Ruler, Shang-ti, while later on as primitive tradition waned or became corrupted, private families assumed the right of offering incense to their own special gods⁹

The smell of agarwood is thought to traverse multiple worlds. Given the cultural significance and commercial value of its wood and resin, agarwood has been referred to as the 'diamond of plants'. This has, however, led it to become the target of theft. Over the past few years, many incense trees in Hong Kong have been illegally felled. Sadly, this precious native tree which has given Hong Kong its name is now an endangered species. This can perhaps be a metaphor for the city itself. Many core values of the city are increasingly under threat. What can be done to reverse these trends?



Stone wall tree (Photo credit: Jonathan Leung, <https://www.flickr.com/photos/jonathan-leung/18918043073/>)

Conclusions

During bad times, people of South China have the tradition of washing themselves with pomelo leaves. As this tradition goes, the citrus fragrance of the leaves washes away evil and bad luck. Perhaps what is needed for Hong Kong right now is a city-wide wash using this formula.

In the preceding discussion, the Taoist and Confucian plant metaphors have illustrated an escapist worldview. The peach forest, the lotus, and the bamboo sea all depict escapist, self-righteous approaches to life. In this sense, living in harmony with nature and keeping a distance from mainstream society appear to be the preferred way to deal with urban vices. However, in this scheme, human connections to landscape are excluded from the urban context, and there is no attempt to improve the worrying state of urban society. To overcome this escapist attitude to life, and to the landscape, what is perhaps needed is a way to once again bridge cultural meanings with the material landscape. Without this cultural enrichment, the mere act of 'greening' (i.e. the addition of plants) would only create empty cultural embellishment without any cultural content.

Without doubt, the selection of plants in the urban landscape is considered with regard to their vigour and

ease of maintenance. However, our understanding and connection to plants should not be limited to such technical considerations. They should include elements and activities deeply embedded in our cultures. We must also build these connections with agriculture, dietary practices, festivities, religion, tradition, and superstition. Perhaps the way to overcome escapism is a reversal in attitude: rather than be perpetually in retreat, we should let our native plant culture re-invade the cityscape. To wage this campaign, we should make use of every opportunity to scatter the seeds of landscape into each and every corner of our society!

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References

1. Tao, Y. (Unknown) 'The Peach Blossom Spring'. Online at <http://www.cbooks.org/readbook.asp?job=2&bookID=2&subnameID=45>.
2. Koehn, A. (1952) Chinese Flower Symbolism, Monumenta Nipponica 8 (1/2): 121-146.
3. Lehner, E. and Lehner, J. (1960) Folklore and Symbolism of Flowers, Plants and Trees. New York: Tudor Publishing Company.
4. Chou, T. (Unknown) 'The Love of Lotus'. Online at <http://www.cbooks.org/readbook.asp?job=2&bookID=2&subnameID=70>.
5. Lehner, E. and Lehner, J. (1960) Folklore and Symbolism of Flowers, Plants and Trees. New York: Tudor Publishing Company. 29.
6. Baker, H. (2011) Ancestral Images. Hong Kong: Hong Kong University Press. 169-170
7. Huang, M. (Unknown) 'Within the Depths of a Bamboo Forest'. Online at <http://www.cbooks.org/readbook.asp?job=2&bookID=4&subnameID=152>.
8. Baker, H. (2011) Ancestral Images. Hong Kong: Hong Kong University Press. 349.
9. Baker, H. (2011) Ancestral Images. Hong Kong: Hong Kong University Press. 348, citing Doré (1914)

'The Tale of Princess Kaguya is centred on a princess of the Capital of the Moon who was sent on Earth by Deva as a form of punishment. The story is vividly set in landscape themed episodes embedded with early garden symbols and representations – which are deeply rooted and shared in East Asian culture (Japan/China).'

Winnie Yuen Lai Chan

Review: The homecoming of the Moon Capital: Landscape symbols and representations in The Tale of Princess Kaguya

Winnie Yuen Lai Chan



is a variation on the iconography of the boy miraculously-born out of a lotus flower 化生童子 in Chinese Buddhist art. An old bamboo cutter walks past the bamboo forest, discovers and adopts her. The Princess spends her humble but carefree years of childhood surrounded by nature with her adoptive parents, and grows up into human size at a fast pace just like a bamboo shoot. Some early scenes in the farm cottage landscape recall the picturesque Swiss mountain in Takahata's 1974 TV anime series *Heidi, Girl of the Alps* (アルプスの少女ハイジ, Arupusu no Shōjo Haiji, 飄零燕). It turns out that the magical bamboo forest has more to offer the future princess, and prepares exquisite silk kimono fabric to make clothes and gold nuggets to build a palace.

Palatial Landscape and Memory Garden

As the palace construction was completed, the family leaves the countryside and relocates to the capital city of Heian-kyō 平安京 (present day Kyoto). They settle into the palace where the country girl learns to become an aristocratic woman. The sumptuous palace architecture and courtyard gardens provide settings for the extravagant social life at court. The banqueting scenes also draw many references from early Heian architecture and interiors, that are depicted in the painting scroll *The Tale of Great Minister Ban* (伴大納言絵詞 Ban Dainagon Ekotoba)¹. The palace for the Princess is built in the style of Shinden-zukuri 寝殿造 of the aristocratic class of the Heian period. Architectural complexes usually consisted of buildings and a water garden in imitation of the land of Amida Buddha (阿弥陀仏 Amitābha) in Pure Land

- Spoiler alert -

The Tale of Princess Kaguya (かぐや姫の物語, Kaguya-hime no Monogatari, 輝耀姫物語) (2013, released in Hong Kong cinemas 2014) is an animated film adaption of the 10th-century Japanese folktale *The Tale of the Bamboo Cutter* (竹取物語 Taketori Monogatari), directed by the acclaimed animation master Isao Takahata 高畑 勲 (b.1935) who co-founded Studio Ghibli along with Hayao Miyazaki 宮崎 駿. This 10th-century Tale of the Bamboo Cutter is the predecessor of all Japanese courtly literature like the classic *Tale of Genji* (源氏物語, Genji Monogatari, early 11th-century). It is centred on the protagonist Princess Kaguya (かぐや姫 Kaguya Hime) of The Capital of the Moon (月の都 Tsuki-no-Miyako) who was sent to Earth by Deva 天人 as a form of punishment.

The story is vividly set in landscape themed episodes embedded with early garden symbols and representations – which are deeply rooted and shared in East Asian culture (Japan/China). The period between the mid-8th to mid-9th centuries marks the Japanese (Heian 平安時代) reception of Chinese (Tang 唐) culture in all aspects. Pure Land Buddhism 浄土宗 and Taoist landscape thought also spread eastward and became localized.

Bamboo Forest and Pastoral Landscape

The bamboo forest is a mythic and productive landscape, where the spirits and the bamboo woodcutter meet. The story begins as the little Princess Kaguya (literally 'luminous radiance'), the size of a thumb, is born out of a growing bamboo shoot. Such an image

Buddhism. The most famous surviving example of such an arrangement is the Phoenix Hall in Byōdō-in Temple 平等院鳳凰堂 (1053), Uji 宇治 in the vicinity of Kyoto.

The rural-city dichotomy is highlighted here by the vastness of the palace chambers and the intimacy of the kitchen garden. The Princess refuses the rigid rituals only to find pleasure in cultivating her own garden. The back yard is used to express her disconnection from courtly affairs. A similar experience of wandering in a natural landscape is recreated here by looking closely at the microcosm of the garden that stimulates imagination and stirs memories of a pastoral landscape.

Paradise Landscape

With her extraordinary beauty and mastery of *koto*, the young Princess receives proposals from five suitors of high official rank and eventually from the Tenno Emperor 天皇 but she rejects them all. One of the five impossible things that the Princess requests her suitors to acquire is the Jeweled Branch of Hōrai (蓬萊の玉の枝 Hōrai no tama no eda). This legendary treasure can only be obtained from the Taoist immortals' abodes of Hōrai (Penglai 蓬萊 in Chinese) Island, believed to be located in middle of the Eastern Sea between China and Japan. One suitor eventually brings a fake one he acquired after miraculous efforts and a sea voyage of 500 days from the port of Namba 難波港. Geographical data is precisely written in the story and matches nicely with the Chinese *Classic of Mountains and Seas* (Shanhaijing 山海經).

It is interesting to note that the manmade 'jade branch' is in a *bonsai* (tray landscape 盆景) arrangement, a miniaturized representation of Penglai. It is believed that by artificially making a replica, one would have power over the real object.² However, the magical connotation is conveyed here as something unobtainable. Furthermore, the artificiality of the 'jade branch' and other treasures is contrasted with their simpler, natural equivalents: birds, insects, wild animals, grass, trees and flowers—all of which the Princess enjoys.

Monoscape

After experiencing the worldly desires of wealth and fame, growth and loss, love and pain, the Princess is drawn by the magical power of the Moon on the 15th night of the lunar month and feels the urge to fly back home. This part references the familiar Chinese mythology of Mid-Autumn: when Chang'e 嫦娥 the Moon Goddess of Immortality flies to the 'celestial palaces' 天上宮闕 / 'jade towers' 瓊樓玉宇 of the moon, as the 11th-century *ci* 詞 poet Su Shi refers to in the melody of *Shui diao ge tou* 水調歌頭". When the lunar deity myth spread to Japan from China during the Heian period, the moon was no longer a taboo image (as in sun worship in Japanese Shinto 神道 tradition) but a trouble-free heavenly utopia like the Peach Blossom Spring, where the Devas enjoy longer lives and fewer desires.

Here, the moonscape is also a subject to evoke emotional attachment, nostalgic mood and a quest for identity.

Pure Land-scape

The final procession scene recalls a Japanese pictorial genre, the *raigō* 來迎 of "Amida welcoming the souls of the faithful to his Western Paradise". A depiction of this scene can be found in a wall painting in the Phoenix Hall of Byōdō-in or those at the Dunhuang 敦煌 caves. The garden platform structure serves as a meeting/parting ground for immortals and men. The Princess leaves her palace, ascends to the clouds, and is received by Amida Buddha and celestial beings playing musical instruments in the flower-rain landscape.

The concept of "mono no aware" (物の哀れ), literally empathy towards

things, was a term coined by 18th-century Edo 江戸 commentator as an important aesthetic concept in Japanese culture.³ Such emotion regarding the passing of things is best demonstrated in the cherry blossom scene and the legend of Mount Fuji.

The Buddhist idea of impermanence (*mujō*, 無常) and the theme of reincarnation as a form of punishment for crimes reveal much of Takahata's philosophy. The Tale of Princess *Kaguya* also marks a beginning and an end for the anime director's career. Supposed to be Takahata's last movie, it has taken half a century to bring the story to the big screen after he came up with the idea in his 20s. This thousand-year-old tale is his all-time favorite. His previous work, *My Neighbors the Yamadas* (ホーホケキヨとなりの山田くん, Hōhokeyo Tonari no Yamada-kun, 1999) also has one

episode based on the Bamboo Cutter story. In terms of cinematography, the choices of camera pans and perspective create a viewing experience similar to reading handscroll narratives. Takahata has referred to *emakimono* (picture scroll, 絵巻物) as "the 12th-century manga". Two examples of Bamboo Cutter picture scrolls are in the collections of Suwa City Museum 諏訪市博物館 and Ryukoku University Library 龍谷大学図書館.⁴ Regarding style, the anime is executed with simple, soft brushstrokes and watercolour to achieve a lightness, graceful, whimsical yet realistic effect reminiscent of traditional ink landscape painting.

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References

1. Collection of Idemitsu Museum of Arts (<http://www.idemitsu.co.jp/museum/collection/introduction/painting/yamatoe/yamatoe01.html>)
2. Lothar Ledderose, "The Earthly Paradise: Religious Elements in Chinese Landscape Art," in *Theories of the Arts in China*, ed. Susan Bush and Christian Murck (Princeton: Princeton University Press, 1983), pp. 165-83.
3. Mark Schilling, Review of "Kaguya-hime no Monogatari (The Tale of Princess Kaguya)": Ghibli's Takahata returns triumphant after 14 years" 21st November 2013. (<http://www.japantimes.co.jp/culture/2013/11/21/films/film-reviews/kaguya-hime-no-monogatari-the-tale-of-princess-kaguya/#.U-djdCiYXKo>)
4. Collections of Ryukoku University Library (<http://www.ryukoku.ac.jp/tenjishitsu/backnumber/no1/t1/0.html>) and Suwa City Museum (http://www.city.suwa.lg.jp/web/scm/siryou/siryou_take/index.htm).



Phoenix Hall in Byōdō-in Temple, Uji, Japan.

'When the planting works for the Hong Kong Disneyland Resort at Penny's Bay were completed in 2005, they were the largest and most high profile that had ever been undertaken in Hong Kong. The project changed lives, and the local horticultural industry. Ten years later, how is the planting doing?'

Mathew Pryor

A return to Disney

Mathew Pryor

When the planting works for Hong Kong Disneyland at Penny's Bay were completed in 2005, they were the largest and most high profile that had ever been undertaken in Hong Kong. The soft landscape along the entrance roads to the Disney Theme Park and Resort, around Inspiration Lake, on the screen bunds that encircle the park, and for all the infrastructure facilities and slope areas, covered more than 110ha.

The planting required the manufacture and placement of some two million cubic metres of fabricated topsoil, the laying of 110km of subsoil drainage, and the installation of one of the world's largest fully computerized irrigation systems. Some 35,000 mature trees and 5,000,000 shrubs, of more than 660 different species, were sourced from across SE Asia, Australia and America, shipped via more than 50ha of temporary nurseries in Shunde and Dongguan, and

then planted by TAS, a team of specialist soft landscape works contractors (Tarzan, Asia Landscaping, Shunde Nurseries), under main contractor China State Construction Engineering with the help of landscape architects and horticulturists from CEDD, EarthAsia and Maunsell's site staff team.

*David Bloxham
Landscape Construction Manager,
China State Construction Engineering
(Hong Kong) Ltd. (2001-2006)*

*Eric Lam
Sen. Landscape Architect (Sourcing /
Nurseries), TAS Specialist Landscape
Subcontractors, (2001-2006)*

*Mathew Pryor
Sen. Resident Landscape Architect,
Maunsell Consultants Ltd.
(2002-2006)*

The project changed lives, and the local horticultural industry. Ten years later, three met up again one Saturday morning at the Boat House on Inspiration Lake, and took a walk to see how the planting was doing and to reminisce on 'what feats were done' in its creation.

The planting design was always subject to much discussion during the construction period. Concerns were often expressed as to whether the complex ornamental design would survive.

"What do you make of the planting design, now that it has had time to mature?"

David Bloxham headed the main contractor's landscape team. "The planting looks very mature, it's amazing how much it has grown, and the place is very popular. The grass and shade of the trees, it's a great atmosphere. It always attracts a lot of school groups and bus tours. It is rare in Hong Kong to be able to sit out and enjoy the sun by the water". Inspiration Lake is now considered to be one of HK's top tourist attractions. When the three old colleagues had arrived that morning there had been only a handful of people, but an hour later the number had swelled to many hundreds.

"I like the lack of intensity, people just walking and enjoying being allowed on the grass." Mathew Pryor was Senior Resident Landscape Architect in the site staff's office. "Now the trees have grown and created a sense of enclosure and some shade it feels just like a relaxing walk by a lake. I know Disney wanted it to be a botanic garden, but the overall effect is just very green, with big skies. There's a lot of people just out here with a picnic. The lack of railings and barriers helps."





Eric Lam worked for TAS, the specialist Landscape subcontractor, and was responsible for sourcing the plant material and managing the holding nurseries. "There's a strong atmosphere along the arrival road. The boulevard effect is very successful. I think my proudest moment was the arrival of the *Phoenix canariensis* palms, it took so much effort to get them all here, then get them matched and set out perfectly. They were really impressive when they were planted, but they have struggled. They don't look so good now. I don't think anyone is brave enough to get up there to cut the pineapple (shape at top of the trunk) properly." Despite the intensive maintenance, the palms have declined since they were planted. The watering of the surrounding ornamental shrubs had made the soil too wet, and the palms were constantly stressed in the first years, which made them more susceptible to pests and disease.

"The planting along the roads is too ornamental: too difficult to maintain," David adds, "the cost must be very high. Disney maintenance within the theme park is very effective, they have a well-developed system. They can make a clear distinction between the formal, ornamental planting close to the visitors and the mass planting in the background. A lot of planting on the back side of berms, however, which cannot be seen by visitors was wasted," he continues, "many of the trees were planted too close together, especially on the slopes below the old quarry. There are some perfect specimen trees up there that could be harvested".

Mathew has been amazed at the speed of growth of some of the trees. "Even though they were planted as semi-mature trees many of the trees seem to have put on several metres of growth just in the last 4-5 years. Trees like the *Eucalyptus* spp. have thrived, but many have been lost." Maintenance contractors have suggested that the high volume of irrigation water has discouraged deep rooting, making some of the tree species vulnerable in typhoons. "The screen of trees between the lake and the railway, for example, has been almost completely blown away."

Eric agrees. "The speed at which plants have grown has caused problems. Most



of the exotic feature species are no longer obvious." As the planting has grown many of the formal characteristics and ornamental effects have been lost. The intricate patterns in the shrub planting alongside the roads are no longer apparent. The planting has a more informal feel, but is still impressive and effective in creating shade and greening. In areas, the planting was probably over-designed.

"I think there were too many trees," Eric continues. "I know that Disney wanted instant effect, but the density of the planting is a problem now." The trees have been pruned, but the old colleagues agree that the landscape would clearly benefit from an active thinning program. The balance between immediate impact and long term maintenance of the vegetation is always a challenge.

Eric notes that the *Phoenix reclinata* at the centre of the cascade waterfall roundabout, which were meant to be the candles in 'Mickey's Birthday Cake'

are still there but almost invisible now. "Joe Lee (TAS Project Manager) went to extraordinary lengths to find them, eventually tracking down a clump of them by a Mexican restaurant in Brisbane. Many of the special plants were bought from private estates."

Mathew points out that the maintenance of Lake Island is obviously difficult, "it looks completely overgrown and most of the variety has gone from the planting. Most of the wetland beds around the edge of the lake have not done well". It appears that only the *Lepironia* sp. have survived.

"Do you remember all those different species?"

Inevitably the talk turns to species. With so many, coming from all over the world, everyone involved in the planting works had their favourites.

"The local species have done well, but there seem to be few exotics left,"

notes David. "At least the fast growing *Ficus* have created a bit of structure in the planting. The big *Ficus* (*Ficus macrophylla*) that we spent all that time sourcing from Australia to plant along the Entry Road are good, although it is probably just as well that they are not growing as fast as we expected. The 3m high cycads we planted outside the hotels, are exactly the same as they were then."

Talk of planting brings back some painful memories. "Good to see the bamboo doing well. They almost killed Joe" says David." The soil drainage below the slope on the north side of the lake had been so poor that TAS had to replant the bamboo several times. Some of the more sensitive species didn't survive (*Phyllostachys* spp.) but those that did are thriving now (*Bambusa vulgaris*, *B. chungii*). The Oil palms (*Elaeis guineensis*) alongside are also struggling. There are better memories. "The big transplanted tree is fabulous," Eric observes. Moving the 25m wide, 175

tonne *Ficus rumphii* from the former Cheoy Lee Shipyard, 1200m across site, and then back again, became the stuff of legend on site. Standing under the tree in its current location in the Arboretum, the three agree that the vast effort and expense seem well worth it. It provides a graceful backdrop to a pair of *Chorisia speciosa*, the project's most spectacular flowering trees.

Some of the species have done very well. "The *Elaeocarpus balansae* have grown a lot," Eric continues, "and the *Eucalyptus* ... I can't remember all the different species. Some of the unusual exotics are really doing well, like those ... " Eric points, but the name has faded from memory. Eventually someone remembers, *Filicium decipiens*.

"It is sad to see that many of the beautiful exotics didn't survive." Mathew is in reflective mood. "I used to love all the fabulous names: *Brachychiton rupestris*; *Caryota no*; *Corypha umbraculifera*; *Ensete ventricosa*; etc. I remember the heartbreak of losing all the beautiful Rain Trees (*Samanea saman*), and do you remember that palm species, where all the specimens died suddenly one night?" (*Oncosperma tigilarium*). "But then there are a few species that I thought wouldn't make it that have done OK," he continues, "the Birds Nest Fern trees (*Schizolobium parahybum*), the Osmoxylon (*O. geelvinkianum*), the Yellow Saraca (*S. thaipingensis*)."

They have reached the north end of the lake and stand and look at a swathe of Agaves. Many of the 20 different species of dramatic looking Agaves brought in from the USA have survived, and some are in flower.

"One thing that I did come away from the project with is a greatly expanded plant knowledge, and an appreciation of the vast range of plants we could be using in Hong Kong." Mathew adds. "Some of the less common local species were a great surprise, such as that Bauhinia shrub (*Bauhinia galpinii*) and the Lipstick Trees (*Bixa orellana*)." He is happy to see some of the species that were unusual at the time have become popular since and are now being planted across Hong Kong: *Tibouchina*, *Xanthestemon*, and *Tabebuia*. Another positive impact of the whole project.

"What do you remember best from the construction?"

"The berms" said David, and a moment of silence follows as they each remember the two year effort in forming more than 10km of the 5 - 9m high earth mounds around the theme park.

"I remember the topsoil mixing best. The scale of the operation was huge. That was a big headache. Getting all the different materials: you remember the peat from Heilongjiang which turned up on site as a frozen lump, screening all that wet CDG from Jordan Valley and all the lime and the fertilizers?"

David spent more than a year of his life sourcing all the component soil materials, and then working out how to mix to a very specific (29:71) recipe. "... and all those soil mixing machines that we built, and the stockpiling and sending soil samples off to America for testing every other day. I am not sure I could do it again". After trailing a range of mixing methods such as front loaders, truck mixers, concrete batching plants etc. China State decided to build their own industrial-scale soil mixing machine. After three unsuccessful attempts they finally built a machine that could mix soil at a fast enough rate (6,000m³ / day). They later built two more to meet the production program.

"The landslip area up on the hill is still bare," David points out. The slope planting high up on the hills to the north was intended to cover obvious slip scars. It's a 30 minute hike by foot from the nearest road, although much of the heavy lifting of materials was done by helicopter. "I think they abandoned the attempt to plant that particular area, it was too steep", Mathew replies. Eric Chan (Senior Field Officer 2003-2006) sent me some post establishment photos of the woodland planting a few years ago. They achieved over 90% success rate in the areas they could plant."

"Joe did most of the construction site work," Eric says, "I was based in the nurseries preparing the plants. There were huge logistical issues in sourcing so many trees and shrubs coming from ten or more different countries around the world." At the height of the project TAS were operating more than 50 ha



of nurseries in Shunde and Dongguan, with all the trees and shrubs needing to be sourced, grown on, and transported to site to meet a very complex planting program.

"I vividly remember the trips to Australia to look for trees, and all the effort to get them export licenses," Mathew recalls. TAS had a full time operation in New South Wales looking for mature *Ficus macrophylla* on farming estates, digging them out and then holding them in a quarantine nursery for a year so that they could pass the Australian phytosanitary requirements for export without removing all the soil.

"Remember Comstock and his 'fruit salad' planting, that didn't survive?" he continues. Disney's Paul Comstock (who had conceived most of the planting designs), had introduced the site team to a new mixed planting technique, which involved throwing plants of different species into a prepared bed and planting them where they landed. The workers were not impressed, and came back after he had left, to plant them 'properly'."

"Do you remember the first tree that was planted?" The site had been so exposed in the first couple of years that when the first tree was planted, all the workers flocked to its shade to eat lunch.

"Did it change the landscape in Hong Kong?"

"Disney were a difficult but highly focused client. I guess their attention to

detail and maintaining progress, is what I was most impressed with," David says. "They were not very knowledgeable about Hong Kong conditions, and I didn't agree with everything they asked us to do, but you couldn't fault their determination in getting it done." The expression 'done, done, done' became well known on site. The Disney team would never accept any work that was not perfect. It was not finished until it was 'done, done, done'.

"All the work on the soil grading, and setting out those swales," David recalls, "Disney wouldn't give up!" The grass swales that encircle the Lake prevent surface water from the lawn areas running off into the lake and potentially taking fertilizer with it. Grading them so that they drained perfectly was an immense effort of trial and error which drove many to the edge. "I learnt a lot about sequencing, irrigation and planting works," he adds, "... and yes, it changed the landscape industry in Hong Kong, in particular, establishing new standards in moving big trees with big root balls. Techniques in Hong Kong for lifting trees on and off trucks, without trunk damage has improved greatly since Disney, and now comply with safety requirements. The workers have moved on to other companies but took their knowledge of the 'Disney' method with them."

Eric agrees. "Penny's Bay lifted standards across the industry. There is a much higher expectation on the quality of plant materials and planting workmanship. Before nurseries in China wouldn't even

wrap the root balls, now everything is properly wrapped and wired. It takes more effort and time but the market is willing to pay for it. We learnt a lot about what is not possible. The palms, I don't think we had the expertise in Hong Kong to keep the palms in good condition."

Mathew reflects "I think we have a better understanding of what will succeed and what won't. Everyone who goes to Disney is really impressed with the planting. It is a great atmosphere and fully worth the effort, but it is the simple things, rather than complex unusual stuff that has had the greatest impact. 'Doing the basic well' has really been the take-away message for me."

"... and finally, do you ever go to the theme park itself?"

David. "No. but I come to the Lake quite often."

Eric. "Yes, I went once after we finished the Penny's Bay contracts, but to check out the quality of Disney's plants, compared to those we supplied for the infrastructure works."

Mathew. "I went once, but I'm too old. If I have visitors in town we tend just to head for the lake."

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'Whereas great damage is done to trees and plantations in the neighborhood of the respective villages of this Colony; and whereas it is frequently difficult or impossible to discover the persons who have committed such damage ...'

Tree Preservation Ordinance, 4 of 1888

A tree preservation ordinance for Hong Kong: An historical note

Mathew Pryor

Calls for an ordinance for the proper protection and management of trees in urban Hong Kong have regularly been made over the last few years¹, although there seems little prospect of specific legislation being enacted. It may come as a surprise, therefore, that more than a century ago Hong Kong did enact a Tree Preservation Ordinance. It was very brief and narrowly focused, and it is not clear if any prosecutions were ever made under it, but it did sit within a wider body of legislation that sought to protect natural vegetation, street trees and forestry plantations, and offered harsh punishment for offenders. This article examines the history of tree protection legislation in the early colonial period, both in relation to the growing value of trees to the community, and to the increasing efforts to green the city and the territory. The rationale for legislating for tree protection in this early period may give insight to the argument over regulation and protection of trees in Hong Kong today.

An early history of the legal protection of trees

Provision for the protection of trees from destruction first appears in the Hong Kong statute book² in the 1845 Ordinance for the Prevention of Nuisances³. The 'felling, cutting, destroying, or injuring of any standing or growing tree, shrub, or underwood, any grass-sod or turf, ...'⁴ is identified as a nuisance carrying the penalty of a fine up to \$100⁵.

Legislation for the protection of natural trees and vegetation at this very early stage in the city's history, before government had even started planting trees, reflects deep concerns over the destruction of the natural landscape. Prior to colonisation,



Historic photograph. 'Wyndham Street, Central District' (c. 1905), The University of Hong Kong Library collection

indigenous villagers⁶ needed timber not only for house building and fuel, but for quarrying activities. Tall grass was cut both for fodder and for constructing mat-shed buildings. These customary practices had resulted in most hill slope vegetation being reduced to little more than sparse grass. Trees only survived where they were inaccessible (ravines) or were growing close to villages and had productive value (fruit trees) or cultural significance (feng shui woods)⁷. The scant vegetation can be seen in early photographs of the territory (1860 onwards), and had given rise to Lord Palmerston's famous denunciation of Hong Kong as a 'barren rock'.⁸

The sudden arrival of tens of thousands of settlers in the first few years of the colony greatly exaggerated this demand, with the new colonists needing wood

and grass for fuel, housebuilding,⁹ and furniture. Timber was imported from Canton, but was expensive, so any opportunity to acquire it from the surrounding landscape was readily taken.

The same wording identifying the wanton cutting of vegetation as a nuisance was inserted into the Ordinance to Regulate Chinese Burials, in 1856.¹⁰ This addressed another common threat to natural vegetation. Chinese burials could be elaborate events requiring wood for both temporary constructions and giving rise to the threat of fires from the burning of incense (a threat that persists today).¹¹

Street tree planting started in 1847, along Queens Road¹², and continued through the 1850s and 1860s along most of the

wider thoroughfares of the new city. The value of trees in greening the city and in creating a healthier environment on the streets became quickly recognised both by residents and visitors to the territory.¹³

Establishing trees along the city's congested streets was a major challenge. Besides exposure to repeated typhoons,¹⁴ new trees faced threats from building works, road alterations¹⁵ and the sheer intensity of activities in narrow corridors. Demand for cheap timber remained high. Queens Road West, for example, was planted in 1855 but photos of the street corridor in 1860 showed that all but one of the trees had been removed.¹⁶ In an account of his visit to Hongkong in 1852,¹⁷ Robert Fortune made reference to locals stripping lower branches from roadside trees for fuel. The continuous loss and replacement of trees resulted in uneven heights and shapes of trees, as can be seen in photos along Queen's Road Central around 1880.¹⁸ Tree avenues were only successfully established along streets in the administrative and military areas of Government Hill (Admiralty) where trees could be effectively policed.

The destruction of natural vegetation and planted trees became so significant for the colonial authorities, that in legal terms it was elevated from being

a nuisance to being a crime (felony). Protection of trees from wilful theft, injury and damage (as opposed to careless destruction) was made explicit in a series of ordinances in 1865 relating to property, all with very similar wording. The provisions of the Larceny Ordinance, 5 of 1865, Clause 23 'Stealing tree etc., growing in pleasure ground or elsewhere', and the Malicious Damage Ordinance, 6 of 1865 Clauses 16-18 'Injuries to crops, trees and vegetable productions', were quickly consolidated into the Malicious Injuries to Property Ordinance, 8 of 1865. Clause 18, 'Destroying trees &c. to the value of more than \$5¹⁹ growing in a pleasure ground &c.' stated:

"Whosoever shall unlawfully and maliciously cut, break, bark, root up, or otherwise destroy or damage the whole or any part of any tree sapling or shrub, or any underwood growing in any pleasure ground, garden, orchard, or avenue, on in any ground adjoining or belonging to a dwelling house (in the case the amount of the injury done shall exceed the sum of five dollars) shall be guilty of felony, and being convicted thereof shall be liable, at the discretion of the Court, to be kept in penal servitude for the term of three years, - or to be imprisoned for any term not exceeding two years, with or without

hard labour, and with or without solitary confinement, and if a male under the age of sixteen years, with or without whipping'

These severe penalties were directly comparable to those stated in the ordinance for damaging a bridge, sea-wall, or electric telegraph, or for killing cattle or setting fire to a ship, suggesting the resolve with which the administration sought to tackle the problem.

Clause 20 relates to the lesser offence of 'Destroying trees &c. wheresoever growing, to the amount of 24 cents', where conviction before a police magistrate made an offender liable to be imprisoned for up to three months for a first offence, six months for a second offence and two years for a third offence. Clause 21 has the exact same provisions but relates to 'Destroying any fruit or vegetable production in a garden' defining this to mean '... any plant, fruit, or vegetable production growing in any garden, orchard, nursery ground, hothouse, greenhouse or conservatory ...' Magistrates were able to impose penalties of six months in prison and a fine of up to one hundred dollars for a first offence. Likewise Clause 22 has the same provisions relating to 'Destroying vegetable productions not growing in gardens &c.' defining these as '... any cultivated root or plant used for the food of man or beast, or for medicine, or for distilling, or for dyeing, or for or in the course of any manufacture, and growing in any land, open or inclosed, not being a garden, orchard, or nursery ground ...' One month in prison and a maximum fine of five dollars comprised the punishment for a first offence.

The rapid publication of these ordinances hint at the state of disorder generally existing within Hong Kong at the time, and the struggle of the British to exert authority over the new colony.²⁰

The theft and destruction of trees continued, despite the new laws, and the police were prompted to issue formal notices in the 1870s, against theft and the collection of wood.²¹

By the early 1870s tree planting had been undertaken along most of the possible street corridors, and attention turned to the afforestation of the barren



Historic photograph. Queen's Road East, Wan Chai 1870s, The University of Hong Kong Library Collection

hills.²² Numerous practical and political motives have been suggested for the sudden initiation of a territory wide afforestation program. While timber production was an obvious driver,²³ there was a growing association of tree planting with public hygiene,²⁴ through cooling and purifying the city's air, and visual greening. Hong Kong had been afflicted with infectious disease from the outset,²⁵ and greening of the barren slopes not only gave settlers hope of some protection from the subtropical sun, but was also symbolic, creating a sense of colonial authority through the 'proper' stewardship of the landscape.²⁶

The British botanist Charles Ford was appointed in 1872 as Superintendent of the newly established Government Gardens, and the Colonial Secretary consolidated responsibility for all tree matters in the territory under him.²⁷ Ford established ten large production

nurseries to raise trees from seed both collected from the hill slopes and donated to Hong Kong by private collectors and botanical gardens in other colonial territories in SE Asia. By the end of the century several million seedlings had been planted out in forestry plantations across Hongkong Island and Kowloon.²⁸

A key problem was the lack of staff; with forestry workers dedicated to planting work they were not able oversee the well-being of the planted trees. Theft and destruction of newly planted seedlings was widespread. Villages used the recently cleared tree plantation areas²⁹ for foraging and grazing of cattle and goats. Six forestry guards were appointed in the early 1880s to protect the newly planted areas, but these were almost completely ineffectual given the plantation areas were scattered all over the island from Aberdeen to Kennedy Town. The Superintendent of Gardens

made desperate pleas to Government to fund a substantial increase in the number of forest guards and greatly increase the severity of punishments for offenders.³⁰

The Legislative Council eventually responded by enacting a Tree Preservation Ordinance, 4 of 1888. The law was to protect trees in government plantations. It was only four paragraphs long, but to the point. After the introductory statement:

'Whereas great damage is done to trees and plantations in the neighborhood of the respective villages of this Colony; and whereas it is frequently difficult or impossible to discover the persons who have committed such damage ...'

... the key provision is set out in the second paragraph:

'Whenever it is proved to the satisfaction of the Governor-in-council, that trees or plantations belonging to the Government in the neighborhood of any village in the colony have been felled, cut, mutilated, lopped, barked, or otherwise damaged or destroyed, and that there is sufficient reason to believe that such damage or destruction was committed by the inhabitants of the said village or by any of them, it shall be lawful for the Governor-in-Council, by order under his hand to levy a special rate assessed upon such village to an amount sufficient to cover the damage done ...'

Essentially, the law was just a refinement of previous legal provisions against damage to trees in government plantations. It was, however, targeted at prohibiting the activities of local villagers, and reflected deep suspicions of them held by the colonial administration. It was enacted in the same year as the 'European District Restriction Ordinance' which sought to bar Chinese from crowding European settled areas on the grounds of health, and was in the context of other legislation that sought to exclude locals from areas of precious natural resources (e.g. water gathering grounds). The identification of 'the village' as the transgressor was legally unusual and probably unenforceable.



Historic photograph, Pedder Street, Looking South from Praya Central, (1868). by John Thomson, The University of Hong Kong Library Collection

The use of fines as penalties suggests the offence was considered a nuisance. It is not clear if anyone was ever prosecuted under the law, but its very existence reflected the competing values of trees to both locals and colonists.

Further attempts to introduce legislation against damage to trees in forests and plantations can be found in the Crown Land Preservation Ordinance, 10 of 1910 (amended in 1912): which sought to prevent injuries to trees upon crown land and other crown property, and the Crown Land Preservation Ordinance, 6 of 1917: which made provision for the better protection of trees on crown land and other crown property from wilful damage. The Forest Fires Prevention Ordinance, 5 of 1917, tried to address the problems of fire in forest reserves and plantations, and the Plants Ordinance, 11 of 1920, reiterated previous provisions in seeking general protection of trees shrubs and other plants. The protection of trees in forested areas was finally condensed in the Forestry Ordinance Cap 96, 11 of 1937, which is the forerunner of the legislation in force today. All of this was set aside, just a few years later, when the extreme shortage of fuel

during WWII resulted in the consumption of nearly all vegetation within the entire territory.

Current laws protecting trees and natural vegetation generally follow the same broad structure as those described above. Wilful damage is covered by Crimes Ordinance (Cap. 200) and Theft Ordinance (Cap. 210) while the lesser matter of casual damage is addressed in terms of a nuisance under the Summary Offences Ordinance (Cap. 228) and Public Health and Municipal Services Ordinance (Cap. 132). The Forests and Countryside Ordinance (Cap. 96), Country Parks Ordinance (Cap. 208), and Antiquities and Monuments Ordinance (Cap. 53) make specific provision for tree protection in special areas.

The enactment of a Tree Ordinance is highly unlikely at this time. Government believe that existing legislative measures for tree protection³¹ are already comprehensive.³² Our urban and rural tree populations are now very much larger and in better condition than 130 years ago. With the value of trees being firmly centred on their benefit to local ecology, urban greening, environmental

improvement and cultural heritage, the threats are also considerably smaller. Common complaints underpinning calls for tree legislation relate mostly to the application of laws (rather than the laws themselves) and the need for clearer definition of administrative responsibilities. With the establishment of the Greening Landscape and Tree Management Section (GLTMS), however, Development Bureau has been able to make significant improvements in the quality of technical guidance and coordination of the administration of tree matters.

The history of tree legislation in Hong Kong indicates that new laws are typically enacted only in response to extreme circumstances, and suggests that we would need to await some new substantial threat to their existence to achieve a second Tree Preservation Ordinance.

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Trees on Queens Road Central (c.1870). The Wellcome Foundation

References

1. HKIP Position on Urban Tree Ordinance, CUHK Comprehensive Tree Ordinance
2. Historical Laws of Hong Kong Online. HKU Libraries. Accessed June 2015 from <http://oelawhk.lib.hku.hk/exhibits/show/oelawhk/>
3. Ordinance for the Preservation of Good Order and Cleanliness and the Prevention of Nuisances within the Colony Ordinance (1 of 1845). Clause 8 'Various other nuisances principally in the nature of trespass or damage' subclause (1.)
4. Similar words can still be found in the current tree protection regulations.
5. In Hong Kong Dollars, although according to the Hong Kong Museum of History silver sycees and Chinese cash coins were the main currency at the time. Banks only began issuing Hong Kong dollar banknotes in 1846, and silver dollars were formally introduced in 1865. 100 dollars was a common amount for summary offences. Casual workman might expect to be paid \$3 - \$5 per month at the time.
6. Mayers, W.F. and King, C. (1867). The treaty ports of China and Japan: A complete guide to the open ports of those countries... Trübner and Co., reported the 1841 British Military Census of the pre-colonial population of Hongkong Island, as 7,450.
7. Hayes, J. (1984). Hong Kong Island before 1841. Journal of the Royal Asiatic Society Hong Kong Branch. 24 105-142 describes the landscape before colonization around village areas
8. Endacott, G.B. (1958) History of Hong Kong. Oxford University Press
9. Shop-house construction in the new city depended largely on the Chinese fir, Shelton, B., Karakiewicz, J., & Kvan, Y. (2010). The making of Hong Kong: From vertical to volumetric. London, Routledge p36
10. Ordinance to Regulate Chinese Burials and to Prevent Certain Nuisances within the Colony of Hongkong, Legislative Council of Hongkong, (Clause.6(i)). (12 of 1856).
11. Chau, K. C., (1994). The Ecology of Fire in Hong Kong. (Doctoral thesis, The University of Hong Kong), Hong Kong.
12. Pryor, M. (2015) Street Tree Planting in Hong Kong in the Early Colonial Period (1842-98). Journal of the Royal Asiatic Society Hong Kong Branch, 2015.
13. Both Fryer and Smith note the value of trees for shade and greening in the new city. Dagenais, F. 'John Fryer's early years in China. II: First impressions of Hong Kong and the Chinese people' JHKIBRAS, 30 (1993) 146-68. Smith, A. (1859). To China and back: being a diary kept, out and home, (Hong Kong: Hong Kong University Press, 1974 reprint of 1859 original). p29
14. Significant numbers of mature trees were lost to typhoons. The storm of 23 September 1874, in particular, caused very sizeable losses HKGG 17 October 1874
15. Ford, C., Report on Government Gardens and Plantations, HKGG 15 April 1880, noted that "During the last five or six years a very large number of trees ... have been sacrificed in the streets to make room for improvements and alterations in streets and building."
16. Historic photographs. 'The western end of Queen's Road, Victoria, Hong Kong' and 'A Street in the Chinese Quarter in Victoria, Hong Kong' (c.1860), Duke of Newcastle's Collection Vol. Ne C 11121/18 and 17, University of Nottingham, UK. '1890s West Central, Queen's Road West, Bird Bridge' (c.1890), Hong Kong Public Library.
17. Robert Fortune, A Journey to the Tea Countries of China Including Sung-Lo and the Bohea Hills; with a Short Notice of the East India Company's Tea Plantations in the Himalaya Mountains: With Map and Illustrations, (London: John Murray, 1852).
18. Historic photograph. 'Queen's Road Central, Central District, Hong Kong Island'. (dated 1880) Hong Kong Public Library,
19. Clause 19 is identical save for the amount exceeding \$25
20. Evans, D.M.E., 'The foundation of Hong Kong: a chapter of accidents', in M. Topley ed., Hong Kong: The Interaction of Traditions and Life in Towns Hong Kong, (Hong Kong: Hong Kong Branch of the Royal Asiatic Society, 1972) 1-41.
21. Police notification, HKGG 1 April 1876
22. Richard T. Corlett, 'Environmental forestry in Hong Kong: 1871-1997', Forest Ecology and Management, 116.1 (1999) pp. 93-105.
23. Humphreys, J.D. (1877). Letter to the Surveyor General, dated 1 October 1877 regarding planting for timber production in Hongkong. HKGG, 17 November 1877.
24. Harland, W.A., Acting Colonial Surgeon's Report for 1853, HKGG 29 April 1854. Request for more tree planting also made by J.I.Murray, Report of the Colonial Surgeon, 1869, HKGG 14 May 1870.
25. Peckham, R. 'Infective economies: empire, panic and the business of disease', Journal of Imperial and Commonwealth History, 41:2 (2013) 211-37.
26. Peckham, R. 'Hygienic Nature: Afforestation and the greening of colonial Hong Kong', Modern Asian Studies 2014: 1-33.
27. A new Tree Planting Department (established 1873), progressively became the Gardens and Plantations Department (1877) and then Botanical and Afforestation Department (1880).
28. Detailed annual reports on the activities of the Government Gardens and Tree Planting

Department, from 1872 onwards were published in the Hongkong Government Gazette.

29. S.E. Hamilton, Watching Over Hong Kong: Private Policing 1841-1941. (Hong Kong: Hong Kong University Press, Royal Asiatic Society Hong Kong Studies Series, 2012)
30. Westland, A.B., Annual Report of the Botanical and afforestation Department for 1885, HKGG, 17 April 1886.
31. GLTMS Development Bureau's 'Measures on Tree Preservation' sets out the current legislative framework. <http://www.trees.gov.hk/en/about_gltms/measures_on_tree_preservation/index.html>
32. LCQ13: Tree management reply by the Secretary for Development, Mr Paul Chan, in the Legislative Council (June 3, 2015) to a question by the Hon Leung Che-cheung. Accessed from <http://www.info.gov.hk/gia/general/201506/03/P201506030254.htm>



A mature *Ficus microcarpa* and a *Mangifera indica* stand so close they appear to be one large tree on Queensway in front of the Bank of China Building

A tree for all reasons: Large trees in urban areas

Barnaby Smith

Introduction

It was encouraging to note the contest "Our Favourite Old and Valuable Trees" organised last year by GLTMS¹, promoting public appreciation of trees in Hong Kong.

Appreciated they may be but many of our urban trees exist in precarious circumstances. Footpaths are filled with underground utilities, there are signage and sight line constraints and, despite guidelines from HKPSG², often only new developments can provide sufficient space required for large street trees. The Greening Master Plans (GMP) by CEDD have helped push the envelope in optimising urban greening³.

With this in mind, a discussion regarding the value of large urban trees and how best to preserve them is timely. The following examples in Wan Chai are presented for discussion. Perhaps the main observation is the great value that even a single large tree can have in transforming our urban landscapes. None of the following examples are OVTs⁴.

Canopy trees in Wan Chai

Perhaps the most important benefit of large canopy trees in this climate is shade, especially now that the traditional shop-house colonnades are all but gone. The cooling effect is remarkable, and it is no coincidence that people put seats under them. Around Wan Chai there are several banyans planted in the late 1980s and early 1990s under the Greening Wan Chai Scheme⁵. The scheme was one of the precursors of the recent Greening Master Plans by CEDD. These have dramatically enhanced the Wan Chai streetscape for generations to come. Several of these trees are now

very notable, primarily because they have had sufficient space to mature.

The *Ficus microcarpa* 細葉榕 on the junction of Thomson Road with Johnston Road, opposite the Hennessy Road Government Primary School, provides some shade and relief from pollution. It has recently been pruned to a high standard and reflects the efforts by LSCD to employ professional local and international arborists to look after these invaluable assets. On the opposite side of the school on Hennessy Road are a line of *Ficus benjamina* 垂葉松 providing much needed shade for several bus stops.



Threat to trees from underground utilities, Queen's Road East



Ficus microcarpa at the junction of Thomson Road and Johnston Road

Nearby *Wodyetia bifurcata* 狐尾椰子 palms, planted under the Wanchai GMP, in the central median of Hennessy Road have created a green corridor. A handful of palms were retained from the existing late 1980s stock, including some *Syagrus romanzoffiana* 金山葵 and *Archontophoenix alexandrae* 假檳榔. These have increased significantly in size and vigour since the concrete paved surface was broken out under the GMP. The new *Wodyetia* palms can be expected to provide visual amenity for decades to come. It is a tribute to CEDD and the resilience of the *Wodyetia* that none of these trees have failed nor been damaged by typhoons since they were planted in 2009.



Wodyetia bifurcata planted in the median of Hennessy Road

Almost opposite the school and slightly west is a similar sized *Ficus microcarpa*, at the junction of Johnston Road with Wan Chai Road. It is a curious fact that this specimen (623rd tree of the Greening Wan Chai scheme), was planted by country singer John Denver in April 1994.

Further down Johnston Road at the junction of Luard Road, opposite Southorn Playground, there is another *Ficus microcarpa* (600th tree of the scheme), this one planted by Governor Chris Patten in 1993. Southorn Playground was laid out in 1934, and benefits the community not just by providing for active recreation, but by its mature trees along both the Hennessy Road and Johnston Road boundaries. Three *Ficus virens* 大葉榕 in the footpath of Luard Road, just west of Southorn Playground, are particularly impressive. Given the low pedestrian usage, there may be potential to break out more concrete paving and allow these trees vital air and water.



John Denver's *Ficus microcarpa* at the junction of Johnston Road and Wan Chai Road, a long way from any country roads.

These street trees provide much needed greening in this dense urban environment. It should be noted that they are well maintained by LCSD. People now talk about the financial value of trees. I wonder what is their monetary worth? Their amenity value to thousands of people every day is unquestionable.

Perhaps the most amazing thing about these trees is that they exist at all. According to Gavin Coates, Michael Kirkbride told him of his great efforts to save some of the trees within or around Murray Barracks when Cotton Tree Drive

and Garden Road were widened in the 1970's. His efforts seem to have paid off in the retention of two trees, a *Ficus microcarpa* and a *Mangifera indica* 芒果, barely a metre away from the slip road linking Cotton Tree Drive to Queensway. The trees subsequently survived the dismantling of Murray House (now in Stanley) and the construction of the China Bank Building in the late 1980s. According to pre-1970's aerial photographs there were many trees in and around the barracks. The benefit that just two mature trees can provide, visually and physically, in ameliorating the polluted canyon that is Queensway, is remarkable.

The mature *Khaya senegalensis* 非洲楝 on Luard Road, planted under the Greening Wan Chai Scheme in the late 1980s, are respectable trees by any standard, considering that they are only 25 years old. The visual quality of Luard Road has been transformed by these excellent specimens. Sadly one failed in recent years, and was replaced with a *Melaleuca cajuputi* subsp. *cumingiana* 白千層. This species, and more recently planted *Garcinia subelliptica* 福木 appear to be the new species of choice for street trees in Lockhart Road and adjacent congested street locations. They at least provide some greening, if not canopy shade.

Understandably maintenance costs for spreading shade trees are higher,



Dominion House, Queen's Road East



Khaya senegalensis on Luard Road planted in the late 1980s.

but what real cost is this to such an international city?

Due to the narrow footpaths and busy traffic, Queen's Road East in Wan Chai has few street trees. The most obvious exception being the row of trees in front of Dominion House just east of Pacific Place 3. Dominion House was designed with a covered arcade running parallel to the footpath which effectively doubles the footpath width while providing shade, rain shelter, space for tree planting and protection from traffic, all in line with HKPSG. What a shame this is the only building designed in this way.

The trees planted there are a collection of *Ficus* and *Cinnamomum*, and at the north end a beautiful *Liquidambar*



Jacaranda mimosifolia recently planted at the junction of Queen's Road East and Hennessy Road.

formosana 楓香 has trebled in size over the past few years. It's especially encouraging that Swire Properties has recently planted an excellent *Jacaranda mimosifolia* 藍花楹 at the junction of Queen's Road East and Hennessy Road. A seat wall maximizes the benefit of its future shady canopy.

Swire Properties also undertook a revamp of the shady Dominion Garden (with two carefully retained wall trees) and Kwong Ming Street Children's Playground, in 2012. It complements similar Wan Chai schemes such as the St. James Settlement / Local Community Scheme of Bauhinia Garden at nearby Lun Fat Street (2002). The *Jacaranda mimosifolia* planted on Star Street at the south west corner of Pacific Place 3 is also well worth a look.



Jacaranda mimosifolia planted at the south west corner of Pacific Place 3, Star Street

Queen's Road East runs approximately along the original coastline and the Hung Shing Temple was virtually on the beach in 1841. Hence this was a ship building / mooring / warehousing area (the memory lives on in street names such as Ship Street and Schooner Street) and in a recent seminar, I learnt that Spring Garden Lane, reclaimed almost opposite, was a place for wealthy foreigners to live and had some of Hong Kong's first merchant gardens in the late 1840s. In fact Queen's Road East was one of the first streets to be planted in Hong Kong, around 1850,⁶ though the original trees disappeared long ago.

The age of the *Ficus virens* just behind the temple is unknown, but the fact that the area has been undisturbed has allowed it to mature and provide significant greening visible from the road. Hopefully the tree will not be damaged by the current construction works.

Similarly, the *Ficus virens* almost opposite in a sitting-out area at the junction of Queen's Road East and Swatow Street provides the only green on Swatow Street and is best viewed from the north. The tree is perched on a wall but appears

healthy. It may even be a seedling from the one above the temple opposite and was almost certainly not planted.

One should credit LCSd for keeping this "rogue tree" in their SOA and allowing it to thrive. The planting area appears to have been extended to accommodate its health and growth. Again, it is proof that one or two mature trees can transform the urban landscape and help ameliorate a gloomy corridor.

Focal Points

Individual trees at focal points can play their part: we know the older urban areas of Hong Kong have limited space for large canopy trees. As a resident, I enjoy and respect the planting of smaller trees in narrow footpaths, which to be fair, are sometimes more practicable and appropriate. However, it would appear that the value of the relatively few large canopy trees in dense urban areas provide massive public benefits. There are often idealistic calls for 'avenue planting' but this will not be possible in the older urban areas without wholesale footpath widening and reduction of vehicular carriageways.



Ficus virens at the junction of Queen's Road East and Swatow Street



Ficus virens just behind the Hung Shing temple on Queen's Road East



Ficus benjamina next to AIG Tower on the wide footpath of Murray Road, Central

Another approach is to provide focal trees, either individuals or groups, at junctions or where there are localised spaces available.

A good recent example of canopy tree groups are the *Ficus benjamina* next to the AIG Tower on Murray Road in Central which provide much needed shade to pedestrians. Landscape design is a critical factor in urban living. It is therefore a positive and critical step for current and future generations that schemes such as the GMPs succeed and associated public / private ventures continue to help the community.

Cost or benefit?

Studies have been carried out overseas and equations devised to place a monetary value on trees based on the environmental services and benefits they provide. These studies usually indicate that the benefits of large canopy trees far outweigh the maintenance or other costs incurred. Trees are not burdens for future generations, they are vital investment opportunities.

It should be an urgent priority to impose a properly assessed value system in Hong Kong so that tree benefits can be properly weighed against their costs. Species choice for new trees is sometimes influenced by the fact that only the costs are quantified and taken into account and this predicated against

large growing species.

We should look for new opportunities to grow large canopy trees. Indeed, the HKPSG Chapter 4 stipulates that 60% of the area of Local Open Spaces should be set aside for large trees. These may be limited, but road junctions, sitting out areas, roundabouts and footpaths with set-backs offer opportunities for planting the OVTs of the future. It is also encouraging that LCSd has been so positive in trialling different tree species in positions where more common species have regularly failed to thrive. A good example is the *Adenantha microsperma* 海紅豆 below the footbridge crossing Hennessy Road. On the west side of the footbridge at Gloucester Road a few *Chukrasia tabularis* 麻棟 are also showing their worth.

Our profession today carries part of the responsibility to ensure that our grandchildren can take their grandchildren to play in the shade of an OVT.

References

1. Greening, Landscape and Tree Management Section in Development Bureau, HKSAR Government. Accessed from <http://www.greening.gov.hk/en/about_gltms/greening_policy.html>
2. Hong Kong Planning Standards and Guidelines (HKPSG) Chapter 4 "Recreation, Open Space and Greening" Development Department, HKSAR Government. Accessed from <http://www.pland.gov.hk/pland_en/tech_doc/hkpsg/full/index.htm>
3. Greening Masterplan (GMP). Civil Engineering and Development Department, HKSAR Government. Accessed from <<http://www.cedd.gov.hk/eng/greening/>>
4. LCSd's Register of Old and Valuable Trees. Accessed from <http://www.trees.gov.hk/en/tree_appreciation/register_old_valuable_tree/index.html>
5. Greening Wan Chai Scheme, undertaken by the Wan Chai District Office in the late 1980s and early 1990s.
6. Pryor, M. (2015). Street tree planting in Hong Kong in the early colonial period (1842-1898). Journal of the Royal Asiatic Society Hong Kong Branch.



2008年長沙灣兒童遊樂場塌樹

香港樹木管理的思維缺憾

劉興達

最近發生的連串塌樹事件，特別是彌敦道栢麗大道的百年榕樹在無風無雨下倒塌，令致無辜市民受傷和財物損失，我們在惋惜痛心之餘，應該從事件中冷靜反思，‘冰凍三日，非一日之寒’，尤其是樹木生長問題，都是多年累積而成，天氣和颱風只是加速問題的表面化，並非所有塌樹的主要原因。無論如何，事件獲得政府最高層的關注，特別在發展局成立了樹木管理辦事處，相信是香港有史以來，首次有政策局全面負責綠化和樹木管理政策，是為香港創造‘優質環境，優質生活’的重要一步。適當而宏觀的綠化規劃和完善的的管理，不僅令香港城市環境優化，美化和宜居宜產，更能協助香港成為優質的低碳城市，提高香港的國際地位和競爭力。因此，正確的政策思維是達至短中長期目標的重要基礎。

首先，上屆政府在成立樹木辦首份報告書中訂立‘人樹共融’政策目標本身在思維上值得商榷，因為提倡和諧共融表示雙方存在矛盾；有爭執，就像政府不斷提倡構建和諧社會一樣。大家要知道，樹木在地球的歷史中，在不同的惡劣環境裏不斷發揮頑強的生命力，為各種生物提供賴以生存的氧氣和棲息地，維持生生不息的生態系統。在城市環境中，更默默地為人類淨化空氣，調節氣候，紓緩生活緊張，為我們創造一個舒適的生活環境而作出無償的奉獻。雖然如此，人類並不感恩，從工業革命以來，在急促的城市化過程中，人類為尋求發展空間，刻意砍伐和傷害樹木之外，更令樹木生長環境惡質化，令樹木容易生病，脆弱和短壽，這情況在高密度的城市環境中更為嚴重，引發出今天和未來要面對的種種環境問題。

在香港回歸以前，市區的樹木管理一向被視為市政工作的一部份，就像清洗街道，垃圾收集，小販管理等。順理成章地，市區的樹木管理就交由兩個市政局負責，並由市政事務署和漁農署執行。早期的工作多集中在市政公園和郊野公園內的樹木，一直到70年代的新市鎮

發展，除了增加不少綠化地帶外，新建道路旁都加入綠化，種植後的樹木大多交由兩個市政事務署或漁農署管理，權責比較簡單和清晰。這段期間的發展，綠意盎然的新市鎮大大提高市民對舊市區的綠化訴求，市政局有見及此，亦成立了市區綠化委員會去統籌和執行市區的綠化工作。但礙於歷史原因，這些工作在故有的市政思維上，並未能提升至專業層面，往往在與專業工務部門商討技術問題時，未能為樹木爭取到合適的生長環境，亦未能有效監督建築和工務工程對樹木的影響。因此，市政局在80年代末期通過在市政事務署內加入專業園境師職系，希望將市區綠化工作和樹木管理從此提升至專業層面，十分可惜的是，此項決定遭到部份市政員工反對而胎死腹中，白白喪失了一次令樹木管理專業化的契機。回歸以後，兩個市政局被取消，市政工作交由康樂文化事務處和食物環境衛生處兩個政府部門負責。可想而知，樹木管理更加受到忽視，在缺乏資源和專業支援的情況下，只能把管理責任按土地誰屬分界，各自負責土地界線範圍內的樹木，亦成為最近被受市民詬病的政出多門和權責不清的問題。

政府一直為現行按部門物業，設施和土地範圍分工辯護，提及斜坡管理亦按同一方法處理而行之有效。但不要忘記，斜坡管理雖由不同部門負責自己範圍內的斜坡，但工作都是由一批訓練有素，經驗豐富的註冊土力工程師負責，他們不單只有專業技能，並受到專業註冊局和學會監管，遵守專業守則之外，更要接受持續專業培訓，終生學習。反觀政府現行的樹藝人員，學歷和經驗程度參差，執業標準模糊，操守欠缺內外監管機制，專業責任不清的情況下，公眾又怎會放心或信服樹木管理工作已做好呢？

樹木管理從來就是一門十分專業的工作，特別是在城市環境中的樹木，需要多方面的綜合知識，包括城市規劃，園境設計，工程，生態，土壤，灌溉，樹木病理，蟲害，真菌等等的科學。因此，在大學修讀

城市森林學 (Urban Forestry) 一般需要4至5年才能獲得學士或碩士學位。畢業後需要從事相關工作若干年，才能獲得認可，按不同地方和專業團體要求，進行專業註冊程序，並受到註冊要求的監管，成為一名問責的專業園林經理，他們的工作就像物業經理，工程項目經理一樣，統籌負責地區或物業內的所有園境和樹木方面的管理工作，運用專業知識和經驗適當引進不同專家組成管理團隊，例如園藝師；病理；真菌專家，草坪專家，樹藝師，土壤專家等。全面而宏觀地製訂符合當區或物業環境需要的管理方針，工作程序，指引，人員培訓，資源調配和監督前線員工，危機處理等重要措施。由於前線樹藝人員是負責執行樹木護理工作，他們的技術和經驗要求十分重要，所以，為樹藝人員進行有系統的培訓和行業註冊十分迫切，並提供充足的工作和進升機會，才能全面提升樹木護理工作的水平。有見及此，香港園境師學會正進行為樹藝從業員進行認證，為樹藝專業化踏出重要一步。

另外，樹木辦經常強調上游的綠化規劃工作和下游的樹木檢測和護理程序，而忽略了最重要的中游部份，即是如何防止其它建築和工務工程進行期間對樹木造成的傷害。有證據顯示，過去大部份倒塌的樹木，根部都受到損害而遭到真菌或害蟲入侵，根部破損後亦未能接受妥善的處理而染上褐根病。要知道，根部受損很難以‘目視法’檢測，專家亦需要適當儀器配合，更遑論依賴市民監察。因此，為減低這方面的風險，所有工務建築工程合約應當設有樹木主任，負責為工人灌輸保護樹木意識，提供指引並監督工程進行期間不會對鄰近樹木造成影響；指導善後護理工作。

最後，希望政府能儘快建立起一支盡職盡責的樹木管理專業團隊與市民一起為香港創造真正優質的市區環境。

Tree management shortcomings in Hong Kong

Patrick H.T. Lau

Recently, there have been a series of incidents of mature trees falling over in Hong Kong. Notably a very old banyan tree unexpectedly collapsed on Nathan Road - Park Lane in good weather conditions, causing avoidable property damage and injury of a number of people. Apart from feeling regretful, we should also rethink and review the issue as tree problems are beginning to multiply. These are caused not only by periodic typhoons and heavy weather. In any case, this has caught the attention of the Hong Kong Government. The TMO (Tree Management Office) was set up by the Development Bureau after a similar incident. It is believed that this is the first time that a bureau was set-up to be responsible for greening and tree management in Hong Kong's history. This is considered a significant move in creating a "quality environment, quality life" in Hong Kong. Appropriate green planning and first class management not only creates a more livable and high quality city environment, but will also help Hong Kong become a low-carbon city, thereby enhancing our international status and competitiveness. This policy is an important foundation to achieve both short and long term goals.

First, the policy objective of "harmony of trees and people" stated by the previous government in the first TMO report is questionable. Promoting harmony implies there is dissension between the two sides, as the government continues to advocate for a harmonious society. We all know trees have played a major role in providing oxygen, habitats for wildlife, and maintaining ecosystems even in harsh environments for centuries. In an urban setting, trees purify the air, regulate the climate, relieve the tension of life and create a comfortable living environment for

the population. However, we are not grateful for this. Humans have damaged trees and deforested lands especially since the industrial revolution through rapid urban development. We have degraded the quality of the tree-growing environment, making trees vulnerable to disease and resulting in them being very short-lived. This situation is becoming more serious and pronounced in dense urban areas, which will face increasingly severe environmental problems in the near future.

Before Hong Kong was returned to China, urban tree management was seen as part of the municipal services, like street cleaning, refuse collection and hawker management. Urban tree management was the responsibility of the Urban Council, and executed by the Urban Services Department (USD) and the Agriculture, Fisheries and Conservation Department (AFCD). Early tree works were concentrated in municipal parks

and country parks, until the development of new towns in the 1970s. This increased the number of green areas, along with greenery associated with newly constructed roads. For the sake of simplicity, planted trees were mostly managed by USD or AFCD. Because of the successful implementation of green new towns, public demands for greening the older urban areas increased during that period. Therefore, USD set up an urban greening committee to coordinate and implement urban greening. However, due to historical reasons and traditional thought, these works were not undertaken professionally. Frequently, when discussing the technical issues with the Public Works Department, they neither provided a suitable growth environment for trees, nor monitored the impact of the construction works on trees effectively. Therefore, the Urban Council introduced professional landscape architects into the Urban Services Department in the late 1980s,



2008 - Fallen tree on Cheung Sha Wan Playground exposing its roots

hoping to elevate urban greening and tree management to a professional level. However, this was turned down by some of the urban services employees and we missed the opportunity of getting the field of tree management specialized. The Urban Council was disbanded after Hong Kong's reunification with China, urban service works were taken over by the Leisure and Cultural Services Department (LCSD) and the Food and Environmental Hygiene Department (FEHD). It was clear that tree management was going to be a low priority. In terms of resources and technical know-how, responsibility for tree management was further divided on the basis of land allocation. Uncertainty over the division of responsibilities has recently been criticized by the press and public.

However, the Government has defended the current division of responsibilities as being equally effective as that of slope management. We should understand, although there are different departments managing the slopes within their allotted areas, all necessary works are done by well-trained and experienced registered geotechnical engineers. They not only have technical know-how and are supervised by the Board and professional institute, but they also comply with professional codes and receive continuous training. On the other hand, arborist staff working for government nowadays are often under-qualified and have little work experience. They have vague standards of practice, are lacking internal and external monitoring systems for integrity, and have an unclear scope of responsibility. How can the public be assured or convinced that tree management work is being done satisfactorily?

Tree management has always required professionalism, especially in urban areas. It requires a wide range of general knowledge, including urban planning, landscape design, landscape engineering, ecology, soils, irrigation, tree pathology, insect and fungal control and so on. That is why professional practitioners generally require 4 to 5 years to get an Urban Forestry Bachelor's degree or Master's degree. After graduation, they must get relevant work experience for years before being professionally recognized, based on the requirements of local professional

groups, via established registration procedures. Becoming a responsible landscape manager, their work roles are just like a property manager or a project manager; coordinating and managing the trees and their landscape zones within a defined site or district. Using their technical know-how and work experience they need to build a management team, composed of experts and consultants from different fields such as gardeners, pathologists, plant disease experts, lawn specialists, arborists and soil experts. They need to formulate a comprehensive and macro-management policy in line with the district property or environmental needs, define work procedures and guidelines, undertake training, resource allocation, supervision of frontline staff, and handle crisis management. Because front-line arborist staff are responsible for the implementation of tree care work, the requirements of their skills and experience are very important. Therefore systematic training and a comprehensive, industry-wide form of registration or licensing is urgently needed, as well as providing ample opportunities for work and promotion in order to enhance the level of tree care work. In view of this, arborist practitioners are being certified by the Hong Kong Institute of Landscape Architects, to assist this important step forward for the arborist profession. In addition TMO's emphasis of green planning on the one hand, and tree defect detection and care procedures on the other, by-passes the most significant

middle ground – how to prevent damage to trees during construction or maintenance of other public works. That was apparent when roots of some fallen trees have been seen to have been invaded and damaged by fungi or insects. The trees did not receive proper treatment and this led to them being infected with Brown Root Rot (BRR) Disease. We have to understand that damaged roots are difficult to detect visually, that is why experts also need proper equipment to do the detection. It is difficult to just rely on public scrutiny. In order to reduce risk, all public construction work contracts should be required to have a tree officer who is responsible for imparting awareness of trees to workers, providing guidance, supervising the works to minimise negative impacts on neighboring trees during the construction period, and undertaking aftercare work.

Finally, I hope that the Government will soon establish a comprehensive professional tree management team that will create genuine quality in our urban forest for the people of Hong Kong.

Patrick H.T. Lau is a former president of Hong Kong Institute of Landscape Architects and the Chairman of Hong Kong caring for trees Association

Article translated by Audrey Du



Extensive roadworks often threaten the roots and health of a tree



Establishing a framework for the recognition of local arboricultural practitioners

Paul Y. K. Chan

HKILA Accredited Arboricultural Practitioners

HKILA launched the *Accredited Arboricultural Practitioners (AAP)* scheme¹ in 2012 to address increasing public concerns over the treatment of urban trees and their potential failure causing personal injury and damage to property. When it was introduced to HKILA members and to the Development Bureau of the HKSAR Government (DEVB) it was made clear that the scheme was established to meet three main objectives in the local context:

- To formulate regulatory control of arboricultural services,
- To create a knowledge platform for the industry, and
- To establish a benchmark for employers, stakeholders, and the general public.

By the end of 2014, the HKILA AAP Vetting Panel had accredited over 50 local arboricultural practitioners. Those who have been accredited through the scheme are entitled to use the designation *HKILA Arb.P.* While the development of the scheme has been promising, it is still far from meeting the stated main objectives.

In 2013 DEVB recognised that holders of *HKILA Arb.P.* were qualified to act as 'Inspection Officers' and 'Endorsement Officers' in conducting Form 1 tree risk assessments; and that they met the qualification requirements to act as 'Inspection Officers' and the training and qualification requirements to act as 'Endorsement Officers' for Form 2 tree risk assessments.

Regulatory environment

Before the scheme was launched, HKILA expressed the confusion felt by the Industry and employers caused by the diverse range of terminologies used for the appointment of tree-related positions in government contracts, and the inconsistency across different technical circulars, practice notes and contract provisions, regarding the qualification required for those providing arboricultural services, and their responsibilities.

In a letter sent to DEVB in May 2011, HKILA *"strongly suggest[ed] Government to establish and maintain a locally recognised registration or accreditation system for arborists under the local context."* Although at the time the newly established Greening, Landscape, and Tree Management Section (GLTMS) under DEVB indicated that the Government had no plans to establish

a locally recognised registration or accreditation system for arborists, they welcomed the initiative by HKILA in establishing an accreditation system for local arborists. In their letter to HKILA in November 2011, DEVB agreed that *"it is desirable to standardise the use of terminologies and qualifications required in government contracts of tree-related jobs."*

Since its establishment, GLTMS has maintained and updated its *Guidelines for Tree Risk Assessment*.² As shown in Table 1 to 4, there is a wide range of training and qualifications recognised for the different roles; however, the lists contain training and qualifications that are not comparable in terms of the hours of training, breadth and depth of topic coverage, assessment method and criteria, learning outcomes, and level of award under the qualification framework of Hong Kong.



| | |
|---|--|
| Training/ Qualification | (a) have attended and completed the following training courses organised by the TMO:- - Comprehensive Tree Risk Assessment and Management Training Course with assessment; OR - Refresher Course with assessment; OR |
| | (b) have undertaken equivalent departmental training recognised by the TMO; OR |
| Work Experience | (c) have successfully undertaken training programmes recognised by the TMO, such as Tree Risk Assessment Qualification (TRAQ) organised by the International Society of Arboriculture (ISA) or Professional Tree Inspection by Lantra Awards; OR |
| | (d) have valid qualification or certification awarded by recognised institution or industry organisation on arboriculture, such as: - Certified Arborist of the ISA, - Registered Arborist (Level 3 or above) of Arboriculture Australia, - Technician Member or above of the Arboriculture Association of the United Kingdom, - Accredited Arboricultural Practitioner of the Hong Kong Institute of Landscape Architects, - Professional Diploma Programme in Arboriculture or Tree Risk Assessment and Management of the School of Continuing and Professional Studies, Chinese University of Hong Kong (CUSCS), - Advanced Diploma in Tree Management and Conservation of the School of Professional and Continuing Education, University of Hong Kong (HKU SPACE), - Certificate in Professional Tree Management of the Open University of Hong Kong, - Professional Diploma in Horticulture and Landscape Management of the Technological and Higher Education Institute of Hong Kong (THEi), etc. |
| Have at least 2 years of work experience in tree care and are familiar with tree risk assessment/ management. | |

Table 1. Qualification requirements for "Inspection Officer" for Form 1²

| | |
|--------------------|--|
| Training | (a) Have attended and completed the following training courses organised by the TMO:- - Comprehensive Tree Risk Assessment and Management Training Course with assessment; OR - Refresher Course with assessment; OR |
| | (b) Have undertaken equivalent departmental training recognised by the TMO; OR |
| Qualification | (c) Have successfully undertaken training programmes recognised by the TMO, such as TRAQ organised the ISA or Professional Tree Inspection by Lantra Awards; OR |
| | Have valid qualification or certification awarded by recognised institution or industry organisation on arboriculture, such as: - Certified Arborist of the ISA, - Registered Arborist (Level 3 or above) of Arboriculture Australia, - Technician Member or above of the Arboriculture Association of the United Kingdom, - Accredited Arboricultural Practitioner of the Hong Kong Institute of Landscape Architects, - Professional Diploma Programme in Arboriculture or Tree Risk Assessment and Management of the School of Continuing and Professional Studies, Chinese University of Hong Kong (CUSCS), - Advanced Diploma in Tree Management and Conservation of the School of Professional and Continuing Education, University of Hong Kong (HKU SPACE), - Certificate in Professional Tree Management of the Open University of Hong Kong, - Professional Diploma in Horticulture and Landscape Management of the Technological and Higher Education Institute of Hong Kong (THEi), etc. |
| Work Experience | Have at least 2 years of work experience in tree care and are familiar with tree risk assessment/ management. |

Table 3. Qualification requirements for "Inspection Officer" for Form 2²

| | |
|---|--|
| Training/ Qualification | (a) Have attended and completed the following training courses organised by the TMO:- - Comprehensive Tree Risk Assessment and Management Training Course with assessment; OR - Refresher Course with assessment; OR - Tree Risk Management Training Course with assessment; OR |
| | (b) Have undertaken equivalent departmental training recognised by the TMO; OR |
| Work Experience | (c) Have successfully undertaken training programmes recognised by the TMO, such as TRAQ organised the ISA or Professional Tree Inspection by Lantra Awards; OR |
| | (d) Have valid qualification or certification awarded by recognised institution or industry organisation on arboriculture, such as: - Certified Arborist of the ISA, - Registered Arborist (Level 3 or above) of Arboriculture Australia, - Technician Member or above of the Arboriculture Association of the United Kingdom, - Accredited Arboricultural Practitioner of the Hong Kong Institute of Landscape Architects, - Professional Diploma Programme in Arboriculture or Tree Risk Assessment and Management of the School of Continuing and Professional Studies, Chinese University of Hong Kong (CUSCS), - Advanced Diploma in Tree Management and Conservation of the School of Professional and Continuing Education, University of Hong Kong (HKU SPACE), - Certificate in Professional Tree Management of the Open University of Hong Kong, - Professional Diploma in Horticulture and Landscape Management of the Technological and Higher Education Institute of Hong Kong (THEi), etc. |
| Have at least 2 years of work experience in tree care and are familiar with tree risk assessment/ management. | |

Table 2. Qualification requirements for "Endorsement Officer" for Form 1²

| | |
|---|--|
| Training/ Qualification | (a) Have attended and completed the following training courses organised by the TMO:- - Comprehensive Tree Risk Assessment and Management Training Course with assessment; OR - Refresher Course with assessment; OR - Tree Risk Management Training Course with assessment; OR |
| | (b) Have undertaken equivalent departmental training recognised by the TMO; OR |
| Work Experience | (c) Have successfully undertaken training programmes recognised by the TMO, such as TRAQ organised the ISA or Professional Tree Inspection by Lantra Awards; OR |
| | (d) Have valid qualification or certification awarded by recognised institution or industry organisation on arboriculture, such as: - Certified Arborist of the ISA, - Registered Arborist (Level 3 or above) of Arboriculture Australia, - Technician Member or above of the Arboriculture Association of the United Kingdom, - Accredited Arboricultural Practitioner of the Hong Kong Institute of Landscape Architects, - Professional Diploma Programme in Arboriculture or Tree Risk Assessment and Management of the School of Continuing and Professional Studies, Chinese University of Hong Kong (CUSCS), - Advanced Diploma in Tree Management and Conservation of the School of Professional and Continuing Education, University of Hong Kong (HKU SPACE), - Certificate in Professional Tree Management of the Open University of Hong Kong, - Professional Diploma in Horticulture and Landscape Management of the Technological and Higher Education Institute of Hong Kong (THEi), etc. |
| Have at least 2 years of work experience in tree care and are familiar with tree risk assessment/ management. | |

Table 4. Qualification requirements for "Endorsement Officer" for Form 2²

After the Robinson Road tragedy in August 2014 in which a falling tree took the life of a pregnant woman, GLTMS made it clear to the public that it is the responsibility of the property owner to maintain trees within private land. This caused widespread anxiety amongst private property owners over potential liability, and it was suggested by some news media that there was a shortage of qualified personnel for tree maintenance. In response, and in an attempt to ease public concern over trees within private land, GLTMS posted a new page on their website, "Information about tree maintenance for private properties."³ The page provides the following lists that "contain the qualified service providers/

members in the professional groups on tree management which are for general reference purposes," namely:
- List of Approved Suppliers of Materials and Specialist Contractors for Public Works / Landscaping⁴
- International Society of Arboriculture, Hong Kong Chapter⁵
- The Hong Kong Institute of Landscape Architects, Accredited Arboricultural Practitioners (AAP)

The service providers/ personnel on the three lists, are of very different natures. The first is a list of companies, the second is the Hong Kong chapter of a society based in the United States, and the third is an accreditation scheme under HKILA.



The companies listed under the List of Approved Suppliers of Materials and Specialist Contractors for Public Works/ Landscaping are specialist contractors approved for carrying out public works in one or more of the 50 categories of specialist works. There are two classes of Specialist Contractors under the 'Landscaping' category, (Class 1 – General Landscape work, and Class 2 – Hydroseeding). Both classes contains two Groups of Specialist Contractors; those in Group 1 are eligible to perform contracts up to a total value of HK\$2.3 million and those in Group 2 can perform contracts of any value. According to DEVB's Contractor Management Handbook,⁶ Specialist Contractors of

the 'Landscaping' category must have at least one "horticulturalist" and one 'tree specialist'. The 'horticulturalist' and 'tree specialist' can be the same person for Group 1 contractors, but not for Group II contractors. Qualifications required for the two positions are shown in Table 5.

Comparing the qualification requirements between the 'horticulturalist/ tree specialist' for Specialist Contractor under the Contractor's Management Handbook and the 'Inspection Officer/ Endorsement Officer' for tree risk assessment under the TRA Guidelines, it is possible for a person to be a 'tree specialist' but not eligible to conduct individual tree risk assessment whether as

| Position | Academic/ Professional Qualifications | Experience | No. required | |
|------------------|--|---|--------------|----------|
| | | | Group I | Group II |
| Horticulturalist | Obtained a university degree in horticulture or related discipline | Three years working experience in horticulture | 1 | 1 |
| | OR | | | |
| | Satisfactorily completed a recognized diploma programme in horticulture or related field equivalent to the standards of Level 3 or above in the Hong Kong Qualification Framework | Four years working experience in horticulture | | |
| Tree Specialist | Obtained a university degree in horticulture or related discipline | Three years working experience in arboriculture | 1 | 1 |
| | OR | | | |
| | Satisfactorily completed a recognized diploma programme in arboriculture or related field equivalent to the standards of Level 3 or above in the Hong Kong Qualification Framework | Four years working experience in arboriculture | | |
| Tree Specialist | Obtained a qualification or certification from a professional institute or organization of horticulture(h) with standards equivalent to those of the Certified Horticulturist from the American Society for Horticultural Science or above | Five years working experience in horticulture | | |
| | OR | | | |
| | Obtained a qualification or certification from a professional institute or organization of arboriculture with standards equivalent to those of the Certified Arborist from the International Society of Arboriculture or above | Five years working experience in arboriculture | | |

Table 5. Minimum requirements for technical staff for specialist contractor in landscaping category, Class 1: General landscape work, listed under DEVB¹⁰

an 'Inspection Officer' or 'Endorsement Officer'. The companies are listed for carrying out landscape works for public projects and under the current strong market demand, individual property owners may have difficulty in engaging them for service; while there are many other companies offering arboricultural services both to the maintenance units of the Government or the general public that are not listed, with their quality of service and professional liability unassured.

engaged in constructing or implementing landscaping works to individuals providing mainly arboricultural consultancies or supervisory services.

Adding to the confusion, immediately after the three lists, reference is made to PN 7/2007⁷ which states that an Authorised Person (AP) should be responsible for tree preservation in

compliance with the relevant clause under land lease for private land, that a Registered Landscape Architect (RLA) or competent person should be appointed for assessment of existing trees and related services, and that an RLA must be appointed for *Self-Certification of Compliance* of tree works. However the "three lists" have nothing to do with AP and RLA.

According to the International Society of Arboriculture Hong Kong Chapter (ISA-HK) website, there are six levels of arboricultural practitioner, established through different examinations or assessments. GLTMS has not indicated how each of the credentials and qualifications under the ISA framework align with the typical arboricultural services required by the general public, such as tree felling proposals, compensatory planting proposals, tree transplanting, emergency tree felling/pruning reports, etc. Together with the HKILA AAP scheme and without further elaboration or differentiation, the three lists contain service provider/ personnel ranging from companies primarily



Top heavy - A fallen tree on Paterson Street, Causeway Bay

Conclusion

The recent development of mechanisms for tree-related works and tree risk assessments, and the newly issued technical information do not help answer the simple question for the general public "who is qualified to do what?" The fundamental issue is still the absence of a benchmark for employers and the general public. This was set by HKILA as one of the objectives of establishing a locally recognised system to arboricultural services. In the past three years the industry has not been able to "standardise the use of terminologies and qualifications required in government contracts of tree-related jobs".

Similar standardisation would be equally important to the general public for non-government projects. Imagine how confusing it would be for employers or any member of society in need of arboricultural services to be confronted with various terminologies like 'Inspection Officer', 'Endorsement Officer', 'Horticulturalist', 'Tree Specialist', 'Registered Landscape Architect', 'Authorised Person', or 'Certified Arborist', and all the diverse

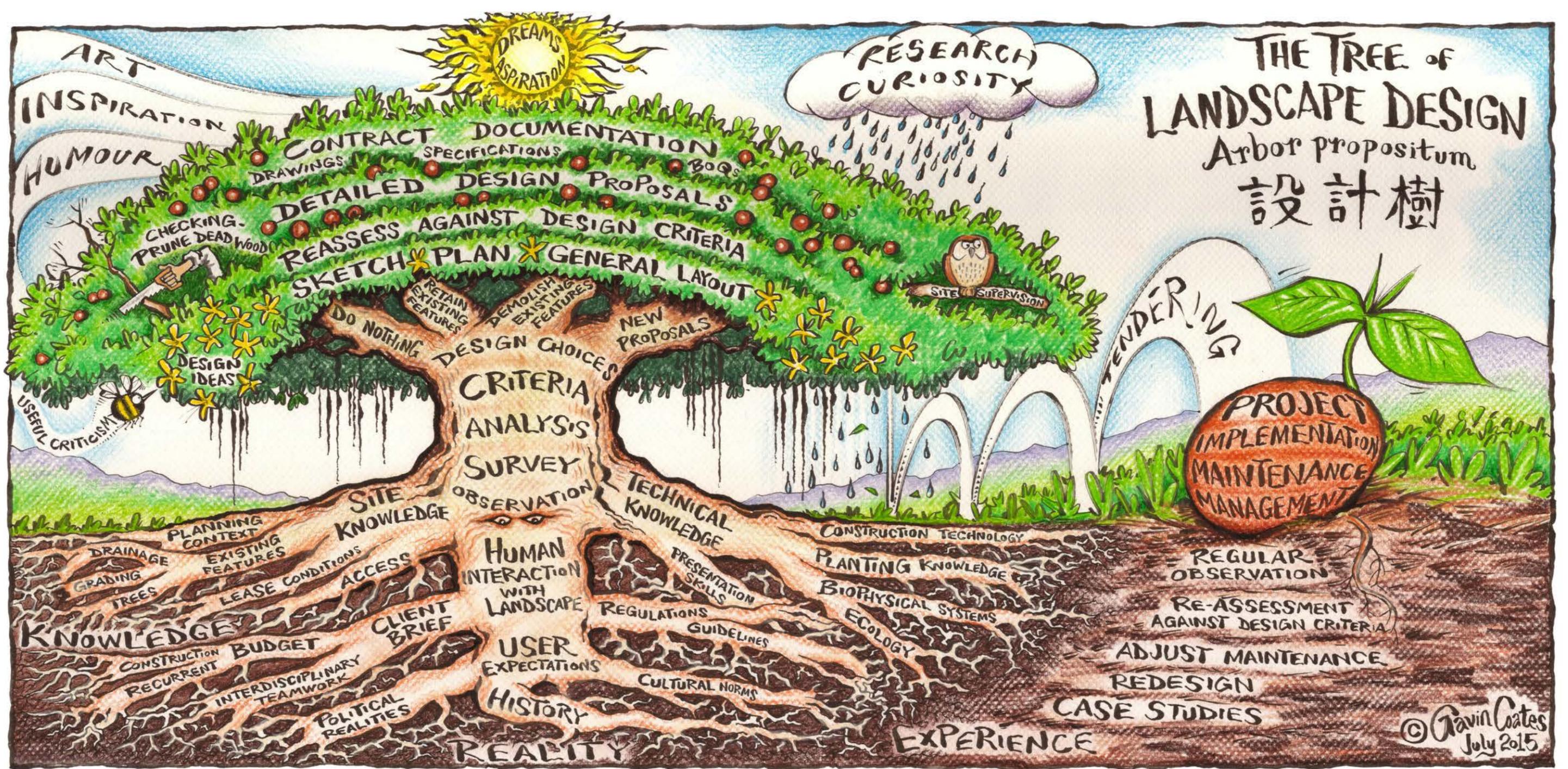
and non-comparable qualifications and responsibilities that go with them.

By making reference to established systems for other construction-related activities such as the *Mandatory Building Inspection Scheme*, *Mandatory Window Inspection Scheme*,⁸ and the *Site Supervision Plan* system,⁹ which clearly set out the required level of qualification and experience and the line of responsibility for each level of practitioners, we hope to see the Government and professional bodies working together in formulating a clearer and more fair system that would facilitate quality supervision and implementation of horticultural and arboricultural works in Hong Kong.

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References

1. HKILA Accredited Arboricultural Practitioners Scheme <http://www.hkila.com/v2/aap.php>
2. Greening, Landscape and Tree Management Section, Development Bureau (October 2014), Guidelines for Tree Risk Assessment and Management Arrangement on an Area Basis and on a Tree Basis, 7th Edition
3. Greening, Landscape and Tree Management Section, Development Bureau (January 2015), Information about tree maintenance for private properties, http://www.trees.gov.hk/en/tree_care/info_tree_maintenance_pp/index.html
4. List of Approved Suppliers of Materials and Specialist Contractors for Public Works/Landscaping
5. International Society of Arboriculture Hong Kong Chapter <http://www.isahongkong.com/>
6. Development Bureau (May 2014), Contractor Management Handbook (Revision B-13)
7. Lands Administration Office Practice Note No. 7/2007 (PN 7/2007), Lands Department
8. Buildings Department (2012), Code of Practice for Mandatory Building Inspection Scheme and Mandatory Window Inspection Scheme
9. Buildings Department (2010), Code of Practice for Site Supervision 2009
10. Annex 35 of Contractor Management Handbook (Revision B-13), Development Bureau (May 2014)



The Tree of Landscape Design, *Arbor propositum* | Gavin Coates 設計樹 | 高嘉雲

'The Tree of Design', admittedly not quite in the same league as its proverbial precursor 'The Tree of the Knowledge of Good and Evil', is here presented as a metaphor for the landscape design process. One aim is to address the apparent contradiction that faces every student and practitioner of the subject, namely that he or she is expected to be 'creative', while simultaneously being 'practical'. Another is to consider how the various components of the design process, from the sublime to the mundane, are inter-related.

Let us take a little arboreal tour. Below the soil surface lies the realm of reality, above it the world of dreams. Our tree is anchored in reality, while its crown reaches up towards the sunlight of dreams and aspirations! The air represents inspiration, art and humour. The rain of curiosity and research waters the roots of knowledge. As plants convert light energy into chemical energy by photosynthesis, so our 'Tree of Design' can convert dream energy into reality.

The primary tap-root is enquiry into human interaction with the landscape, with history at its deepest extremity. The two main lateral roots are technical knowledge and site knowledge. These converge at the root collar of observation, corresponding with the survey stage of design development. The trunk is the design analysis stage where the different aspects impacting the design are integrated, leading to the formation of design criteria. The trunk divides into four design-decision branches: Do nothing; Retain existing site features; Demolish them, and; Formulate new proposals. Various design ideas flower in the sketch design

foliage above. Some are pollinated by the bee of useful criticism (which can also sting, of course!), some fall away as they are reassessed against the design criteria. The remaining flowers develop into the fruit of final proposals in the detailed design foliage, maturing into competent contract documentation! Aerial roots may be sent down from the design branches at will to seek more knowledge.

Some seeds fall to the ground and germinate as projects, implemented, maintained and managed under the watchful eye of the wise old site-supervision owl. The debris of fallen leaves and 'failed' design ideas metamorphose into the compost of experience further nourishing the roots of knowledge. So it is that the design process, like the learning process, is not linear but cyclic!

Things can go wrong. The root of government regulation may become a girdling root that strangles the design process. If the sun of aspiration does not shine, the breeze of inspiration does not blow or the rain of curiosity does not fall, then the tree will be stunted. The design process may be cut down to the ground in the case of a project being abandoned, but if the soil and root system are healthy, a complete new tree can grow back. The moral of the story? Never stop dreaming. Never stop learning. Never stop growing. Be the Tree of Design!

Gavin Coates is a landscape architect and illustrator based in Hong Kong since 1982. Since 2005 he has been involved in the design and implementation of the Greening Master Plans for CEDD, and is now a senior lecturer in landscape architecture at The University of Hong Kong.

'The challenges of introducing native species and developing a natural succession woodland structure have been hard to meet due to the exposed site which is critically short of soil water. However, careful woodland management, thinning of plantation species and assisted introduction of native species, should allow for a gradual and continued evolution, whereby the knowledge obtained through planting trials during the operation stage can be fully utilised.'

Barry Wilson

Trials in succession woodland planting at SENT Landfill, Tseung Kwan O

Barry Wilson



Site of SENT Landfill and adjacent Tseung Kwan O Industrial Estate

Background

There are currently just three operating landfill sites in Hong Kong following the closure of the thirteen other sites between 1975 and 1996. SENT Landfill, the 3rd landfill site in Tseung Kwan O, receives about 35% (2012 figure) of the total waste generated in Hong Kong and is operated by Green Valley Landfill Ltd, a subsidiary of the Veolia Environmental Services Group contracted for the design, construction and operation of the landfill for the Environmental Protection Department of Hong Kong SAR Government.

The landfill is fast approaching capacity and typically landscape restoration works would be undertaken at closure. However planting at SENT has been undertaken as an ongoing process ever since the commencement of progressive restoration. The Restoration Masterplan, was developed by consultants Urbis Ltd prior to letting of the works contract and the operator, contracted to manage for a further 30 years following its closure, will ensure ongoing maintenance and management of the facility. Ultimately the facility is intended for passive recreational use, with its position abutting the Clearwater Bay Country Park making it a potentially valuable public asset.

Initial planting was undertaken in 1997 on the first fill slopes formed around the base of the site area. Subsequently, restoration planting has been undertaken during the planting season more or less on an annual basis as each section of the landfill has been completed. The Restoration Masterplan essentially envisaged the creation of three types of native vegetative cover; woodland; scrubland; and grassland, with the objective of creating a natural system promoting wildlife and nature conservation through colonisation and natural succession, ultimately achieving a climax woodland community.



2003 - Restoration Phases 1-4. Phased planting blocks can be clearly identified as the landfill grows.

clear conclusions of one ameliorant over another, however it was apparent that seedling survival rates were severely affected by the extent of amelioration, with no apparent benefit being identified where ameliorants were limited to the immediate rooting zone of the individual (200x200mm) plant pit.

A change in the planting mixes to hardier species was adopted and the Second Year Plant Performance Report demonstrated that the use of leguminous species, in both improving soil structure and showing good survival characteristics, was beneficial. This suggested that more use of *Caesalpinaceae* tree species could be successful, eg. *Bauhinia*, *Cassia*, *Delonix* and *Peltophorum*.

The ongoing problems with low soil water content

Whilst continual watering of seedlings during establishment may have been adequate during the first year of growth, once the establishment period ended and watering was suspended survival became problematic. Only the plantation species seemed able to cope with the water stress on the site and a longer term approach to soil water content needed to be addressed if any success with growth of non plantation species was to be achieved.

The use of water absorbent polymers within the plant pit was considered but not utilised due to the fact that the major problem appeared to be the difficulty of getting roots to leave the extent of the planting pit, and the polymers could not be applied consistently throughout the top layer.

The conclusion was that a significant change to the topsoil structure would be required to promote success in developing non-plantation species within the restoration. The 1500mm deep planting medium structure was revised to be 300mm CDF covered with 1200mm CDV compacted to 95% MDD. The CDV material was initially available on site, having been stripped and stockpiled during site formation. Whilst it was not in sufficient quantities to last for the duration of the landfill it was considered beneficial to utilise the material whilst it was available.



2014 - Erosion problems have affected the success of hydroseeding in some areas. Newly planted delicate species in microclimatic growth tubes can be seen with early phase woodland in the background.

Subsequently imported soil material from various sources has been used for the 1500mm deep planting medium. Use of CDF was suspended once the construction waste sorting plant was no longer on the landfill. For the top 300mm, CDV has been used which is of a similar nature to that excavated on site.

Trials in species mix and arrangement

Over the following years between 1998 and 2003 restoration was carried out utilising variations of tree species within the planting matrices. Whilst the overall greening appeared to be satisfactory, on closer inspection the species diversity within the tree groups was still well below that desired. Nurse species were expected to make up about 60% of the cover at this stage, however due to the failure of the more delicate species they numbered more than 90%. In planting Phase 4, *Schima*, *Castanopsis*, *Cinnamomum* and *Machilus* in particular, all struggled to survive even in the sheltered south east area of the landfill. As a result the balance of plantation species was increased from Phase 6 onwards by adding a second nurse species in order to increase both the degree of shelter provided and the physical amount of greening. Those species directly down slope from the blocks of fast growing nurse species were observed to thrive most successfully. This was considered to be

due to the increased shelter from wind and sun afforded to them. In particular nurse species at the bottom side of a block appeared to be redundant. As such the matrices were amended to attempt to provide more and smaller pockets of sheltered planting areas by increasing the distribution of nurses through the block.

The good performance of *Albizia lebbek* in phases 3 and 4 recommended it to more extensive use on the landfill whilst *Aleurites* and *Gardenia* species also demonstrated acceptable performance. Poor success in establishment was noted from the following species:

- *Alnus formosana*
- *Celtis tetranda*
- *Cratogeomys ligustrinum*
- *Eucalyptus torrelliana*
- *Ficus hispida*
- *Ficus superba*
- *Gordonia axillaris*
- *Itea chinensis*
- *Liquidambar formosana*
- *Litsea rotundifolia*
- *Macaranga tanarius*
- *Mallotus paniculata*
- *Phoenix hanceana*
- *Pandanus tectorius*
- *Quercus edithae*

In general it became apparent that a balanced block matrix mix would be made up of six species based on the following :

1. *Acacia* spp. – from *A. confusa* / *A. auriculaeformis* / *A. mangium*
2. Secondary nurse – from *Eucalyptus citriodora* / *Casuarina equisetifolia* / *Cassia surratensis* / *C. siamea* / *Lophostemon confertus* / *Hibiscus tiliaceus*
3. Tertiary nurse - *Albizia lebbek* / *Calliandra haematocephala* / *Delonix regia*
4. Native species A – (aggressive) – *Cinnamomum* spp. / *Litsea glutinosa* / *L. monopetala* / *Ficus microcarpa* / *F. benjamina* / *Celtis sinensis*
5. Native species B – (delicate) – *Schima* / *Machilus* / *Schefflera* / *Castanopsis* / *Sapium* / *Ficus virens*
6. Protected species – *Magnolia grandiflora* / *Lagerstroemia indica* / *L. speciosa* / *Rhododendron simsii* / *Ailanthus fordii* / *Rhodoleia championii* / *Camellia* spp. (not *C. japonica*)

Phased planting currently being undertaken has essentially followed the 6 species block matrix utilising clustered blocks of 25 plants spaced at 1500mm with some revisions to the species included above.

Current Active Landfill Sites in Hong Kong

| Landfill | Location | Ha | Opened | Capacity |
|--|-----------------------------|-----|--------|---------------------------|
| West New Territories Landfill (WENT) | Nim Wan, Tuen Mun | 110 | 1993 | 61 million m ³ |
| South East New Territories Landfill (SENT) | Tai Chik Sha, Tseung Kwan O | 100 | 1994 | 43 million m ³ |
| North East New Territories Landfill (NENT) | Ta Kwu Ling, North District | 61 | 1995 | 35 million m ³ |

Early Trials

The masterplan called for a series of planting trials in the initial phases of the restoration, the objective being to identify at an early stage which plant species and soil media would be most effective at promoting growth. With approximately 1.5million m³ of soil required for the landfill it was considered imperative that as much material could be found on site as possible. Small amounts of site stripped topsoil and Completely Decomposed Volcanics (CDV) were available for re-use however early trials looked at the possibilities of utilising Construction and Demolition Fines (CDF) which would be available through the duration of the landfill development at an appropriate scale. CDF are principally composed of gravelly / sandy particles with high pH (9.0) and potassium content. Once ameliorated, the medium offered good possibilities of undertaking large scale sustainable planting. Initiated in April 1997,

twelve trial blocks were established to test variations in soil amelioration, planting spacing and methods. The plant performance was monitored over the next 6 years (until 2003) by the Department of Applied Biology and Chemical Technology at The Hong Kong Polytechnic with the Institute for Natural Resources and Waste Management and Department of Biology at Hong Kong Baptist University. The results obtained helped influence decision making for the following planting seasons.

Early Results with Soil Mixtures

The early attempts to manufacture a growing medium were based on a 1200mm layer of CDF over the polyethylene cap layer, with an ameliorated top layer up to 300mm deep. Ameliorants included horse and pig manure, shredded recycled wood products and regular horticultural products. Survival rates for tree seedlings were variable and it was hard to draw



2014 - Restoration phase 9. One year into establishment. Phase 7 planting blocks can be seen at the rear.

Introduction of microclimatic growth tubes

Following the continued disappointing results in establishing native trees within the restoration, a new approach has been considered since the 7th phase of planting (undertaken in 2010) whereby approximately 10% of plants were installed with microclimatic growth tubes (MGTs), as a trial. A detailed review was carried out in August 2011 to ascertain the effect of the tubes and whilst there were some positive indications for some species, the conclusions were hard to draw due to the small sample size. As such, wider and more stringent trial monitoring has now been established over the last three planting phases combined with the introduction of weed mats.

Early indications are that mortality rates do appear lower for plant species planted with MGT's against those without, however the percentage difference often appears minor for some species, making it difficult to justify the extra cost. Further trials are looking at specific species that might best benefit from the addition of tubes in combination with the use of weed mats as well as critical watering at key times after planting. What has been observed however is the clear differentiation in size between seedlings, where tubed material is consistently larger and more robust in health. It would also appear that many of the delicate species, such as *Ilex asprella*, are unable to successfully establish on the landfill without the assistance of MGT.

Maintenance issues

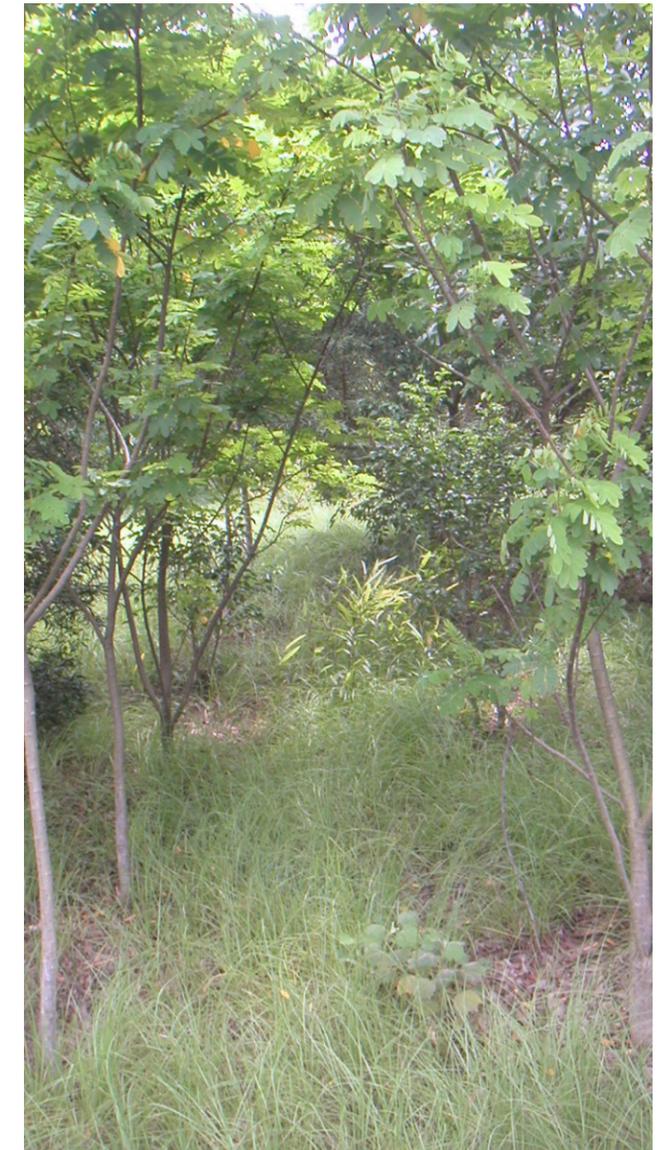
Large numbers of invasive *Leucaena leucocephala* have become an increasing problem on the landfill in recent years, taking a hold on both temporary fill areas and final restoration slopes. They are particularly problematic in areas of tree planting as they colonise en-masse, compete with seedlings for the valuable soil water and crowd out new plantations. If not continually removed at the earliest possible moment their removal becomes increasingly difficult as they become too large to be pulled by hand. Whilst they were initially viewed positively in their ability to colonise the landfill, their profuse seeding is now a major concern.



2010 - Woodland planting about 10 years old. *Leucaena* has started to invade the light pockets and woodland margins.



2014 - Restoration phase 9. 1500mm planting medium being graded for future planting phase



2004 - A mixed canopy established. Grass cutting can be suspended and the woodland left to develop.

Conclusion

Continual restoration planting at SENT has ensured that the visual quality of the landfill has been significantly improved during its operation. Initial tree planting has now developed into a tall and dense canopy, giving a positive green image around the development and integrating with the surrounding environment. The ecological makeup is similar to that of the surrounding plantation woodlands contained within the Country Park areas, with a variety of invasive flora and fauna having been increasingly identified.

The challenges of introducing native species and developing a natural succession woodland structure have been hard to meet due to the exposed site which is critically short of soil

water. However, careful woodland management, thinning of plantation species and assisted introduction of native species, should allow for a gradual and continued evolution, whereby the knowledge obtained through planting trials during the operation stage can be fully utilised.

Barry Wilson is a landscape architect, urbanist and university lecturer. His practice, Barry Wilson Project Initiatives, has been tackling urbanization issues in Hong Kong and China for over 20 years.

www.initiatives.com.hk

Project Team

Client – Environmental Protection Department

Operator – Veolia Environmental Services Group

Landscape Masterplan – Urbis Ltd.

Independent Consultant – Meinhardt Infrastructure and Environment Ltd.

Landscape Independent Checker – Barry Wilson Project Initiatives Ltd.



2004 - Weed suppression in planting blocks is essential in the early years of woodland development

Bibliography

1. Carnevale, N.J. & Montagnini, F. 2002. Facilitating regeneration of secondary forests with the use of mixed or pure plantations of indigenous tree species. *Forest Ecology and Management* 163: 217–227.
2. Chong, S.L. 1999. Restoration of degraded lands in Hong Kong. In M.H. Wong, J.W.C. Wong & A.J.M. Baker, eds. *Remediation and management of degraded lands*. Boca Raton, London, New York, Washington, DC, Lewis Publishers. 185–193
3. Coomes, D.A. & Grubb, P.J. 1998. Responses of juvenile trees to above- and below-ground competition in nutrient-starved Amazonian rain forest. *Ecology* 79(3): 768–782.
4. Corlett, R.T. 1999. Environmental forestry in Hong Kong: 1871–1997. *Forest Ecology and Management* 116: 93–105.
5. Haggard, J.P., Briscoe, C.B. & Butterfield, R.P. 1998. Native species: a resource for the diversification of forestry production in the lowland humid tropics. *Forest Ecology and Management* 106: 195–203.
6. Hau, B.C.H. 1999. The establishment and survival of native trees on degraded hillsides in Hong Kong. (Doctoral thesis), The University of Hong Kong, Hong Kong.
7. Hau, B.C.H. 2000. Promoting native tree species in land rehabilitation in Hong Kong, China. In S. Elliott, J. Kerby, D. Blakesley, K. Hardwick, K. Woods & V. Anusarnsunthorn, eds. *Forest restoration for wildlife conservation*. International Tropical Timber Organization and The Forest Restoration
8. Lai, P.C.C. and Wong, B.S.F. 2005. Effects of tree guards and weed mats on establishment of native tree seedlings: implication for forest restoration in Hong Kong, China. *Restoration Ecology* 13 (1): 138-143.
9. Lay, C.C., Chan, S.K.F. & Chan, Y.K., 1999. The utilization of native species in local afforestation programme. Agriculture and Fisheries Department, the Government of the Hong Kong SAR. (unpublished)
10. Richardson, D.M. 1998. Forestry trees as invasive aliens. *Conservation Biology* 12(1): 18–26.
11. Zhuang, X.Y. & Corlett, R.T. 1997. Forest and forest succession in Hong Kong, China. *Journal of Tropical Ecology* 14: 857–866.
12. Zhuang, X.Y. & Corlett, R.T. 2000. Survival and growth of native tree seedlings in secondary forest of Hong Kong. *Journal of Tropical and Subtropical Botany* 8(4): 291–300. (in Chinese with an English abstract)

Research Unit, Chiang Mai University, Thailand. 109–120





Extreme trees

Mathew Pryor and Li Wei

The desire for instant landscaping effect in China's high volume residential development sector has recently generated an extreme form of arboricultural practice. Very mature trees (trunk diameter up to 3000mm dbh) are being extracted from areas of natural vegetation, and having most of their root systems and all of their canopy removed to allow them to be transported to commercial tree nurseries, where they are brought back to life and sold on. The authors visited four commercial nurseries near Guangzhou specializing in this form of extreme transplantation, and three landscaping sites that had used trees from the nurseries, to make detailed observations and to conduct interviews with the operators and site managers to understand the specific operations and techniques employed in handling the trees, and the values associated with this practice. Current scientific literature on the responses of mature trees to transplanting and physical damage gives us some insight into the arboricultural condition of these trees and how they might be able to survive such treatment, and allows us to speculate on how their condition might develop afterwards. This 'extreme transplantation' is contrary to all established arboricultural science and practice guidelines for transplanting mature trees. The apparent commodification of our green heritage, also contradicts the principles of environmental preservation and stewardship that underpin the landscape profession.



Newly arrived *Ficus microcarpa* without root ball

Introduction

Mature trees have been used in landscape construction projects for more than 300 years, to bring an immediate sense of maturity and enclosure to a space. It is commonly understood that successful transplanting requires as much as possible of the original root system and canopy to be moved intact in order to minimise water stress, and ensure survival and healthy growth. The mechanics of lifting and moving trees gets progressively more difficult as tree size increases. Transplanting very mature trees (>750mm trunk diameter) this way can be problematic.

An alternative, extreme form of transplanting has developed in China over the last twenty years, to address some of the operational issues involved. Very mature trees, some with trunk diameters in excess of 3000mm (DBH), are now being transplanted from areas of natural vegetation, with most of the root systems and all of the canopy removed to allow them to be transported easily to

commercial tree nurseries, where they are brought back to life and sold on.

Extreme transplanting practices

Four different nurseries specialising in extreme transplants in Guangzhou were visited in 2014. Sample trees were measured and their health condition was assessed, and two of the constructed root balls were partially excavated to examine the root condition. Some of the on-going operations involved in moving the trees were also observed. During the visits, interviews were conducted with the nursery owners and site managers to determine the operational and horticultural processes involved in the business. Three landscaping projects which had used trees from these nurseries, were also visited and the condition of twelve extreme transplants, which had been re-planted between 2012 and early 2013, were assessed.

The nursery owners reported that this form of transplantation was mostly practiced in Guangdong Province¹ but

had also been adopted in Hainan, Hunan, Guangxi, Jiangxi, and Yunnan provinces. Some trees were taken directly from forests in Vietnam or Malaysia which are being cleared for infrastructure and development projects, others come from local forests in China, notably where vegetation is removed for new road projects. Across Guangdong, at least thirteen local species of tree are now being transplanted in this way (Table 1).

Bischofia polycarpa 重陽木 (approx. 30% of the market)
Ficus microcarpa 榕樹 (approx. 25%)
Cinnamomum camphora 樟 (approx. 20%)

Other 25% is made up of:
Artocarpus nitidus subsp. *lingnanensis* 桂木
Dimocarpus longan 龍眼
Hibiscus tiliaceus 黃槿
Ficus altissima 高山榕
Ficus benjamina 垂葉榕
Ficus virens 黃葛樹
Ilex rotunda 鐵冬青
Litchi chinensis 荔枝
Podocarpus macrophyllus 羅漢松
Sapindus saponaria 無患子

Table 1. Common species of tree subject to extreme transplantation

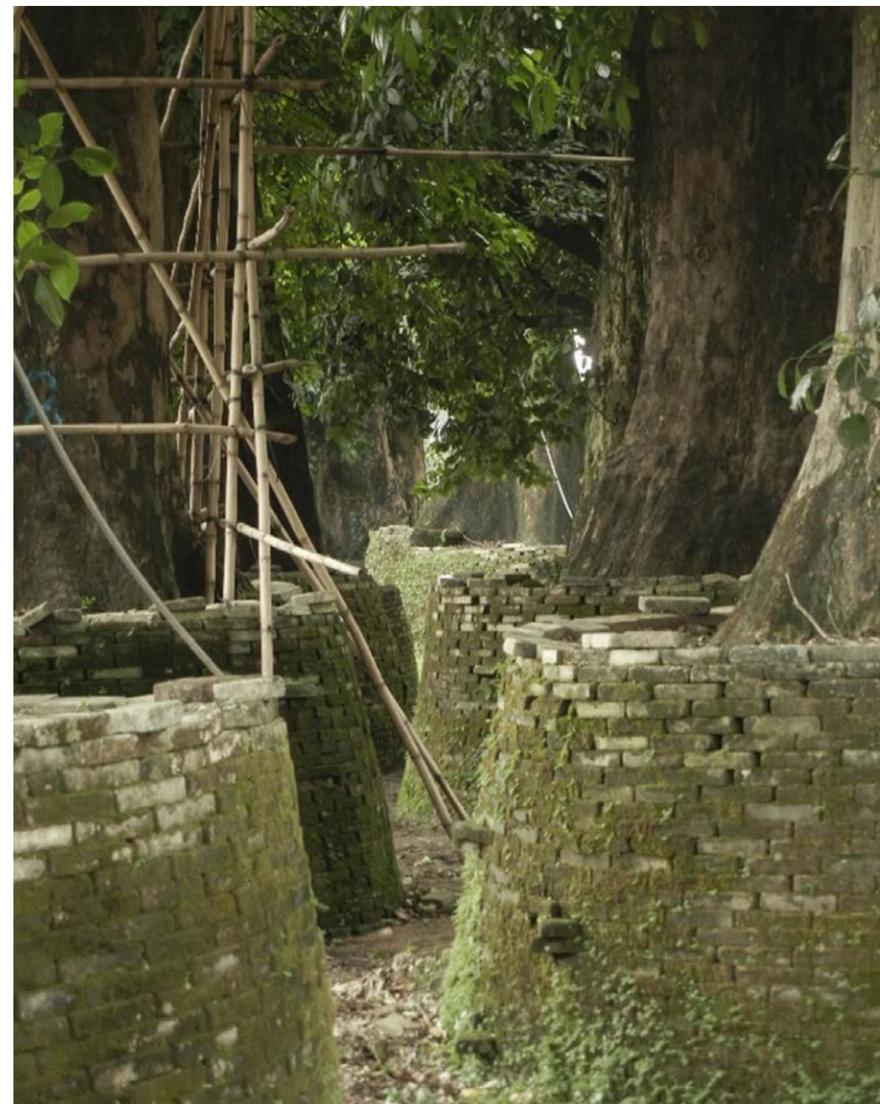
Each of the nurseries visited sold principally *Bischofia polycarpa*, *Ficus microcarpa*, and *Cinnamomum camphora* trees. They were bought by government agencies for public landscaping works and by real estate developers for residential and commercial developments.² The price of the trees in the nurseries varied from RMB 90,000 to RMB 2,500,000 based on size, form and health condition. *Ficus microcarpa*, in particular, were prized for their unusual trunk formations.

Specimens were usually sold within the second or third year after arriving in the nursery, i.e. when they had produced sufficient new foliage to have a recognisable tree-like appearance and to hide the wounds. Some trees, however, had been in the nurseries for four years. The comparatively low operational cost compared to potential returns, offset

the significant failures and inefficiencies in the business.

Demand was, reportedly, high and each nursery had recently expanded its operations.³ It was believed that there were 15 nurseries in the Guangzhou area selling only this form of extreme transplant, while many traditional horticultural nurseries also had a few extreme transplants in stock. Collectively it was estimated that there were between 1,800 and 2,200 such trees on sale in Guangzhou (in 2014).

Nursery owners claimed the survival rate for these extreme transplants to be about 95%, although a higher proportion of failures were apparent in the nurseries and evidence of dieback suggested that the life expectancy of many specimens would be short.



Brick walls built to create a new root ball

Where possible, trees were harvested (root pruned) in early spring (Feb-Mar), although the nurseries avoided the period around the Ching Ming festival (early April) as the trees did not survive well if cut at this time.⁴ Transplanting was also undertaken in late summer and early autumn (up to the end of September) but survival rates tended to be lower. Transplantation was not considered feasible between November and January due to the low humidity.

The original sizes of the *Bischofia polycarpa* specimens before pruning were typically 18-25m tall with 0.8-2.0m trunk diameters: *Ficus microcarpa* specimens were originally 10-20m tall with 0.6-3.5m trunk diameters, and *Cinnamomum camphora* were 18-40m tall with 0.6-2.3m trunk diameters.

Trees were pruned three months in advance of moving. The canopy was cut first to stop all transpiration, before root pruning was undertaken. This was to help avoid severe desiccation and immediate death. The canopy was removed completely with a horizontal cut through the trunk and main stems at approx. 9-11m above the ground (to allow them to be moved by road and sea). Smaller side branches were removed. In taller forest specimens where branching started high up, the tree was truncated to a single massive stem.

The roots were cut very close to the trunk. The root ball ratio for trees with a trunk diameter of, say 750mm, might be 3:1, for larger trees it tended to 1:1. The diameter of the root ball did not exceed 2.25m (except where the trunk did so), and the depth was between 0.6 and 1.5m. For *Bischofia polycarpa* most of the root ball soil was removed (essentially the trees were transplanted bare rooted). The remaining roots had to be wetted constantly to avoid desiccation. *Ficus microcarpa* could be transplanted either with no soil, or with small soil root balls. *Cinnamomum camphora*, required soil root balls. The remaining trunk and root system were wrapped entirely in clear plastic to reduce water loss.

Trees were lifted via padded straps around the trunk. Trees from overseas were loaded into standard shipping containers with a crude wetting system to keep the roots moist. Trees from local

sources were transported on flat bed trailers. Total weight of the trees was approx. 6-12 tonnes.

Upon arrival in the nursery, trees were lifted by crane into an upright position atop a small pedestal of compacted soil to elevate it above the surrounding ground, to avoid the possibility of flooding. After the roots had been unwrapped, a wall was constructed from loose laid bricks in a ring immediately around the root ball. The wall was inclined inwards slightly for stability. It was backfilled with soil as it was constructed. The ultimate height of the wall was approx. 0.9-2.2m.



Intense efforts to re-hydrate a failing *Bischofia polycarpa*

The backfill soil was a nutrient poor pond mud that has been cut into rough cubes (20-45mm) and allowed to dry and harden. This material was very dense and broke down very slowly even with repeated wetting. It allowed the development of fine soil root interaction within the root ball while achieving both good drainage and high water-holding capacity. Peanut residue⁵ was applied to the soil surface as a rapidly decomposing organic fertilizer, every six months.

Newly constructed root balls were thoroughly watered to ensure the soil was at field capacity (based on the nursery worker's judgement), and then the brick structure was wrapped in plastic film to keep the moisture in. The



Tree set on bricks before root ball walls constructed around what is left of the roots

root ball was only watered again when it is seen to be drying out, with the intention of promoting deeper rooting.

Micro-spray irrigation systems were sometimes installed to apply water to the cut upper surface of the trunk, in an attempt to keep the bark from drying out. This was seldom effective, and often counterproductive. Some nursery owners bound the bark at the top of the trunk with steel bands to prevent it from splitting. The trunk was also wetted up to three times per day to reduce moisture loss through the bark and decrease surface temperatures. The plastic film wrapping on the trunk was not removed until new buds had begun to appear.

Pruning wounds could be very extensive, particularly the top of the trunk.⁶ Nursery owners often covered the surface of the wound with paint or plastic film to keep the exposed heartwood dry and to discourage fungi and insects. Trees were also sprayed with fungicide on a regular basis to try and prevent decay. If the bark around a wound died, it was cut back to live tissue to encourage the growth of callus tissue.

Nursery owners reported that new roots appeared within one month of transplantation for each species. Brick walls of two *B. polycarpa* specimens which had been in the nursery for approx. nine months were dismantled and the soil carefully removed, to allow the development of roots to be observed. Fine new roots (<2mm dia. x 30-60mm long) could be seen around most of the cut ends of old roots. Roots were encouraged to develop within the

brick wall structure, but those that grew through the wall were cut as the trees needed to be moved again to their final planting locations.

Buds appeared within one to two months of transplantation for each species. Buds appearing on the lower part of the trunk were removed to encourage bud formation towards the top and twig elongation in an upward direction (i.e. avoiding the development of lateral branches). Sprouting was dense from the cut bark tissue around the wounds. Trees that had been in the nursery for three years, had regenerated branches up to 75mm diameter and 4.5m in length, forming a dense, narrow canopy. This shape balanced the need for foliage to make the tree saleable, while facilitating transportation after sale, without further substantial pruning.

Despite the surface treatment of the pruning cuts in the nursery, the health condition of many of the wounds was poor, with notable bark cracking and die back and limited evidence of callus tissue being formed. Obvious Areas of decay were noted on approximately half of the *Ficus microcarpa* specimens.

Trees were sold on the basis of their size, shape and condition. Those in poor health were removed from the nursery. Nursery owners estimated that life expectancy of the transplants was likely to be only a few years.

The twelve specimens observed in the three ornamental landscaping sites were in full foliage but still had narrow canopies with a mass of small diameter

upright branches. They were all supported with large bamboo tripod stakes. The landscape site managers confirmed that the trees did not receive any special horticultural maintenance, but were simply watered as other trees. As the trees were seen to be growing and in full leaf they were assumed to be healthy.

No treatment was made of the cut wounds or preventive measures taken against pests and disease. Despite outward appearance of vitality, each of the trees had sizeable pruning wounds, although these were mostly obscured by surrounding foliage and water sprouts. None of the wounds observed had closed significantly, and the surface condition was generally very poor with areas of bark dieback, incipient decay, and signs of insect attack wounds.

Understanding tree responses to extreme transplantation

The extreme approach taken with these very mature specimens seems to contradict established science and technical guidance on transplanting trees. Considering arboricultural responses to typical transplanting operations and physical damage helps us to understand how these trees are able to survive this extreme form of transplanting. It also allows us to reflect on the different commercial and environmental values that are associated with transplanting mature trees.

To survive transplantation, a tree has

to overcome water stress which results from the reduction in water absorbing capacity due to the root pruning needed to facilitate relocation, while continuing to lose water through transpiration. Trees do not recover from water stress until they have regenerated enough new fine (<2mm dia.) water absorbing roots to restore water balance.⁷

The severity of the water stress suffered depends on the species. Those that have the highest chance of survival have:

- (a) high tolerance of root loss and ability to initiate and grow new roots in the soil outside the root ball,
- (b) high root : shoot ratio (a measure of the physical and physiological balance between root system and canopy),⁸ and
- (c) high vigour, as this gives the tree greater capacity to change its growth pattern to re-establish internal balance.

Transplanting is most successful when soils are moist and warm, and transpiration is low.⁹ Root pruning operations should not be undertaken during periods of natural shoot elongation.

American National Standards for Tree Care Operations provide guidance on the transplanting of mature tree specimens in the United States.^{10,11} These are based on established arboricultural research coupled with long practical experience. They emphasise approaches which minimise disruption and damage to the tree, and envisage that as much of the

mature tree's canopy as practical will be retained intact. In doing so, the volume of the root system moved with the tree should also be maximised.

The Standards suggest a root ball ratio (root ball diameter: trunk diameter) for trees >450mm trunk diameter to be minimum 8:1. Recent research in Hong Kong has indicated that root ball volume (as opposed to diameter) is a more relevant measure in this regard as it aligns closely with leaf area index (the measure of tree canopy), i.e. the water absorption capacity of the root system and transpiration through the canopy are in balance. The research studied examples of mature tree transplanting and concluded that it could be successful at smaller root ball ratios (5:1) if care was taken in mapping root systems and adjusting root ball shapes to match.¹²

Extreme transplantation practices observed in the nurseries, reflect an understanding of the water balance and transplant stress, but adopt an opposite strategy to the Standards. The removal of most of the roots (est. >95%) is off-set by the removal of all foliage. The constant watering of the roots and the trunk is intended both to reduce water loss through transpiration through the trunk and maximise water uptake through regenerating fine roots. This raises the question as to how they can re-grow without a functioning root system or foliage, and at what cost to the tree.

During periods of shoot growth, trees rely on stored carbohydrate energy to

initiate and grow new roots.¹³ After shoot growth ceases, root growth is supported by newly produced photosynthate. Extreme transplants, which have had all of their foliage removed, have to depend on carbohydrate stored in the trunk to initiate root growth. In mature trees, however, this should be adequate to support root growth, as a much higher proportion of total stored carbohydrate is in the trunk rather than in the root system,¹⁴ when compared to small trees. Further, transplanted trees require much less carbohydrate to produce new roots than established trees do to generate the constant turnover of fine roots. So it is possible for extreme transplants to grow sufficient new fine roots to absorb water to support a limited amount of top growth, based solely on trunk stored carbohydrate.

In the long term, the trees need to regenerate a significant proportion of their original root system to support a full canopy. The limited growth on the trees observed in the field suggests that they had yet to do this.

Extreme transplantation, requires other significant compromises in the long-term health of trees, which may overwhelm them before they have had a chance to re-establish their root and canopy systems fully.

Accepted transplanting practices embody the principle of retaining enough of the branching structure to allow the tree to regain a balanced form afterwards. In removing all the branches, extreme transplantation results in the complete loss of structural form. The dense new foliage observed at the top of re-planted specimens gave the appearance of healthy growth, but this consisted of a large number of small diameter water sprouts arising from the ends of truncated stems. The unbalanced canopy that is likely to develop from these, and the associated structural weaknesses, are likely to increase health problems for the tree in time. Thinning of water sprouts may help to address this, but may further compromise the appearance.

The density of the newly formed canopy with respect to the total loss of anchor roots may also make extreme transplants more susceptible to failure in typhoons.



Tree after one year in the nursery

This would also emphasise the necessity of thinning.

Pruning cuts require trees to devote energy away from growth and towards wound responses, so Standards recommend minimising cuts. Open wounds create a route for fungal infection and pest attack (notably termites) of the heartwood of the tree.¹⁵ Declining availability of resources in mature trees means that they have less capacity to respond to damage than younger specimens,¹⁶ and are likely to take longer to recover.¹⁷ Larger size wounds take proportionately more energy and longer time to close. Wounds on each of the extreme transplants seen in the nursery were so wide (dimensions

up to the diameter of the trunk), that they were not able to compartmentalise and close them. Indications of extensive decay were observed in many of the specimens.

Species that are able to survive extreme transplantation can be broadly divided into two groups; those with very active growth that allows them to respond rapidly to changes in growing condition, and those with dense, decay resistant wood.

The *Ficus spp.* trees transplanted this way are all strangler figs.¹⁸ They are fast growing and can initiate and produce new roots rapidly. Aerial root structures allow them to develop their root system



Brick wall structure containing the backfill soil



Dense pond mud cubes used as an open soil material in the new root ball

from multiple points, bypassing areas of damage or decay and taking advantage of different ground conditions. This is particularly the case for *Ficus microcarpa*, which has resulted in it being one of the most commonly transplanted tree species in Hong Kong, with one of the highest survival rates.¹⁹

In contrast, *Bischofia polycarpa* and *Cinnamomum camphora* are slower growing trees which are better at compartmentalising wounds, and have dense heartwood which is more resistant to insect attack and decay. This allows them more time to overcome the extensive pruning cuts inflicted during extreme transplanting. Both species appear to initiate shoots and roots from cut stems easily. Nursery owners reported successful cases where *B. polycarpa* trees, with 1500mm diameter trunks, were cut into multiple trunk sections and regenerated effectively as hard wood cuttings.

Survival is a relative term in tree transplanting. No specimens were observed in either the nursery or in the landscape projects that had successfully closed wounds. In the humid climate, decay and insects get into wounds quickly, and the size of the wounds on these trees were clearly too large for the tree to deal with. The effects may be hidden for a time, but there is a strong suggestion that these wounds start an inevitable process which leads to decline and death within a few years. In effect, the tree's adaptation and resistance probably keeps them alive and apparently healthy just long enough for the nursery owners to sell them.

Commodification of Nature

Extreme transplants have considerable commercial value, so why do landscape architects find them abhorrent?

First, the assumption that the value of the trees is disposable, i.e. used just to sell a property or give instant effect to new landscape, suggests that the trees are regarded as a commodity rather than a part of nature. It is sadly ironic that the value of the trees to buyers lies in their mature appearance (which has grown over decades), but due to their treatment that value is very short-lived.

It is not clear if buyers were unaware that the trees might have short life expectancies, or did not care. From discussions with nursery owners, it was apparent that these trees were bought solely for immediate, decorative effect. No concern was expressed that the trees may need to be replaced within a few years. Rapid obsolescence has been an accepted facet of property development in China for a long time, but is now beginning to manifest itself in associated landscaping works.

Secondly, this commodification of trees purely for profit, represents a despoliation of nature. Setting aside any sentimentality, trees of this size must have had significant ecological value in their original, natural settings, not to mention any possible cultural, heritage or amenity worth. The validity of the sources from which the trees were obtained, and the ethics of removing them, seem highly questionable.

Landscape architects undoubtedly come under pressure from their clients to use such trees, but as professionals entrusted with a duty of care for the environment, they should view the use of such trees as unacceptable.

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Re-planted extreme trees in an ornamental landscaping site in Guangzhou

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New top growth, after two years in the nursery



Cut stems quickly succumb to decay, which is often hidden by water sprouts

References

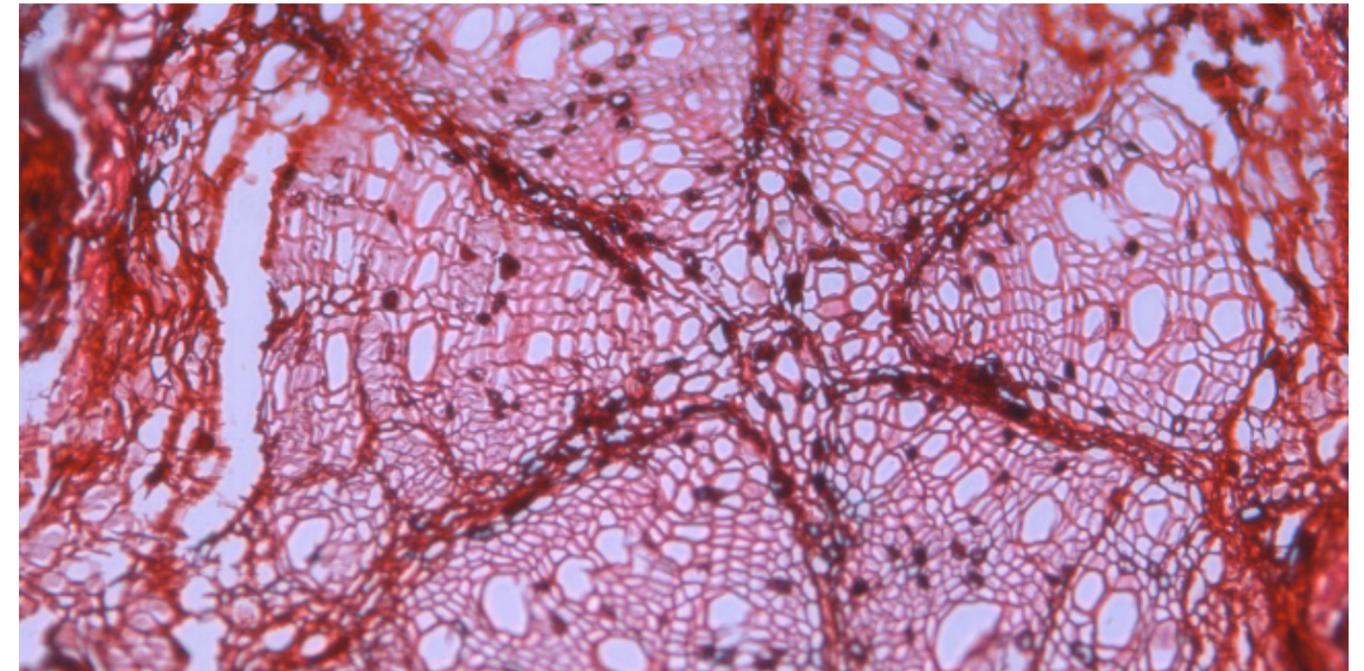
1. Notably in the cities of Guangzhou, Zhongshan, Zhuhai and Zhanjiang.
2. Extreme transplants have been used in landscape schemes in Hong Kong.
3. The total number of trees in stock in 2014 were 120, 260, 110, and 190
4. Period might coincide with the period of natural shoot development, during which root pruning can severely disrupt the internal system of a tree.
5. Peanut residue is a by-product of peanut oil extraction process, and has a small carbon-nitrogen ratio.
6. Trees have great difficulty in effectively compartmentalising the wounds from substantial heading cuts.
7. Watson, G.W. 1992. Root development after transplanting. In: Neely, D. and Watson, G.W. (eds.). The landscape below ground I: Proceedings of an international conference on tree root development in urban soils. International Society of Arboriculture. Champaign, Illinois, US. 55-68
8. South, D.B. and R.J. Mitchell. 1999. Determining the "optimum" slash pine seedling size for use with four levels of vegetation management on a flatwoods site in Georgia. U.S.A. Canadian Journal of Forest Research 29: 039-1046.
9. Harris, J.R., N.L. Bassuk, R.W. Zobel, and T.H. Whitlow. 1995. Root and shoot growth periodicity of green ash, scarlet oak, Turkish hazelnut, and tree lilac. Journal of the American Society for Horticultural Science, 120:211-216; Richardson-Calfee, L.E. and J.R. Harris. 2005. A review of the effects of transplant timing on landscape establishment of field-grown deciduous trees in temperate climates. HortTechnology, 15:132-135.
10. American National Standards for Tree Care Operations (2012) ANSI A300 (Part 6)-2012 Tree, Shrub, and Other Woody Plant Management – Standard Practices (Planting and Transplanting). Tree Care Industry Association Inc.
11. Tree transplanting operations in Hong Kong often mistakenly refer to arboricultural standards that have been written for the production of field grown nursery transplants, e.g. American Standard for Nursery Stock ANSI Z60.1 (2014) which covers tree with a trunk diameter up to 200 mm, and European Technical and Quality Standards for Hardy Nursery Stock (2010), which covers trees up to 190mm trunk diameter.
12. Pryor, M. and Watson, G. (2015) Mature Tree Transplanting: Science and Practice. (under review by Arboriculture and Urban Forestry journal)
13. Van den Driessche, R. 1987. Importance of current photosynthate to new root growth in planted conifer seedlings. Canadian Journal of Forest Research 17:776-782; Sloan, J.L. and D.F. Jacobs. 2008. Carbon translocation patterns associated with new root proliferation during episodic growth of transplanted *Quercus rubra* seedlings. Tree Physiology 28:1121-1126.
14. Kozlowski, T.T. and S.G. Pallardy. 1997. Physiology of Woody plants (Second Edition). Academic Press, New York, New York, US. 411 pp.; Esparza, G., T.M. Dejong, and S.A. Weinbaum. 2001. Effects of irrigation deprivation during the harvest period on nonstructural carbohydrate and nitrogen contents of dormant, mature almond trees. Tree Physiology 21:1081-1086.
15. Balder, Von H., D. Dujesiefken, T. Kowol, and E. Schmitz-Felten. 1995. Zur Wirkung von Wundbehandlungen an Wurzeln bei Eiche und Linde. Nachrichtenbl. Deut. Pflanzenschutzd. 47(2): 28-35.
16. Coley, P., J. Bryant, and F.S. Chapin. 1985. Resource availability and plant antiherbivore defense. Science 230:895-899.
17. Clark, J.R. and N. Matheny. 1991. Management of mature trees. Journal of Arboriculture. 17:173-183.
18. Strangler figs are epiphytes of the *Urostigma* subgenus of *Ficus*
19. Pryor, M. Demystifying Tree Transplanting. In proceedings of the International Arboricultural Society Hong Kong Conference 2010, Hong Kong (November 2010).

"Chinese Banyan grows rapidly with but little care, its foliage is of a glossy green colour, and it soon affords an agreeable shade from the fierce rays of the sun, which renders it particularly valuable in a place like Hong-kong'."

Robert Fortune, (1852).
A Journey to the Tea Countries of China

Aerial roots of *Ficus microcarpa*

Mathew Pryor and Li Wei



Section of flexible aerial root of *Ficus microcarpa*

This article reports on a study to investigate the nature of aerial roots in Chinese banyan trees, *Ficus microcarpa*, and the common belief that their presence and growth is associated with wet atmospheric conditions.

First, the form and distribution of free-hanging aerial roots on eight selected *Ficus microcarpa* trees growing in a public space in Hong Kong, were mapped on their form and distribution. Secondly the extension of selected sample aerial roots from each tree were measured over twelve months against prevailing atmospheric humidity. Lastly, section samples of aerial roots of different ages were taken, and the anatomical structure was observed and compared with that of terrestrial water-absorbing roots to assess the mechanism by which they might take up water.

The distribution and growth of aerial roots was observed to be highly variable, but there was a clear link between growth and high levels of atmospheric humidity. The anatomical structure of the aerial roots suggests that while aerial roots could absorb water under certain conditions, their growth was generated from water drawn from terrestrial roots via trunk and branches, and that the association with humid conditions was most likely to be due to the greater availability of ground water in such conditions.

Introduction

Chinese Banyan, *Ficus microcarpa*, is a native of Southern China and has been planted as a shade tree throughout the region for centuries. In Hong Kong, it has been planted as a roadside tree

since the beginning of the colonial period,² and was used almost exclusively for this purpose until the 1870s.³ The botanist Robert Fortune noted, as early as 1852,⁴ that the Banyan grew 'rapidly with but little care, its foliage is of a glossy green colour, and it soon affords an agreeable shade from the fierce rays of the sun, which renders it particularly valuable in a place like Hong-kong'. Even the Hongkong Governor, in 1881, observed that Banyans turned 'glaring roads to green avenues with the rapidity that would surprise arboriculturists in Europe'.⁵

It has been valued both for its shade and greenery, and its ability to cope with the typhoon winds and the poor growing environment in dense urban settings. The majority of Hong Kong's wall trees are *F. microcarpa*,⁶ and it is the species

that has been successfully transplanted most often at mature size within the Territory⁷.

‘Banyan’ is a generalized term used to refer to *Ficus* trees of the *Urostigma* subgenus of *Moraceae*, which includes tree species with aerial adventitious roots.⁸ A number of these grow in Hong Kong, e.g. *F. microcarpa*, *F. benjamina*, *F. benghalensis*, *F. elastica*, *F. macrophylla*, and *F. altissima*.⁹

The origin of aerial roots of *Ficus* trees has not been studied in detail. In Southern China, it is widely believed that the growth of aerial roots of Chinese Banyan is related to periods of high atmospheric humidity. Aerial root development is seasonal with the initiation and elongation of roots starting in spring with the rise in atmospheric temperature and humidity, and continuing until late autumn when humidity falls again.¹⁰ From this, it has been assumed that aerial roots are able to absorb water and nutrients from the atmosphere to sustain their growth. However, little research has been conducted on this point.

Gill (1975) notes that adult *F. microcarpa* trees produce slender, pendulous (free-hanging) aerial roots, i.e. roots exposed to air for at least of 50% each day and free of any support or substrate,¹¹ which under gravity grow downward. There is a high degree of variability between tree specimens in the number of aerial roots and their distribution within the canopy, but no clear indication of what factors influence this variability.

From simple field observations, there are three distinct stages in the development of aerial roots.

1. Growing tip – 1.5-2.0mm diameter, up to 120mm long, pale yellow, flexible but brittle,
2. Flexible aerial root – 2.0-5.0mm diameter, up to 10.0m long, dark reddish-brown, woody, flexible,
3. Lignified aerial root – >5.0mm (can be >100mm) woody, light grey, rigid.

In all three stages the longitudinal form of the root is variable from straight to very twisted, although they appear to become more twisted with the age. The growing tip will mature into a flexible aerial within two to three weeks. The



Typical pattern of aerial roots on a mature Chinese Banyan

flexible aerial will thicken into a lignified aerial within one to three years. The lignified aerial root has a similar appearance to a branch but does not bear foliage.

Aerial roots originate from a single point on a branch or stem, and as they grow they divide at the tip. Mature roots may have all three stages present, with a single lignified root giving rise to a cluster of many (can be <50 no.) individual flexible aerial roots and growing tips. The cluster is a self-contained system within which individual flexible aerial roots can intertwine, but do not fuse together.

Roots elongate very rapidly, and have been observed in a Miami based study to lengthen by up to 10mm per day.¹² Aerial roots arising in the upper canopy can

take several years to reach the ground or come into contact other stems or structures. Zimmermann, et al. (1968) describe the process of lignification of aerial roots in *Ficus benjamina*,¹³ a closely related species. When the flexible aerial root reaches soil it initiates and elongates terrestrial roots to absorb water and nutrients. This new terrestrial root system forms an anchor, allowing the above ground portion of the root to contract and straighten by producing tension wood. Finally, the root enters a consolidation phase, thickening to become prop stem to support lateral branches.¹⁴ Prop stems are noticeably straighter than lignified aerial roots that have not reached the ground.

Aerial roots produced from branches immediately around the main trunk or mature stems, may attach themselves to

the trunk or stem first as surface roots, and after they lignify may fuse with the stem, creating highly complex surface rooting structures.

Gill separately defines “clasping” aerial roots that are exposed, but remain appressed to some surface, as seen in the root fan of a wall tree. Aerial roots can also develop from the callus tissue around a bark injury which has severed the phloem,¹⁵ and have been observed to bridge over sizeable trunk wounds (spanning > 500mm), ultimately closing the wound altogether.¹⁶

Currently there has been no systematic study of the conditions under which flexible aerial roots occur on mature Chinese banyan trees, their presence and distribution within the tree, their growth rates, and how these might relate

to environmental conditions. Although aerial roots have been observed to absorb water under certain conditions,¹⁷ the mechanism by which they do so has not been investigated, and how this might affect the growth of the aerial root has not been assessed.

The objectives of this research study were to understand the role of flexible aerial roots in the growth and development of mature Chinese Banyan trees in Hong Kong. Specifically, to investigate:

- the occurrence of aerial roots within the tree, i.e. their number and broad distribution within the structure of the tree,
- the development and elongation rate of aerial roots, in relation to environmental conditions,
- the morphological structure of the

aerial roots at different developmental stages, and their potential for absorbing water from the atmosphere.

From these, an understanding of the nature of aerial roots and their role in the growth of the tree can be formed, which may help explain the predominance of Chinese banyans in manmade landscapes in Hong Kong.

Materials and methods

Eight mature *Ficus microcarpa* trees were selected for the study by random number from a set of 52 trees growing in paved areas in public spaces in Lei King Wan, Eastern District. They had all been planted at approximately the same time and were some 30 years old. The trees were healthy and vigorous, and growing in identical environmental conditions. They ranged from 9.0 to 12.0m in height, with trunk diameters of 0.24-0.55m (DBH), and average canopy spread of 9.0-13.0m. Landscape maintenance workers reported that free-hanging roots were periodically cut (typically twice a year) at approx. 2.0m above the ground, to prevent them from reaching the ground, and to avoid nuisance to park users.

First, the distribution of aerial roots within each tree was mapped. As no methodology for mapping aerial roots has previously been established, the following was devised for this study. The point of origin for each cluster of free-hanging aerial roots was identified and its distance from the centre of the tree was measured. The diameter of the stem at the point of origin was noted, together with its position within the cross section of the stem (stems divided into sectional quarters). The biomass of each cluster was calculated as the product of the aggregate diameter of aerial roots within the cluster and their average length (measured at the start of the study). Results for the percentage of total aerial root biomass for the tree by: (a) distance from the centre of the tree; (b) stem size; and (c) position of point of origin on the stem, are given in Table 1.

Second, the rate of elongation of roots was measured in relation to atmospheric humidity. Selected sample roots from each tree were tagged, and a reference point was identified on the root (typically the lowest branching junction). The



Mature *Ficus microcarpa* trees growing in a paved public space in Lei King Wan, HK



length of the root below the reference point was measured every week over a period of twelve months. The difference between successive measurements represented the elongation over the time interval. Records of the mean weekly atmospheric temperature and relative humidity for the period were obtained from the Hong Kong Observatory.

Lastly, specimens of flexible aerial roots were collected from two of the trees. Samples were taken from both the tip and the central portions of the aerial roots. These were cut into 10mm sections and fixed in FAA (Formalin-Acetic Acid - Alcohol) for at least 24 hours. Sections were embedded in paraffin after dehydration, then cut with 8-10µm on a rotary microtome, and finally stained with safranin and fast green. The sections were observed under a light microscope and photos taken with Motic Images Advanced 3.2 software. The anatomical structure was observed and analyzed to determine the ability of the different portions of the aerial roots to absorb water.

Results

Distribution of aerial roots

Amongst the eight trees, the number of root clusters varied considerably between the trees (from 1 to 44), with an average of 13.7 clusters per tree. The aerial root biomass also varied. The tree with just one small cluster measured at just 0.025 ltrs, while the largest tree with

the densest pattern of aerial roots, had a biomass of 38.5 ltrs. The radial distance of the point of origin of the roots from the centre of the tree was categorized into 1.0m intervals. The tree canopy spread (expressed as a radius) varied between 4.5m and 6.5m, although with the close arrangement of trees, canopies tended to be elongated along one axis. Nearly two thirds (62.3%) of the aerial root biomass was within 2.0m of the trunk which broadly reflects the proportion of the branch biomass within this distance of the trunk. 12.6% of the aerial root biomass was beyond 4.0m

from the centre. The majority (76.5%) was found on stems between 100 and 250mm diameter. Only one tree had roots on a stem >250mm, but only three of the trees had branches of this size. Only a few roots were found on small diameter stems (0-50mm), although on one tree these accounted for more than 10% of the total. Aerial roots were predominantly (85.8%) growing from the underside of stems, with only a small percentage growing from the two sides of the stem, and very few (1.7%) from the top side.

| | Low | High | Average |
|---|-----------------------------------|--------|---------|
| Number of aerial root clusters (no.) | 1 | 44 | 13.7 |
| Total aerial root biomass (ltrs) | 0.025 | 38.5 | 12.6 |
| Distance from the trunk (m) | Proportion of aerial root biomass | | |
| 0-1.0m | 0% | 66.0% | 37.6% |
| 1.0-2.0m | 21.8% | 100.0% | 24.7% |
| 2.0-3.0m | 0% | 28.8% | 15.3% |
| 3.0-4.0m | 0% | 18.4% | 9.9% |
| 4.0-5.0m | 0% | 12.1% | 7.5% |
| 5.0-6.0m | 0% | 8.6% | 5.1% |
| Stem diameter (mm) | Proportion of aerial roots | | |
| 0-50mm | 0% | 10.2% | 3.8% |
| 50-100mm | 0% | 25.1% | 12.4% |
| 100-150mm | 7.6% | 100.0% | 17.6% |
| 150-200mm | 0% | 59.8% | 28.4% |
| 200-250mm | 0% | 49.6% | 30.5% |
| 250-300mm | 0% | 19.1% | 7.3% |
| Position on the stem cross section | Proportion of aerial roots | | |
| underside | 76.9% | 95.5% | 85.8% |
| side | 4.5% | 19.2% | 12.3% |
| top | 0% | 4.4% | 1.7% |

Table 1. Distribution and position of aerial roots of *Ficus microcarpa*

Aerial root growth

Aerial roots selected for measurement were all active. They started elongating in late February and stopped sometime in October. Rate of root elongation varied over the course of the year, with April to August being the most active months (Table 2). There was little or no growth between November and February. In averaged measurements across samples from all eight trees, root elongation was greatest in May, with an average monthly increase 244.9mm. Roots extended on average by 1154.3mm over the year.

Individually the rate of elongation of flexible aerial roots varied very greatly between different roots. One root might elongate only a few millimeters in a month while its immediate neighbor within the same cluster might put on a few hundreds of millimeters of growth. The maximum elongation of any single root (from all samples) in one day was 17.4 mm, (321.8mm in one month 1983.4mm across the year)

Anatomical structure

The new aerial root tip, in section (Fig. 1), shows one layer of exodermis cells covering a broad cortex, consisting of 9-12 layers of parenchyma cells, arranged closely. The endodermis is not well defined. The roots have 4-5 xylem groups. A broad parenchymatous pith occupies the centre.

The radial longitudinal section through the new aerial root tip (Fig. 3), shows three distinct regions: division zone, elongation zone and differentiation zone, as would be expected in a terrestrial root structure. But the root tip has no root hairs in the differentiation zone. In the elongation zone, roots begin secondary growth. In detailed section (Fig. 4), the cork cambium differentiates cork outwards and phelloderm inwards. The epidermis, as the outmost cell layer, could be shed as the tree grows and includes many lenticels. Most lenticels on the epidermis are transversely orientated.

The mature flexible aerial root, in section (Fig. 2), shows many xylem vessels. Medullary rays cross the xylem. The broad cortex has been sloughed off and the parenchymatous pith has become lignified. Lenticels are raised. The radial longitudinal sections through the mature aerial root (Figs. 5 and 6), indicate more xylem vessels and some scattered sclereids.

Discussion

The distribution of aerial roots was highly variable. Some trees had very few or no aerial roots at all, while immediate neighbours (in the same environmental conditions), might have many hundreds. Although the trees were of the same age, their size (reflecting past growth) was very different. No relationship was observed between size of tree and presence of aerial roots. Small trunk diameter trees were as likely to have aerial roots, (and the same volume of aerial roots) as large trunk diameter trees.

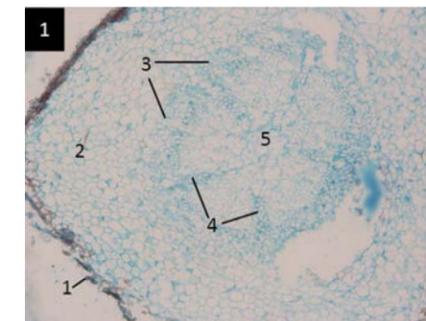


Fig. 1. Section of aerial root tip of *Ficus microcarpa*. X10. 1. Exodermis, 2. Cortex, 3. Endodermis, 4. Xylem, and 5. Broad pith.

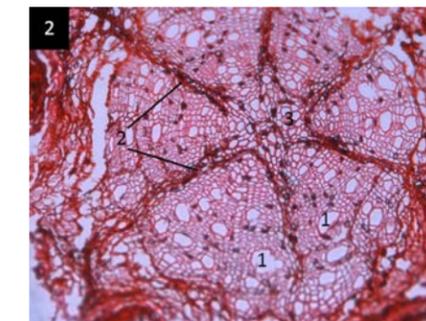


Fig. 2. Section of flexible aerial root of *Ficus microcarpa*. X10. Cortex has been slough off. 1. Xylem vessels 2. Cortex 3. Pith

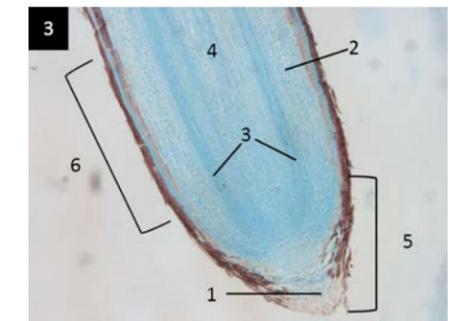


Fig. 3. Radial longitudinal section of an aerial root tip of *Ficus microcarpa*, (x5). 1. Root cap; 2. Cortex; 3. Xylem; 4. Pith; 5. Division zone; and 6. Elongation zone

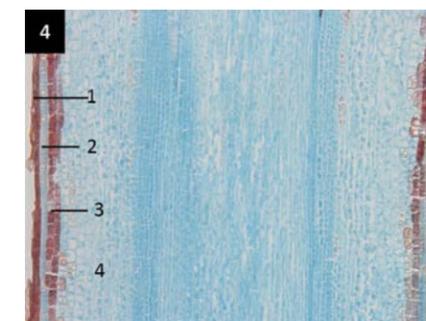
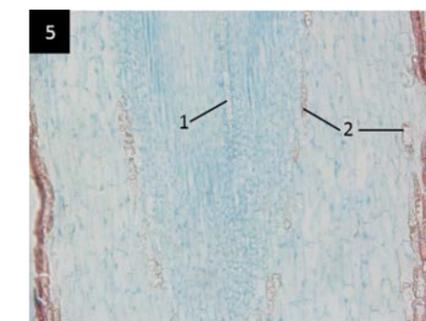


Fig. 4. Detailed radial longitudinal section of an aerial root of *Ficus microcarpa*, (x10). 1. Epidermis; 2. Cork; 3. Cork cambium; and 4. Phelloderm



Figs. 5 & 6. Detailed radial longitudinal section of a flexible aerial root of *Ficus microcarpa*, (two samples, x10). More xylem vessels exist in mature part of aerial root. 1. Xylem vessel; and 2. Sclereids.

The distribution of aerial root biomass within the canopy appeared to follow the distribution of branch and twig biomass within the canopy, with the greatest proportion being close to the trunk. Broadly, the distribution of aerial roots around the canopy was even, i.e. roots did not tend to grow just on one side.

Aerial roots were observed to originate from all sizes of branch, some as small as 25mm diameter. A higher proportion of aerial root biomass were growing from larger diameter branches, compared to smaller branches, but this was probably because of their relative age.

Aerial roots were initiated, very largely, from the underside of branches. This is likely to reflect the more humid conditions there, compared to the upper side, with rain water naturally draining to the lower side, and it being less exposure to sunlight. The fact that a few roots initiated on the sides and upper surfaces of branches suggests that initiation is not related to whether the wood is in compression or tension.

The pattern of growth in aerial roots was also highly variable, with some roots growing very vigorously alongside others, in the same conditions, that were hardly growing at all. Initiation of new roots and elongation of existing roots was clearly related to high levels of atmospheric humidity (relative humidity and rainfall). Substantial growth was recorded in the wet summer months, while no growth was observed during

the dry winter months. Rate of growth in individual roots was inconsistent. Some grew steadily throughout the summer, others would grow quickly then stop. Averaged maximum daily extensions for the five months June, July, August, Aril, and May ranged between 10.1 and 12.4. This is in line with measurements recorded in the Miami study.

With an average annual elongation of 1154.3mm, the vertical distance from the upper canopy to the ground, equated to several years growth. The rougher bark of the flexible roots, with raised lenticels, served to prevent them from fusing together (as was observed in the lignified aerial roots), allowing their free movement during this time.

It was noted that where a root tip stopped growing and had matured into a flexible aerial root structure, further growth tended to be initiated through side shoot rather than extension of the existing root i.e. roots divided (ramified) hence the multiple roots were usually found in clusters. Further, it was noted that aerial roots grew by elongation rather than by thickening, possibly to enable them to reach the ground as quickly as possible, while minimizing demand on energy resources.

Characteristics and ability to absorb water

The structural characteristics of aerial root tips and flexible aerial roots of *F. microcarpa* observed in this study can be compared with root tips, flexible aerial

roots and fine <2mm water absorbing terrestrial roots of *F. benghalensis* as described by Kapil and Rustagi¹⁸ (Table 2). The aerial roots of the two species are fundamentally alike, and both have distinct pith but lack of root hairs. These two characteristics make them more resemblance to stem than terrestrial roots. Kapil and Rustagi also note that the structure of aerial roots of *F. benghalensis* has greater resemblance to stems. More vessels exist in secondary xylem in *F. microcarpa* than *F. benghalensis*.

Root hairs, however, are just structures that substantially increase the absorbing surface of the roots, and the absence of root hairs would not prevent aerial roots from absorbing water. As Esau notes, hairless epidermal cells are capable of absorbing water.¹⁹

In terrestrial absorbing roots, water passes from the absorbing cells to the conducting tissues. Esau identifies that the notable features of this pathway are: the presence of abundant intercellular spaces in the cortex but the lack of such spaces in the vascular cylinder; together with the presence of a specialized endodermis between the cortex and vascular cylinder.

In new aerial root tips of *F. microcarpa*, cells in the cortex and vascular cylinder are closely arranged with few intercellular spaces. The endodermis is also not clearly defined. This would suggest that new aerial root tips cannot absorb water and conduct it to the xylem

| Species | <i>Ficus microcarpa</i> | | <i>Ficus benghalensis</i> (after Kapil and Rustagi 1966) | | |
|----------------------------|-------------------------|---|--|---|---|
| | Aerial root (new) | Aerial root (mature) | Aerial root (new) | Aerial root (mature) | Terrestrial absorbing root |
| Root Hair | Absent | Absent | Absent | Absent | Present |
| Cortex | 9-12 cells thick | Sloughed off | 20-25 cells thick | Sloughed off | 8-15 cells thick |
| Endodermis | Poorly defined | Poorly defined | Poorly defined | Poorly defined | Better defined |
| Xylem strands | 4-5 groups | Absent | Usually 5-7, occasionally 10-15 | Absent | Usually 3 or 4, rarely up to 7 |
| Pith | Distinct and board | Lignified | Distinct and large | Lignified | Absent or scanty |
| Secondary vascular tissues | Absent | Less of parenchyma, many vessels, well developed medullary rays | Absent | Many fibres, less of parenchyma, fewer and smaller vessels, poorly developed medullary rays | Few fibres, more of parenchyma, numerous and large vessels, well developed medullary rays |
| Periderm | Well developed | Well developed | Well developed | Well developed | Poorly developed |
| Lenticels | Many | Many | Many, raised, transversely oriented | Many | Scanty, scattered |

Table 3. Characteristics of aerial roots of *Ficus microcarpa* and *Ficus benghalensis*

in the same way as terrestrial roots.

In mature aerial roots of *F. microcarpa*, existing vessels serve as conduits. Water is actually drawn up from roots and transported to branches and leaves through vessels. The hanging aerial roots can be likened to branches of their parent stem. Water moves from branch to aerial roots through vessels in the flexible aerial roots.

The role of radially orientated ray tissue is the uptake of water through the outer surface of twigs²⁰. The well-developed rays observed in transection of the

flexible aerial roots of *F. microcarpa* might act in a similar way, allowing uptake water and movement to the conducting vessels.

In terrestrial roots of dicotyledonous plants, water usually flows from high soil water potential to low root water potential, and is then transported up the stem and leaf by evaporation. The reverse may occur if the water potential gradient is reversed.²¹ Some experiments show the water can flow into limbs under external pressure through xylem vessel of cut limbs.^{22,23} The external pressure plays an important role in uptaking water through leaves and branches. Aerial roots of other plant types such as epiphytic orchids have been shown to be anatomically adapted to absorb water.^{24,25} Epiphytic orchids uptake water and nutrients efficiently via a multilayered velamen arising from the epidermis.^{26,27} But aerial roots of *F. microcarpa* do not have such anatomical features.

Liu (2011) observed that aerial roots of *F. microcarpa* have CO₂ and water vapor exchange functions, and concluded that new aerial roots were active in CO₂ intake and H₂O release, and flexible aerial roots had weak respiration and transpiration activity. Aerial root tips could only absorb water in very high (almost 100%) relative humidity. In flexible aerial roots,

CO₂ intake was reduced but they could absorb water like a sponge/activated carbon in at least 75% relative humidity conditions.

Conclusion

The occurrence and distribution of aerial roots in *F. microcarpa* trees, and the initiation and elongation of aerial roots was highly variable. Trees growing in identical conditions often had very different aerial rooting patterns. Even in very wet conditions, some roots grew, others did not.

When aerial roots did grow, it was at times of the year, in environmental conditions, and at locations within the canopy and on the originating branch, that were associated with wet atmospheric condition. This supports the common belief that their presence and growth is linked to water availability.

From the detailed study of the cellular structure of the aerial root tips, however, it was clear that the secondary vascular tissues and cells are not closely arranged, and they do not have structures to absorb water. The more mature, flexible aerial roots were observed to have structures (lignified surface tissues, many vessels and medullary rays) that would allow the absorption and movement of some water, but as Liu²⁸

| | Growth rate (averaged across samples from eight trees) | | Relative Humidity | Rainfall |
|-----------|--|--------------------|-------------------|--------------------|
| | Maximum daily (mm) | Monthly total (mm) | Monthly mean | Monthly total (mm) |
| July 2014 | 10.1 | 187.8 | 80% | 260.5 |
| August | 10.8 | 201.3 | 81% | 548.2 |
| September | 8.0 | 73.7 | 77% | 140.6 |
| October | 4.1 | 12.1 | 71% | 109.8 |
| November | 0.3 | 1.1 | 78% | 31.1 |
| December | 0.0 | 0.0 | 67% | 44.7 |
| January | 0.0 | 0.0 | 72% | 41.7 |
| February | 0.4 | 1.2 | 78% | 32.0 |
| March | 5.1 | 38.3 | 85% | 28.4 |
| April | 11.9 | 196.2 | 77% | 65.4 |
| May | 12.4 | 244.9 | 85% | 513.0 |
| June 2015 | 10.5 | 198.7 | 80% | 291.0 |

Table 2. Observed growth rates of aerial roots



observed, this only occurred under high levels of atmospheric humidity. As roots were observed to be growing throughout periods where relative humidity was relatively low (70-80%), rapid elongation of the root tips is most likely to be based on water (and nutrients) drawn up from terrestrial roots and conducted along branches. The presence of many conducting vessels and well developed medullary rays in the cellular structure of flexible aerial roots suggest that their function is the transportation of water rather than its absorption from outside.

The link between the aerial root growth of Chinese Banyans and wet conditions, therefore, may be associated with their ability to take advantage of wet ground conditions, i.e. uptake water through their terrestrial roots and move it quickly within trunk and branch structures, rather than an added capacity of absorbing water through the aerial roots themselves.

References

- Liu, Liying, Fu Xiangzhao, Luo zhiqiang, Guo Xinxiang. (2011). Gas exchange characteristics of aerial root and affecting factors of *Ficus microcarpa* (In Chinese). 19(1): 45-50.
- Pryor, M (2015) Street tree planting in Hong Kong in the early colonial period (1842-98), *Journal of the Royal Asiatic Society Hong Kong Branch* 2014.
- Ford, C. (1872). First annual report on the Government Gardens and Tree Planting department, HKGG, 1 February 1873. Surveyor General's letter to the Acting Colonial Secretary on 'Tree Planting'. HKGG 17 November 1877. Chinese Banyan (*Ficus microcarpa* L.f.), also referred to as *F. retusa* or *F. nitida* at the time.
- Fortune, R. (1852). *A Journey to the Tea Countries of China*. John Murray, London
- Pope Hennessy, J. 'The Governor's Report' HKGG 29, April 1881. para 133.
- Jim, C. Y. (2014). Ecology and conservation of strangler figs in urban wall habitats. *Urban Ecosystems*, 17(2), 405-426.
- Pryor, M. *Demystifying Tree Transplanting*. In proceedings of the International Arboricultural Society Hong Kong Conference 2010, Hong Kong (November 2010).
- Wu, Z. Y., P. H. Raven & D. Y. Hong, eds. (2003). *Flora of China*. Vol. 5. Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis. 37-71.
- Hong Kong Herbarium, HK Plant Database <<http://herbarium.gov.hk/introduction.aspx>>
- Anecdotal comments from growers and nurserymen in Guangzhou
- Gill A.M. (1975). Aerial roots: an array of forms and function. In Torrey J.G. and Clarkson D.T. (Ed.), *The development and function of roots*. Academic press. 237-260.
- Gill 'Aerial roots'
- Zimmermann, M., Wardrop, A., & Tomlinson, P. (1968). Tension wood in aerial roots of *Ficus benjamina* L. *Wood science and technology*. 2(2): 95-104.
- Barlow, P. W. 1986. Adventitious roots of whole plants: their forms, functions, and evolution. Pp.67-110. In: *New root formation in plants and cuttings*. Springer.
- Kozłowski, T.T. (1971). Root growth. In *Growth and development of trees II*. Academic press. 196-250.
- Author's unpublished research on sources of damage of trees during transplantation
- Liu (2011)
- Kapil, R.N. and Rustagi, P.N. (1966). Anatomy of the aerial and terrestrial roots of *Ficus benghalensis*. *Phytomorphology*. 16: 382-386.
- Esau, K. (1953). *Plant Anatomy*. Chapter 17. The root. John Wiley & Sons, INC. 470-529.
- Katz, C., Oren, R., Schulze, E.-D., & Milburn, J. (1989). Uptake of water and solutes through twigs of *Picea abies* (L.) Karst. *Trees*. 3(1): 33-37.
- Cook, R., & Papendick, R. (1972). Influence of water potential of soils and plants on root disease. *Annual review of phytopathology*. 10(1): 349-374.
- Baxter, P., & West, D. (1977). The flow of water into fruit trees. II. Water intake through a cut limb. *Annals of Applied Biology*. 87(1): 103-112.
- Granier, A., Anfodillo T., and Breda, N. (1994). Axial and radial water flow in the trunks of oak trees: a quantitative and qualitative analysis. *Tree Physiology*. 14(12): 1383-1396.
- Zhang, Z. (1995). Anatomical structure of the nutritive organs of *Dendrobium candidum*. *J Anhui Agri Univ*, 1995, 22(3) : 301- 304. (in Chinese)
- Li, M., Su J. L., Wu R. H., et al (2001) Anatomical study on the nutritive organs of *Dendrobium candidum*. *J. Henan Agri Univ*, 2001, 35(2) : 126- 129. (in Chinese)
- Bowes, B.G. and Mauseth, J.D. (2008). *Plant structure. A colour guide*, Second Edition. Manson publishing.
- Zotz, G., Winkler, U. (2013). Aerial roots of epiphytic orchids: the velamen radicum and its role in water and nutrient uptake. *Oecologia*. 171(3): 733-741.
- Liu, Liying, Fu Xiangzhao, Luo zhiqiang, Guo Xinxiang. (2011). Gas exchange characteristics of aerial root and affecting factors of *Ficus microcarpa* (In Chinese). 19(1): 45-50.

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*Lignified aerial roots on *Ficus elastica*, on Lugard Road, The Peak*

'There are still many bare areas along the margins of our footpaths and roadsides but patches of green can often be seen spontaneously popping up in the nooks and crannies of the concrete jungle. These self-seeded plants are an unplanned and unintentional feature of the urban environment. Can the "unplanned" vegetation be "planned" to further green our city?'

Gap Chung Wai-kin

An alternative way to green the city: Unplanned vegetation in Hong Kong

Gap Chung Wai-kin

In densely populated Hong Kong, both public and private sectors are carrying out active planting, maintenance and preservation of plants to enhance greening in the urban areas. There are still many bare areas along the margins of our footpaths and roadsides but patches of green can often be seen spontaneously popping up in the nooks and crannies of the concrete jungle. These self-seeded plants are an unplanned and unintentional feature of the urban environment. This research project investigates unplanned vegetation as an alternative way to green the city where every square inch counts. It examines the planning, design intervention and management of self-seeded vegetation and its promotion as a sustainable greening strategy. Can the "unplanned" vegetation be "planned" to further green our city?

Existing greening in Hong Kong

Greening works in the urban areas of Hong Kong currently focus mainly on ornamental planting in gardens, parks, housing estates, roadsides, drainage reserves and green roofs. Most need regular and intensive maintenance to keep them tidy and attractive. Development land is scarce as described by the HKPSG¹ 'Developments within these limited land resources have necessarily resulted in a compact urban form with limited scope for provision or preservation of greenery.' Historically the limited land supply has resulted in extremely high land values and greening has usually been something of an afterthought compared to the architectural and technical priorities of development. As a result, greening often ends up relegated to plant pots or narrow strips in locations which are not conducive to healthy plant growth,



Pilea microphylla

or even replaced entirely with artificial plants for ease of maintenance. At the same time, most self-seeded vegetation is regarded as a nuisance and we spend a lot of resources trying to remove these so-called untidy weeds. Self-seeded 'wild' plants that do survive tend to be found in areas where the administrative or maintenance authority is unclear with the result that no one is willing to remove them, or where access is difficult such as walls above street level or inaccessible highway barriers.

Opportunities for naturalised and self-seeding plants

In the past five years, Government has planted 44.3 million plants in Hong Kong, 75% being shrubs and 10% annuals.² Annuals are usually used for seasonal decoration or special events, some shrubs struggle in adverse growing conditions or are damaged. Only 10% of these plants are trees and of those only one in ten is planted in the urban areas. We need to look for a more sustainable



Pocket park with pots

way to green the urban areas. In Hong Kong 74,100 ha (67%) of the land area is woodland, scrub, grassland and wetland,³ we should take advantage of this natural resource which is constantly producing seeds, and let Mother Nature plant for us. This additional greening option for Hong Kong's urban area should be flexible, adaptable and scalable to fit the fast changing Hong Kong urban environment. Such a greening policy should incorporate a strong (excuse the pun) grass-roots element, to encourage more citizens to appreciate the value of self-seeded vegetation.

Self-seeding plants in Hong Kong

There are many different types of self-seeded plants in our concrete jungle, including algae, mosses, ground covers, herbs, ferns, climbers, grasses and trees, and even succulents. They come in many shapes and sizes, and take advantage of many different urban conditions. Their flowers and foliage provide colourful highlights in the grey concrete monotone. Most of these pioneer and opportunistic plants seed themselves freely. They exploit a variety of strategies to distribute their seeds and expand their territory. Most have tiny seeds which can gain a foothold in very small crevices. Self-seeded plants occur everywhere in the urban areas and may either invade existing planting areas or take advantage of openings in places not intended for planting such as in walls or footpaths.

Existing planting areas usually have a comparatively rich growing medium and water supply allowing self-seeded plants to establish easily, especially where the original planting has aged or failed for some reason. Areas not designed for plants usually have nooks and crannies that accumulate litter and organic matter which in turn provides nutrients and moisture to seeds and spores that find their way into these habitats. Besides physical conditions, there are other factors affecting the survival rates of unplanned vegetation, so you may find the performance of the same species varies widely between different districts and environments. The survival of these opportunistic plants is largely determined by the accessibility and use of the space. Areas that are

heavily trafficked, regularly maintained and cleaned offer little prospect for successful establishment. Water availability is also critical with some locations offering more scope for would-be invaders thanks to drain blockages, regular spillage, overflow or leakage.

Value for the City

Unplanned, out of control vegetation is often considered messy, and blamed for causing nuisances such as mosquitos and bad smells. However, ornamental planting areas may well fare just as badly due to design defects, littering, or poor management and maintenance. In fact unplanned greening provides most of the public benefits associated with ornamental plants, such as improving air quality, reducing the urban heat-island effect, moderating soil erosion, stabilizing slopes, reducing storm water runoff, etc. They also have additional benefits including easy establishment, rapid growth rates, and high tolerance of extremely adverse site conditions, thereby reducing landscape installation and maintenance overheads. Annual plants exhibit seasonal changes, and some wild vegetation is edible or has medicinal uses. They provide habitats for many insects and birds in the urban environment, and contribute to the natural process of soil development, while providing passive recreation and educational opportunities for the community. In fact unplanned vegetation serves as an indicator of space that is not used for other functions in the urban fabric. Some monitoring and control measures are required to deal with problematic species such as *Mikania micrantha* and *Leucaena leucocephala*,

which are “hazardous to the native plants, reduce the biological diversity, and affect the ecosystem.”⁴

Research intention

The overall objectives of the project are to explore how unplanned vegetation can be employed to connect the city with surrounding nature and enhance its ecological diversity. The definition of greening can be widened to incorporate this effective and sustainable method and reduce the financial and environmental cost of greening. Why remove all the “weeds”? We should recognize their intrinsic value.

Strategies to achieve these objectives include promoting the idea of harnessing the power of plant naturalization, and explaining the value of small scale interventions using ‘wild’ plants. A change of attitude is advocated to appreciate the value of unplanned vegetation, turning it from a nuisance to a resource that can provide another alternative approach to urban greening.

Proposed actions under these strategies fall into three categories. First, cultivate a positive relationship between society and this aspect of ecology by means of a community-based greening approach that adopts greening interventions using ‘wild’ plants. Secondly, provide design intervention guidelines and management strategies for Government, landscape architectural professionals, and the wider community. Thirdly, implement demonstration projects to show the advantages of self-seeding plants and benefits of using them as a greening method.



Highway intervention - Detail



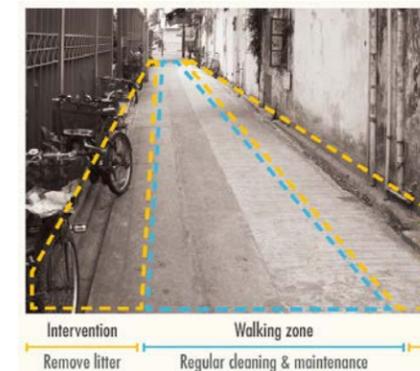
Highway intervention



Alley intervention - Detail



Grass growing in paving gaps



Proposed management in alley intervention



Alley intervention

Site selection

In contrast to the traditional top-down city planning process, greening with self-seeding plants should take a more grass-roots approach, because local citizens understand more about their own local community. Firstly, a task force should be set up including community groups, government sectors and professionals, to explain the value of unplanned vegetation to the community. Secondly, community groups can identify locations which already have significant unplanned vegetation and suggest locations which they think require additional greening, so that the task force can review these possibilities and identify suitable interventions and species. Thirdly, the task force should establish a schedule

of work based on the agreed outcomes, engaging the community in preparation and construction wherever safe to do so. Community involvement in this sustainable greening method can increase local residents' sense of belonging to their district, and enhance their environmental awareness, so that greening becomes more than just cosmetic.

Design Intervention

Here we have three distinct types of intervention for typical Hong Kong urban conditions, namely brick paving, alleyways and highway median barriers. The interventions are flexible, adaptable, and scalable. They are flexible with several options for each

type of situation, applied according to the requirements and restrictions. Most of them can be adapted to the existing situation easily with simple modification. This makes the greening process more sustainable. They can be implemented at any scale, on the basis that many little interventions ultimately add up to something significant! The integrated design includes a water retention mat and reservoir layer which can keep water inside the system, keeping the soil moist during the dry season. The success of these measures can be assessed by the establishment of wild plants and their ability to sustain themselves, their greening effect and contribution to the local ecology.

Cost

The cost of self-seeding plant interventions are generally lower than conventional ornamental planting, because most of the wild plants can be established by seed which is much quicker and cheaper to implement and more likely to survive in the urban situation. Reduced maintenance requirements will lower ongoing costs of greening. As the definition of greening is widened, more areas can be set aside for greening, creating jobs for professional and technical staff.

Management

Systematic management is essential with regular inspection, localised trimming to ensure user safety, and removal of invasive species. In any given area, existing self-seeded plants may be retained because they help indicate which areas are appropriate for further greening, and provide a living in-built seed bank. Existing poor quality 'ornamental' plants may be removed from existing planting areas. Where structural considerations permit, self-seeded plants may be retained on structures and walls. In alleyways with low pedestrian flow, the paving arrangement can be reviewed, opening up unused areas for planting. Growing medium can be brushed into crevices and sown with common wild plant seeds. Litter can be removed with pick-up tongs, avoiding brooms or water-jets which easily dislodge growing

medium and seeds. In areas that are not accessible and where user safety is not affected, zero-maintenance may be appropriate and the plants allowed to grow wild. This achieves the goals of sustainable greening and saves costs.

Promotion of wild plants

Community acceptance is one of the key issues. School visits and community sharing sessions will be key to raising public awareness about the value of this kind of planting. Through community action, such as green workshops, citizens can make themselves more familiar with these plants, harvest seeds in person, and instigate sustainable community landscapes where they can help to sow wild plant seeds and get involved with their ongoing management.

'Unplanned vegetation' is a feasible and sustainable way to green our urban environment and enhance the ecology of the city. Attitudes will change as we understand the value of small scale interventions by wild plants. It is said 'great oaks from little acorns grow'. Many small greening interventions of this kind can add up to a great transformation of the city!

Gap Chung Wai-kin was an MLA Thesis Student (graduated 2015) at the Division of Landscape Architecture at the University of Hong Kong.

References

1. Planning Department, HKSAR. Hong Kong Planning Standards and Guidelines (HKPSG), 2007, Ch4: 2.1.3 Development Bureau, HKSAR.
2. Planting Records. Accessed from <http://www.greening.gov.hk/en/people_tree_harmony/planting_records.html>
3. Planning Department, HKSAR. Land Utilization in Hong Kong 2014, Accessed from <http://www.pland.gov.hk/pland_en/info_serv/statistic/landu.html>
4. Legislative Council HKSAR. LCQ15: 2011. Proliferation of Mikania micrantha in rural areas and criteria in selecting plant species. Accessed from <<http://www.info.gov.hk/gia/general/201103/09/P201103090123.htm>>



School children preparing the ground for seeding with wild plant species.



The ground seeded and established



Brick paving intervention - Detail



View of Yuen Long Town Park from the Pagoda

Amenity and sports turfgrass in Hong Kong

Eric YT Lee, PhD

Turfgrasses are plants that form a more or less contiguous ground cover which persists under regular mowing and traffic.¹ They were selected through years of experience and practice. All turfgrass belong to the grass family (*Poaceae* or *Gramineae*). Of the approximately 600 genera and 7,500 species, only a few dozen are being used as turfgrass and they are randomly distributed among 8 of the 25 genera in the family. Quality of turfgrass is determined by its texture, usually the finer the better, tolerance to wear and tear, quick recovery rate and more recently tolerance of contaminants. In Hong Kong there are some 20 native and introduced turfgrass species.² Prior to the 1970s, only mixed grasses were used for amenity and sports turf. Carpet Grass or Big-Leaf Grass (*Axonopus compressus*), because it was readily available in the wild, became the predominant and preferred grass species for amenity and sports fields. Grassing works were carried out by 'sodmen'. Classification of sods was more or less done on percentage of the named grass against the other locally grown grasses. If the sod contained about 70% of Carpet Grass and 30% of other grasses, such as Tilo Grass (*Paspalum conjugatum*), Knotgrass (*P. distichum*) and Wild Oat Grass (*Chrysopogon aciculatus*), the grass was called '3/7 grass.' Sods were harvested mainly from abandoned fields in the New Territories where they formed natural colonies. After planting, not much follow up maintenance would take place, except initial watering as there was a general myth among the sodmen that grass grown roughly should be nursed roughly.

In Hong Kong as elsewhere, turf management has evolved from a craft to a science in the last four or five decades. Hong Kong Golf Club should be credited

for the breakthrough, as in the early 1970s, the Club introduced the then newly improved hybrid Bermuda grass, namely Tifton 419/Tifway and Tifton 328/Tifgreen (*Cynodon dactylon* x *C. transvaalensis* cv. Tifway and Tifgreen) into its golf courses, together with new propagation methods, e.g. stolonization. This was a landmark in local turf management history, and a big step forward. The practice has since been adopted by many major local institutes such as the Hong Kong Jockey Club and Hong Kong Cricket Club. Subsequently, many newer turfgrasses were introduced into this region, e.g. TifDwarf in the 1980s, TifEagles and several improved varieties of the Seashore Paspalum grasses at the beginning of the 21st century.

Of the 20 or so turfgrasses known locally, only five are commonly used for amenity, sports and/or erosion control purposes. They are the common and the improved Bermuda Grass (*Cynodon dactylon*), Korean Grass (*Zoysia japonica*) and Manila Grass (*Z. matrella*) the two *Zoysia* Grasses, Carpet Grass, usually mixed with Tilo Grass, and Bahia Grass (*Paspalum notatum*); the other turfgrass species, mainly because of their limited availability, are

seldom used. Perennial Ryegrass (*Lolium perenne*) is used for over-seeding and hydro-seeding purposes. Weeping Love Grass (*Eragrostis curvula*), a bundle-type grass, is commonly used in hydro-seeding for slope protection, because of its quick germination rate and easy establishment.

Turfgrass species

Common and Improved Bermuda grass

Common Bermuda Grass (*Cynodon dactylon*) though a native grass, has not been widely used for amenity and sports fields because of its inferior characteristics such as coarse texture, long internodes and poor matting. Seeds of Common Bermuda Grass are readily available in the market and the grass is specified as a pre-dominant grass component for hydro-seeding or erosion control.

Seeds of Improved Bermuda grass are now readily available in the market. Specifiers should take the initiative to use the finer and better varieties in the future. Improved Bermuda Grass is also referred to as Hybrid Bermuda Grass. Merits of these hybrids include better turf character and better response to



Common Bermuda Grass



Hybrid Bermuda Grass - Tifway

cultural practices. Since its introduction to Hong Kong in the early 1970s, these improved varieties have been used widely in nearly all the local golf courses and some sports fields. Quite recently, some ultrafine strand selections, e.g. TifEagle, have been used on greens of golf courses.

When properly maintained, Hybrid Bermuda Grass stays green throughout the cooler months in Hong Kong. For aesthetics and also for increased turf density, Perennial Ryegrass is commonly used for over-seeding dormant Bermuda Grass fields.

The use of shade-tolerant varieties such as TifGrand and others should be considered for turf facilities with potential shade issues.

Carpet Grass

Although Carpet Grass (*Axonopus* spp.) is a preferred grass in nearly all government tender specifications for the construction of sports turf facilities, it does not meet the standards set by national and international authorities, e.g. numbers of shoots per unit area. The successful change of the Employer's Requirements (Tender Specification) from Carpet Grass to Hybrid Bermuda grass for hosting the East Asia Games in 2009 serves as an excellent precedent.

Although Carpet Grass is best known for its poor turf quality, coarse texture, (i.e. wide leaf blade), shallow rooting, poor wear and tear resistance, and poor winter colour, as a low maintenance turfgrass, it remains a desirable grass for amenity areas and also for less demanding sports fields.

Based on my observation, in most Carpet Grass based amenity or sports fields, a large percentage of Tilo Grass was found. This is because some of the turfgrass growers cannot distinguish the two in their nursery. The contamination actually originated from the production site. The two types of turfgrass blend in well in the field as both of them share more or less the same turf character, e.g. texture, creeping pattern and growing pattern. They grow harmoniously side by side. Tilo Grass, however, is characterized by a longer greening period: it turns brownish later than Carpet Grass during the onset

of winter and turns green earlier in Spring than its counterpart.

Seeds labeled as 'Carpet Grass' can be purchased from seed companies in Australia. Grass produced from these seeds is identified as a different species in the same genus, i.e. *Axonopus affinis*. This grass is characterized by much narrower, boat-shaped leaves and a much longer, slender and, protruding

flowering stalk. Since 'Carpet Grass' is listed as one of the acceptable constituents of hydro-seeding in Hong Kong, people often mix this up with the other Carpet Grass (*A. compressus*) and use it occasionally in their seed mix. *A. affinis* can be found in small patches in some amenity and sports fields but it is never considered a good quality turfgrass locally.



Tropical Carpet Grass



Tilo Grass



Carpet Grass

Zoysia Grass

Korean Grass (*Zoysia tenuifolia*) is characterized by coarser leaf blades and less dense sod. This grass is not commonly used in Hong Kong as its availability is limited.

Manila Grass (*Zoysia matrella*) is perhaps the most commonly used turfgrass for home lawn, gardens and at times for sports turf as it is readily available in the market and the price reasonable. Small Manila Grass sod farms are common in Shenzhen, Zhuhai and Guangzhou. The price is relative cheap, i.e. about \$1 per square foot.

Although Zoysia Grass is known for its tolerance of medium traffic, if the wear and tear exceeds its threshold, damage is permanent and recovery is very slow.

Zoysia Grass is difficult to maintain as it requires verti-cutting regularly to thin out the thatch. Otherwise, the grass turns patchy with time. Poorly maintained Zoysia Grass fields are prone to weed infestation.

In the past, seeds of Zoysia Grass were known to have a very low germination rate. With pre-treatment, the germination rate of Zoysia Grass seeds can be up to 98% and seeds can germinate in about one week. With this improvement, hydro-seeding contractors should consider Zoysia Grass seeds in their seed mixes for grassing projects in less fertile or arid sites, e.g. fill and soft cut slopes.



Korean Grass

Seashore Paspalum

Improved Seashore Paspalum (*Paspalum vaginatum*), namely Salam, Sea Isle Series, Sea Spray, etc. have only been available commercially in Hong Kong for some 10 years. Because of its high tolerance to salinity, it can take nearly all kinds of water for irrigation; hence it has been considered as an 'environmental' grass. Quite a few golf courses and amenity areas in Hong Kong have used this grass in their facilities, e.g. the Third Course at Kau Sai Chau Public Golf Course, SkyCity Golf Course at the Hong Kong Airport, and the lawn for the Dr. Sun Yat Sen Memorial Park. As a new comer among the turfgrasses, Seashore Paspalum is a tricky grass to maintain due to a lack of local experience maintaining it, and its compatibility with commonly-used pesticides.

Bahia Grass

Bahia Grass (*Paspalum notatum*) is more a pasture grass than a turfgrass as its leaf is quite wide and the stolons are robust. Bahia grass is best for low maintenance amenity areas such as roadside lawns and on fill slopes.

Seeds of Bahia Grass are also included in the seed mix for hydro-seeding during summer months and is widely used by local contractors. Mainly because of its resistance to drought, Bahia Grass often becomes the surviving grass species on hydro-seeded sites.



Manila Grass



Seashore Paspalum



Bahia Grass

Weeping Love Grass

Weeping Love Grass (*Eragrostis curvula*) is one of the few non-stolon and non-rhizome producing warm-season grasses. It grows in bundles and has never been intended to be used as a turfgrass. Seeds are readily available in the market; this together with its high germination and establishment rate has made it a popular grass species for use in slope control projects. Weeping Love Grass is a bundle-type grass and produces tillers only. It is worth noting that full grown and dry patches of Weeping Love Grass could become fire hazards on remote sites.



Perennial Ryegrass

As indicated before, uses of Perennial Ryegrass (*Lolium perenne*) in Hong Kong are restricted to winter over-seeding operations and as a component of the winter seed mix for hydro-seeding. The grass dies completely with the onset of spring.

Perennial Ryegrass



Other cool-season turfgrass such as Tall Fescue (*Festula arundinacea*) and Blue Grass (*Poa* spp.) have been used for over-seeding and hydro-seeding by local hydro-seeding users, and the results were disappointing, e.g. on turf tracks on race courses and on some local golf courses.

Other Turfgrass Species

In contrast to its popularity as a native turfgrass in southern United

Tall Fescue



Weeping Love Grass

Blue Grass



Centipede Grass



Wild Oat Grass



Long-Flower Digitaria



Lawn at the Sun Yat Sen Memorial Park

States, Centipede Grass (*Eremochloa ophiuroides*) is commonly found in open pastures, roadside and hill slopes in Hong Kong (and also in mainland China and Taiwan). The use of this grass locally has not been fully explored. Although it is listed as a component grass seed species, grassing contractors are reluctant to use Centipede Grass seeds due to its high price, (e.g. retail price up to US\$ 32/lb). Major seed production is restricted to the southern states in USA, the amount produced is small, and is at times affected by weather. Based on my observations, seed production in China (including Taiwan and Hong Kong) is low and unpredictable as the majority of spikes produce infertile seeds.

Two other local grasses: Wild Oat Grass (*Chrysopogon aciculatus*) and Long-Flowered Crabgrass (*Digitaria longiflora*) are commonly found in old and worn-out sports fields. These two grasses possess good turfgrass character but their use has never been fully assessed because of their limited availability in large quantities for any grassing projects.

Conclusions

It is clear that there are sufficient turfgrass species available locally to cope with the demands for various users. Carpet Grass, Hybrid Bermuda Grass, Zoysia Grass and/or Seashore Paspalum are all suitable for use in amenity and sports fields. When managed properly, natural turf facilities can be made sustainable.

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References

1. Turgeon, Alfred J, 2012 – Turfgrass Management, 9th Edition. Prentice Hall
2. Lee Yin-tse, 2003 - Turfgrass in Hong Kong, Herbarium Leaflet No.15, Agriculture, Fisheries and Conservation Department, Hong Kong.

Given the limitation of space, it seems difficult to achieve a sustainable built environment by striking a balance between development and greenery. By exploring the untapped spaces offered by building roofs and walls, skyrise greenery can be a positive answer through weaving green fabric to a condensed city at multiple levels.

Greening, Landscape and Tree Management Section,
Development Bureau

Weaving green fabric to a condensed city

Greening, Landscape and Tree Management Section, Development Bureau

General overview of development of urban greening in Hong Kong

Hong Kong is well known as a “city of skyscrapers” characterised by its high density, high-rise forms and multi-storey mixed use buildings in the urban areas. In addition, extensive infrastructure dominates our urban landscape. As the majority of Hong Kong’s 7 million people are concentrated in around 20% of the land, the city’s highly compact development and scarcity of land pose a great challenge to providing greenery in the city.

So, are there opportunities for more greening in our city? In fact, the answer is encouraging - our city can be greened in various dimensions. Apart from planting at-grade, we can apply skyrise greenery to high-rise buildings and structures on various planes and surfaces.

Skyrise greenery provides us with a wide range of benefits, such as improving aesthetic quality, providing visual relief and psychological comfort, as well as ameliorating the heat island effect,



Roof greening at Sha Tin Sewage Treatment Works



Vertical greening on IFC Footbridge

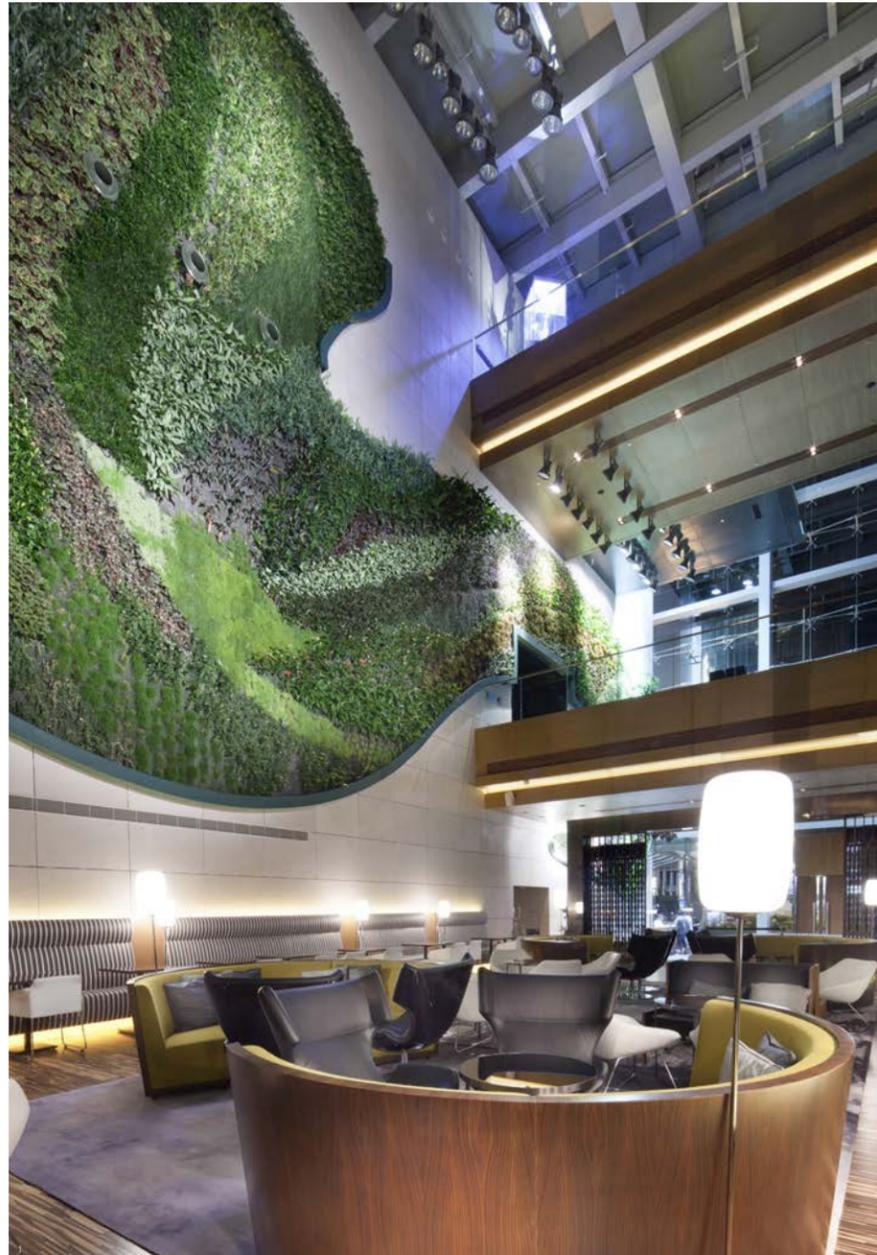


Flyover at Junction of Prince Edward Road East and Choi Hung Road

improving air quality through pollution absorption and oxygen generation, and reducing storm water runoff. It is also beneficial ecologically as it promotes biodiversity, creates wildlife habitats and provides links for habitat in the inner urban core. From an economic point of view, it can improve the lifespan of buildings and reduce energy consumption by insulating buildings from the summer heat.

The Government has been taking proactive steps to promote wider use of skysrise greening in the form of green roofs and vertical greening. In the past decade, the number of skysrise greenery projects has been rising, and over 400 government projects have now been constructed with green roofs and/or vertical greening. In addition, the skysrise greening of more than a hundred government projects is being planned or is in progress. There is an increasing trend to apply skysrise greening in commercial and residential developments. Many projects showcase the effective application of skysrise greening technologies with creative designs.

Besides, many schools and non-government organisations (NGOs) have made use of the Environmental and Conservation Fund for constructing green roofs for educational purposes. Over 130 green roofs have been subsidised in the past five years. Some of them were winners in the Skysrise Greenery Awards 2012 organised by the Greening, Landscape Tree Management (GLTM) Section of the Development Bureau.



Teaching Hotel Complex, The Hong Kong Polytechnic University



Roof garden at Ng Yuk Secondary School



Citywalk 1& 2



Roof garden at Munsang College Primary School



Roof garden at Munsang College Primary School

Opportunities and potential areas for greening enhancement

So what kind of landscape works can be called skysrise greenery projects? In a broad sense, skysrise greening encompasses all greening on buildings or structures above ground level, including green roofs and vertical greening. Though not new in Hong Kong, it offers opportunities to optimise space for urban greenery which may take the form of sky gardens, podium gardens, extensive green roofs, edge greenery, green walls and living walls. Recently, skysrise greenery has also added new dimensions for educational and therapeutic purposes.



Landscape Plan and perspective drawing of Kai Tak Development (Source: Kai Tak Office)

The leading role of the Hong Kong Government in greening the city

The greening policy aims to bring about noticeable improvements in urban greenery, to enhance existing greened areas and create quality greening opportunities. To achieve these targets, technical circulars, guidelines and standards for skyrise greenery provisions have been promulgated. For government building projects, a minimum 30 % of greenery coverage for site areas over 20,000 m², and a minimum 20% greenery coverage for site areas between 1,000 m² and 20,000 m², has to be achieved. Similarly, site greenery coverage requirements have been incorporated as prerequisites for granting Gross Floor Area concessions in building plan submissions to promote sustainable green building design in the private sector. For example, the Kai Tak Development has greening ratios of an overall 30% recommended as a design parameter for both public and private sites and minimum 20% of total roof area.

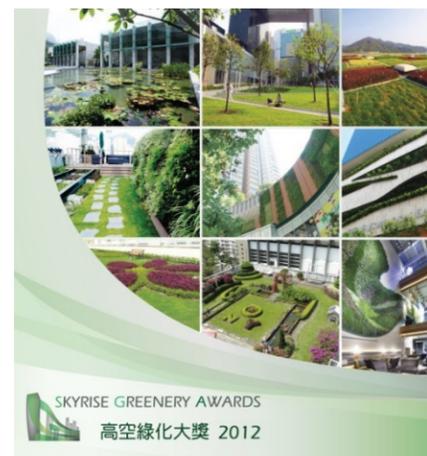
The Government also encourages integrating skyrise greening in the early planning and feasibility stages so that adequate structural loading capacity, planting space, irrigation and drainage systems are duly incorporated for successful implementation.

The GLTM Section of Development Bureau promotes a holistic greening approach embracing adequate space allocation for new planting, proper selection of planting species as well as quality landscape design and

planting practices in the upstream and proper vegetation maintenance in the downstream, with due emphasis on protection of public safety as a priority consideration. The Section also spearheads the promotion of skyrise greening through organising seminars, workshops, project visits, facilitating exchange among practitioners, and professional institutions, and encouraging research studies to enhance the knowledge of new greening technologies and their application of skyrise greenery. Some recently completed or on-going research studies such as 'Study of Climbing Plant Species for Application of Vertical Greening in Drainage Services Department's Facilities', 'Green Roofs: Green Roof Guidelines, Water Quality and Peak Runoffs' and the bilingual 'Pictorial Guide to Plant Resources for Skyrise Greenery in Hong Kong' can be found at the Greening website <www.greening.gov.hk>.

These measures provide an open cross-discipline platform for the trade and industry to share valuable professional and practical experience so as to lower the technical barriers in the application of new greening techniques.

In 2012, we organised the Skyrise Greenery Awards to promote skyrise greening as an integral part of the project to achieve quality landscape in the built environment and fostering public appreciation of exemplary skyrise greenery projects. The launch of the Awards scheme, included a series of activities and publicity: award ceremony/ seminar; roving exhibition;



The book 'Skyrise Awards 2012' and 'Pictorial Guide to Plant Resources for Skyrise Greenery in Hong Kong' can be downloaded at www.greening.gov.hk.

publication of the book 'Skyrise Awards 2012', and has successfully raised public awareness of skyrise greenery and promote wider engagement and support from the public for the development of quality skyrise greenery in Hong Kong.

Skyrise greenery in various dimensions in Hong Kong

We are glad to see not only the increase in quantity but also a wider scope in adoption of skyrise greenery in various projects in Hong Kong. The following are some exemplary skyrise greenery projects showcasing creative designs.

Open spaces for the community

Tamar Development, the Silver Award winner in the 'Government Projects' category of the Skyrise Greenery Award 2012, "demonstrates outstanding

quality in master planning, in which the elements of skyrise greenery are skillfully incorporated into the building design for the enjoyment of the public," according to comments from the jury.

Built on four main themes: openness; enjoyment; sustainability; and togetherness, the project was completed in 2011 to house the Central Government Offices. A 'Land Always Green' concept is reflected in the natural lush landscape of the 1.27ha Tamar Park, a landscaped roof providing a public open space, developed as an integral part of the Tamar Development Project. This 'urban lung' is a welcome green space amidst the conglomeration of skyscrapers in our central business development area.

Another exemplary open space is the Kai Tak Cruise Terminal Park which is nestled on the roof of the iconic new Kai Tak Cruise Terminal Building. The park occupies an area of 23,000 m² which is currently the largest green roof in Hong Kong. It features a spacious central lawn, a dedicated viewing platform, a peaceful water garden, an eye-catching fountain plaza and it is a unique space to enjoy the open air and magnificent harbour view with stunning cityscapes.

Play and learn

In 2010, with the support of the Environment and Conservation Fund, Munsang College Primary School converted its rooftop into a beautiful roof garden – a green lawn where students can relax, walk, chat, play and paint. The school received a Silver Award in the Skyrise Greenery Awards 2012 in recognition of its efforts and commitment to greening.

Not only does the roof garden help to absorb heat by 2°C to 3°C and save energy, it also provides students with a relaxing environment for outdoor educational activities such as student exchange programmes and a food waste recycling scheme. Through planting a variety of flowers, herbs, seasonal fruits and vegetables in the roof garden, students have acquired the skills to sow, irrigate and weed the land. They observe the growth of plants and gain a better understanding of plants while teachers provide guidance. Students can "eat, play and learn" by experiencing organic farming in the roof garden.



Munsang College Primary School



Munsang College Primary School



Tamar Park



Tamar Park



Tamar Park



Kai Tak Cruise Terminal Park



Kai Tak Cruise Terminal Park

Therapeutic garden

The North Lantau Hospital features a roof garden with various greening elements, such as an extensive green roof, vertical greening and a rain garden. The rehabilitation roof garden is also designed with a patient-focused approach with therapeutic and restorative healing effects with features such as the horticultural therapy area, colour therapy columns, tactile walls etc., to stimulate the full range of senses – memory, hearing, touch, smell and taste – as necessary supplements to the visual experience.

Green infrastructure

With the successful experience in applying vertical greening and green roofs of the Shatin Sewage Treatment Works, a Silver Award winner of the

Skyrise Greenery Award 2012, Drainage Services Department has been focusing on enhancing greening in its other facilities, for example the Kowloon City Pumping Station. In order to bring aesthetic and environmental benefits to the surrounding residents, the site coverage of greenery of the project reached an impressive level of nearly 60%. In addition, the project is a showcase of green infrastructure where the pitched green roof, rain garden and terrace planters make rain water harvesting possible.

Conclusion

Given the limitation of space, it seems to be difficult to achieve a sustainable built environment by striking a balance between development and greenery. By exploring the untapped spaces offered by building roofs and walls,

skyrise greenery can be a positive step forward, weaving green fabric through a condensed city at multiple levels.

We see that there are still substantial bare roofs and walls yet to be exploited. This living green fabric in the form of skyrise greenery can transform our dense building mass to a green oasis.

Article by the Greening, Landscape and Tree Management Section, Development Bureau.



North Lantau Hospital (Source: Architectural Service Department)



Kowloon City Pumping Station (Source: Drainage Service Department)



North Lantau Hospital





Productive green roofs

Mathew Pryor

As with many high density cities, Hong Kong's thousands of grey roof spaces constitute a significant proportion of the built area, and represent a severely underutilised asset.

A 'green roof' is a roof that is covered with growing medium and vegetation planted over a waterproofing membrane, typically with some form of root barrier, drainage layer and irrigation system to support it. Green roofs have been incorporated into new buildings and retrofitted to existing buildings since the 1960s and have been shown through numerous scientific studies to offer a wide range of potential environmental benefits and contributions to a sustainable urban lifestyle. Depending on the type of green roof (extensive / intensive) and location, these might include:

- Improving thermal performance and building energy conservation
- Improving urban air quality
- Reducing urban heat island effect

- Improving building sound insulation
- Providing visual greening within the city
- Ameliorating some effects of storm water, and
- Increasing biodiversity and urban wildlife

Since 2011, Development Bureau's 'Skyrise Greening' campaign¹ has promoted the benefits of greening at height in Hong Kong, and has resulted in more than 400 green roofs² being established in urban areas. These have mostly been retrofitted to school and infrastructural buildings, for example the award winning Shatin Sewage Treatment Works³. The 'Be our Greening Partner campaign'⁴ has brought support from commercial and community organizations for this initiative.

Green roofs have rapidly become a key 'green development' tool in the urban expansion and renewal of the city. Following the lead of countries such as Singapore, Germany and France, green

building coverage is now mandated for new building projects in Hong Kong⁵ and has become a central component of green building certification systems.⁶ For landscape architects, green roofs have created exciting new sites for landscape in the city and new technical challenges in dealing with plants in extreme conditions.

Practical issues

In practice, however, problems can occur on green roofs when the long term health of the vegetation is compromised to the point where it cannot perform its functions properly. Common symptoms of failure include: poor plant health / loss of vigour; plant death; growth / predominance of weeds and invasive plants; soil waterlogging, and soil desiccation. These typically result from one or more of the following:

- Poor drainage
- Over watering
- Inadequate irrigation



Brooklyn Grange commercial organic farm, New York

- Soil nutrient deficiencies
- Misuse - unplanned active use
- Use of unsuitable species
- Insects and pathogens (virus, bacteria, fungi)

It is unsurprising that in a recent study of 42 green roof systems in Hong Kong (that had been established for more than 2 years)⁷ more than 40% of owners / managers reported significant long-term problems in the performance of their green roof system, and in a small number of cases the green roof had failed outright. Problems appear more prevalent in intensive green roof systems, with thinner soil layers. Green roofs with a greater depth of soil were generally more resilient.

From the study survey, there appear to be a number of underlying causes of green roof under-performance.

- Green roofs are artificial constructions dependent on precise irrigation and effective drainage systems. Small problems or deficiencies in either, can rapidly lead to systemic failure. The vegetation is not self-sustaining and does not function as an urban ecological habitat. Plants are growing in very marginal conditions, and are constantly under stress. The very thin drainage layers have no capacity for storage, and under intense summer monsoon rains the soil above can easily become waterlogged. Conversely, the very thin layers of soil used to support growth, leave plants vulnerable to rapid drying out in the winter months. The number one killer of plants in Hong Kong is too much water, the number two killer is not enough water. Hong Kong's aggressive climate poses big challenges to green roof systems.⁸ This problem is compounded by active use. Even seemingly lightweight activities such as pedestrian walking can be sufficient to result in significant compaction of soil layers, and a decline in plant performance. Access to some green roofs has been restricted by managers to avoid such problems.

- Green roofs have very specific maintenance requirements which are more intense than standard horticultural maintenance that might be appropriate for ground level planting. Many managers were completely unaware of



Rooftop farm growing vegetables, corn, lotus and rice, Liuzhou (Photo: Xinhua)

the need for: constant monitoring of plant and soil health; regular checking of drainage layers; undertaking very regular soil aeration; and the continual adjustment of watering regimes, all of which are vital to long-term success. Even an understanding of the need for active re-planting, and improvement of soil nutrition was largely absent. Further, the design of many green roofs is reliant on proprietary systems (irrigation, drainage, soil materials, etc.), which tend to be inflexible and difficult to adjust, so may not be resilient in the long-term. We need to recognise that the value of a green roof is dependent on it being maintained in a specific way. Typically they are not conceived as self-sustaining vegetation systems, based on native flora and fauna. In many respects green roof systems are far closer to carpet bedding than urban ecological habitats.⁹

- Ownership has been identified as a key factor in green roof success. Where there is no clear definition of who is responsible for maintenance (i.e. it is 'someone else's issue'), or the approach

to maintenance is reactive (act only when problems occur), or the maintenance team is encouraged to minimise effort and expense, then the green roof is likely to fail in time. Up on the roof, planting can be 'out of sight and out of mind', and becomes just another building façade material. Even where there is oversight of rooftop vegetation, it is usually from a distance where plant health problems may not be obvious.¹⁰ Only where an individual or community feels a sense of ownership in a green roof, will it receive the careful and proactive stewardship it needs.

There is still much to be learnt in the design and management of green roof systems, in particular mechanisms for monitoring their health, identifying incipient problems, and taking timely action to address them. Beyond the technical refinements which will come from the continued practice of building and operating green roofs, there are other ways we can improve our approach to greening roofs across the city.



We need to move beyond the ornamental planting of exotic species (in bold geometric patterns). These mono-specific blocks have no ecological value and are not resilient. If they fail, they do so comprehensively. We need to investigate the use of combinations of native species that have a chance of developing into a sustained ecological habitat, or the use of particular species that can actively engage the community in their care and maintenance e.g. productive crop species.

The use of unitary systems, which are more flexible and adaptable to complex roof shapes, and the consideration of partial systems, (i.e. not blanket coverage), would allow for greater depths of soil (up to 250mm) so that a wider variety of plants can be used and existing species choices can be grown in less marginal conditions.

Different operational models that encourage and facilitate active use and positive ownership, should be considered. To be successful in the

long-term, a green roof system (indeed, any non-self-sustaining vegetation) has to be planned, designed and managed as a fully integrated part of the natural environment and centred around a resident community that has a vested interest in its on-going maintenance, care and development. Our management of green roofs should recognise that the vegetation, like all landscapes, has seasonal and life-cycle patterns, and will naturally evolve and adapt to environmental conditions. We need sensitive, proactive maintenance of the vegetation (and attendant water, soil and fauna), that help it grow and develop over time.

Where they are safely accessible, and can be designed for active use, green roofs can have considerable community and public health benefits ('soft benefits') in the form of social / community interaction, recreation, and interaction with nature (salutogenic environments).

Productive green roofs

The environmental benefits of rooftop farms (growing crops for food) have been found to be broadly similar to those of more conventional (intensive) green roofs, namely:

- Reduction in solar heat gain, and positive impact on building insulation and urban heat island effect¹¹
- Energy conservation, improved thermal performance
- Biodiversity and wildlife
- Improvement in urban air quality
- Noise and sound insulation
- Urban greening¹²
- Buffering stormwater run-off

In addition, rooftop farms can have significant social / community benefits¹³, and have the potential to help address the rapidly growing issue of food security for urban areas¹³ and help to reduce their ecological footprint.¹⁴

Rooftop farm projects have been initiated in many high density cities

across the world, in the last ten years. Brooklyn Grange commercial organic farm, and the Eagle Street Farm Greenpoint, in New York City are the best known, but fine examples can be found as far afield as Johannesburg and Bangkok. Even in China rooftop farms are becoming popular with notable examples of people growing vegetables, corn, lotus and even rice on rooftops in Nanhai and Liuzhou.

In Hong Kong, some 45 of the 400 green roofs that have been established, are productive rooftop farms, growing vegetables and fruit (Table 1). These have all been built on grey roofs (rather than as part of a new building development), or are conversions of existing green roofs. They range in size from 25 to 1,000m², and the largest can actively engage up to 50 gardeners. They are operated either by the building owner or by a community enterprise group. Demand in many of these rooftop farms outstrips supply, with long waiting lists. The motivations given by owners and users for setting up a productive rooftop farm include:

- Social / community enterprise e.g. City Farm, Taikoo
- Corporate sustainability e.g. Bank of America Tower, Central
- Educational e.g. Australian International School (HK)
- Family e.g. Very MK, Mong Kok
- Restaurant e.g. The Pawn, Wan Chai
- Charitable causes e.g. Feeding Hong Kong at Confucius Hall Secondary School, Causeway Bay

The HKU Rooftop Farming project on the Runme Shaw Building HKU Main Campus (built by the Division of Landscape Architecture and Time2Grow) is an example of a community enterprise project, and is the basis of a new book on rooftop farming in Hong Kong, which is intended to help individuals and community groups create and run productive gardens on their building roofs.¹⁵

Any comparison of on-line images of traditional green roofs and those of productive rooftop farms reveals one startling difference: people. Where green roofs are seen as decorative planting patterns, rooftop farms are clearly shown as centres of vibrant social communities.

Table 1: Rooftop farms in Hong Kong

| Commercial Buildings (6) | Year | Institutional Buildings (20) | Year |
|---|------|---|-----------|
| - Mission Green Top, Kowloon Bay | 2009 | - Spring Workshop, Wong Chuk Hang Rd | 2014 |
| - IPC Foodlab Farm, Fanling | 2012 | - Fresh & Green's Balcony, Fo Tan | 2014 |
| - Hysan Building Rooftop Farm, CWB | 2013 | - Art Garden 818, Kwai Chung | 2014 |
| - Bank of America Tower Rooftop, Central | 2014 | - Crystal Group Rooftop Farm, Kwun Tong | 2014 |
| - King's Centre, North Point | 2014 | | |
| - Rooftop Republic x Green Monday, Nan Fung Tower, Central | 2015 | Institutional Buildings (20) | |
| | | - HKU Rooftop Farm: Run Me Shaw Building, Simon KY Lee Hall, Pokfulam | 2012-2014 |
| Residential Buildings (9) | | - CUHK: Library, Shaw College, Teaching Complex, Wu Yee Sun College, Lee Woo Sing College, Shatin | 2012-2014 |
| - Kam On Court Parking Building, Shatin | 2009 | - Tai Yuen Estate Market Rooftop, Tai Po | 2012 |
| - Yau Ma Tei Gardener Rooftop Farm | 2011 | - HKCEC Sky Garden, Wanchai | 2012 |
| - Au Young Family Rooftop Farm, Chai Wan | 2011 | - Australian International School, Kowloon Tong | 2012 |
| - SLOW Experience, Wan Chai | 2011 | - HKICC Lee Shau Kee School of Creativity, Kowloon City | 2013 |
| - The Pawn Restaurant Rooftop, Wan Chai | 2011 | - Chinese Young Men's Christian Assc'n Center, Kwai Chung | 2013 |
| - Stella So's Rooftop Farm, Cha Kwo Ling | 2012 | - JCCAC rooftop farm, Shek Kip Mei | 2013 |
| - Time to Grow x Gardens & co. Urban Farm, Sheungwan | 2012 | - CityU GROW Rooftop Farm, Kowloon Tong | 2014 |
| - 11/F Sham Shui Po, Sham Shui Po | 2013 | - CCC Tam Lee Lai Fun Memorial Secondary School, Tuen Mun | 2013 |
| - Very MK Rooftop Farm, Mong Kok | 2014 | - Madam Lau Kam Lung Secondary School, Lam Tei | 2014 |
| Industrial Buildings (10) | | - Kowloon City Baptist Church Hay Nien Primary School, Ma On Shan | 2014 |
| - HK Honey/HK Farm Creative Industry's podium, Ngau Tau Kok | 2010 | - Lui Ming Choi Primary School, Tsing Yi | 2014 |
| - City Farm - Taikoo, Quarry Bay | 2010 | - Tan Siu Lin Primary School, Olympic | 2014 |
| - Project GROW, Ma Tau Chung | 2011 | - Feeding HK Causeway Bay, Causeway Bay | 2014 |
| - Fun n Farm, Kwun Tong | 2012 | | |
| - City Farm - Kwun Tong, Kwun Tong | 2012 | | |
| - City Farm - Tsuen Wan West | 2013 | | |

Source: Division of Landscape Architecture HKU Review of green roof performance in Hong Kong (2014)



City Farm, Taikoo is an example of a Private Commercial Enterprise project. It was established on 900m² of grey roof space in the ZungFu Industrial building in Taikoo (with subsequent projects in Kwun Tong and Tsuen Wan). The farm is run on rented roof space as a commercial (for-profit) venture. Individuals or small groups of local residents interested in urban farming for fresh food production, health or therapeutic benefits, social interaction and recreation, can rent up to 10 moveable planters (900x600mm) on a monthly basis. Each planter can produce up to 10-15kg produce per year. City Farm advocates green living for city people and the health benefits of "Eat Fresh, Eat Local". The company provides organic soil in planters, planting materials and tools, for growing vegetables. Staff manage the garden and provide daily watering services. City Farm runs 8-week learn-and-practice gardening skills courses, as well as workshops on different urban gardening subjects.



Time2Grow's rooftop farm on 39/F of Bank of America Tower, Central (Photo: Time2Grow)



AIS(HK) Edible Rooftop Community Project at the Australian International School (HK), Kowloon Tong, (pictured above) is an example of an owner-led project. The school renovated approx. 25m² of its ailing green roof into a productive garden, with the aim of getting students interested in gardening, raising awareness of food production and healthy living. Managed by the AISHK Edible Roof Club, the garden is funded by club subscription. Set up involved rehabilitating existing planting beds (various sizes, 0.4 - 6.5m²) and adding new planters, soil materials and gardening equipment. Students of various ages look after the plants once or twice a week after school while the main responsibilities lie on a teacher who manages the garden and ensures essential tasks are undertaken. On weekends and school holidays the tasks are undertaken by building maintenance staff. The garden is seasonal with a growing schedule designed to ensure key planting and harvesting activities happen within term time. The garden has a modest output due to its small-scale operation. Participating students get to keep what they harvest as an encouragement. In terms of raising awareness, and providing a rewarding educational and social experience for students it is highly successful. What was planned as an extra-curricular activity has become a teaching tool for students to learn about food and plant life cycle. It is also a popular venue for other staff and student activities.



Very MK rooftop farm, Mong Kok (Photo: Very MK)



Feeding Hong Kong rooftop farm at Confucius Hall Secondary School, Causeway Bay (Photo: Feeding Hong Kong)



The HKU Rooftop Farming project, Runme Shaw Building HKU Main Campus, was set up in 2012 as a two year research project by the Division of Landscape Architecture, investigating the differences in environmental and technical growing conditions between the city's rooftops and those at a ground level. The farm was designed and constructed by undergraduate students as part of their Landscape Practicum class. The work was funded by HKU knowledge exchange and teaching development grants. The farm was initially 110m², and comprised some 90 planters (typically 600x400mm), growing a variety of vegetable crops. The farm is now managed by the student-led HKU Rooftop Farming team. With the help of Time2Grow (Rooftop Republic), it has now been expanded to more than 400m² and has a community of some 40 active gardeners, all organized via their Facebook page. Farm produce is communally shared, or donated to the on-campus vegetarian restaurant, or given to the Feeding Hong Kong food distribution charity. (Photo: HKU Rooftop Farm)

Commercial production on rooftops

The potential for commercial-scale food production on urban buildings is starting to be explored.¹⁶ Workable techniques and approaches have already been demonstrated,¹⁷ and predictions of food self-sufficiency in the city from rooftop production are beginning to be made.¹⁸ Studies suggest that if access and logistics can be resolved, the roof spaces of large-scale industrial buildings and housing estates can be activated for the production of high value crops grown using hydroponic and aquaponics practices,¹⁹ making a positive contribution to the city's food security and reducing its ecological footprint.

Most commercial productive rooftop farm operations that have been developed to date have been based on some form of vertical

farming infrastructure²⁰, sometimes in combination with aquaponic / hydroponic structures,²¹ or more conventional structures such as glass houses²² or wind / shade structures.

At a more speculative level there are any number of bold architectural proposals for using the facades of buildings for growing crops.²³ The 'agri-tecture' movement²⁴ gives new definition to the concept of a 'green' building, but issues of access and seasonality of processes have yet to be addressed.

Research is starting into various aspects of vertical farming, including: species growth performance / yield;²⁵ scale of operation;²⁶ necessary building modifications;²⁷ the level of infrastructure required to establish and maintain;²⁸ different types of planter;²⁹ the effects of climate on rooftop growth;³⁰ and operational costs.³¹

Following the lead from a number of recent studies in the USA,³² the Division of Landscape Architecture, HKU, has just embarked on a new research initiative to map potential rooftop green space in Hong Kong and to develop a mechanism for evaluating the potential for commercial farming on rooftops in high density cities.

Rooftop production is unlikely ever to be commercially competitive with ground level food production due to the cost of installing soil, water, infrastructure, and the added costs of operation at height. Revenues, however, may offset the cost of green roof maintenance, and active use would bring positive stewardship to their management, thereby increasing the chances of long term success. We need to re-evaluate our current approach to 'green buildings', and see if we might make more effective use of our roof spaces as a way of greening the city.



Jack Ng's vertical farm in Singapore uses a rotating structure to gain enough sunlight to grow salad vegetables (Photo: Amusing Planet)

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References

1. Skyrise Greening campaign < http://www.greening.gov.hk/en/new_trend/benefit_of_skyrise.html >
2. Hui, S. C. Green Roof / wall Research Database. Department of Mechanical Engineering, HKU, <<http://www.mech.hku.hk/bse/greenroof/resources.htm>>
3. HKILA Design Awards 2012. In Yuan Lin 2011-12: 80-93
4. Greening, Landscape and Tree Management Section, Development Bureau.
5. Buildings Dept. 2011. APP 152 Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers 'Sustainable Building Design Guidelines' HKSAR Government
6. Hong Kong Green Building Council, BEAM Plus
7. Division of Landscape Architecture HKU, Review of green roof performance in Hong Kong (2014)

8. The same 'thin layer growing media' problem that beset many of the vegetation systems applied to concrete slope surfaces in HK in the last few years, and more recently some of the green wall / vertical green projects.
9. Tan, P. Y. and Sia, A. (eds.), (2008). A Selection of Plants for Green Roofs in Singapore, Second Edition, Centre for Urban Greenery and Ecology, National Parks Board, Singapore.
10. There is a general misconception that as long as vegetation is green, it is healthy.
11. Delor, M. (2011). Mini-project report summary Current state of Building-Integrated Agriculture, its energy benefits and comparison with green roofs.
12. Quesnel, A., Foss, J., & Danielsson, N. (2011). Solutions from above: Using rooftop Agriculture to move Cities towards Sustainability (Doctoral dissertation, Thesis School of Engineering, Karlskrona, Sweden)
13. Specht, K., Siebert, R., Hartmann, I., Freisinger, U. B., Sawicka, M., Werner, A., & Dierich, A. (2014). Urban agriculture of the future: an overview of sustainability aspects of food production in and on buildings. *Agriculture and Human Values*, 31(1), 33-51
14. Drumm, R., & Ridgeway, O. H. Singapore: Growing Up. An article describing the food problem of Singapore, then introduce rooftop farming (hydroponics) as a solution.
15. Pryor, M. Edible roof: productive rooftop farming in a high density city. Due for publication Oct. 2015. Hong Kong, MCCM Creations.
16. Nowak, M. (2004). Urban agriculture on the rooftop (Doctoral dissertation, Cornell). Accessed June 2015 from <http://lib.f0.am/_media/roofgarden_thesis.pdf>
17. Hui, S. C. (2011). Green roof urban farming for buildings in high-density urban cities. In Hainan China World Green Roof Conference 2011 (pp. 1-9). Sanyé-Mengual, E., Cerón-Palma, I., Oliver-Solà, J., Montero, J. I., & Rieradevall, J. (2015). Integrating Horticulture into Cities: A Guide for Assessing the Implementation Potential of Rooftop Greenhouses (RTGs) in Industrial and Logistics Parks. *Journal of Urban Technology*, (in print), 1-25.
18. Germain, A., Gregoire, B., Hautecoeur, I., Ayalon, R., & Bergeron, A. (2008). Guide to setting up your own edible rooftop garden. Alternatives and the rooftop garden project. EcoDesign Resource Society, 2013. The Urban Farming Guidebook 2013: Planning for the Business of Growing Food in BC's Towns & Cities. EDRS, Vancouver, Canada. Philips, A., 2013. Designing Urban Agriculture: A Complete Guide to the Planning, Design, Construction, Maintenance, and Management of Edible Landscapes, Wiley, Hoboken, New Jersey.
19. Hydroponic and aquaponics technologies are already in operation in Hong Kong, such as VF Innovations Sustainable Farming and Aquaponics.com.hk
20. Banerjee, C., & Adenauer, L. (2013). Up, Up and Away! The Economics of Vertical Farming. *Journal of Agricultural Studies*, 40-40 Platt, P. (2007). Vertical Farming: An Interview with Dickson Despommier regarding on the future projection of vertical farming.
21. Arai, J., & Ozaroff, E. Use of hydroponics technology to address growing problems in urban environments.; Le Blond, J. (2012). Rooftop Fish Farms to Feed Germany's Sprawling Urban Population'. *The Guardian*.
22. Cerón-Palma, I., Sanyé-Mengual, E., Oliver-Solà, J., Montero, J. I., & Rieradevall, J. (2012). Barriers and opportunities regarding the implementation of rooftop eco-greenhouses (RTEG) in Mediterranean cities of Europe. *Journal of Urban Technology*, 19(4), 87-103
23. Yeang, K. (2011). *Eco Skyscrapers* (Vol. 2). Images Publishing
24. 'Buildings that grow food', Accessed June 2015 from <<http://agritecture.com/>>
25. Thomaier, S., Specht, K., Henckel, D., Dierich, A., Siebert, R., Freisinger, U. B., & Sawicka, M. (2014). Farming in and on urban buildings: Present practice and specific novelties of Zero-Acreage Farming (ZFarming). *Renew Agr Food Syst* (Online First). doi, 10(1017), S1742170514000143
26. Wilson, G. (2002). Can urban rooftop microfarms be profitable. *Urban Agriculture Magazine* (7) August, 22-24.
27. Specht, 2014
28. Mackay, C. Modifying the Green Roof for Downunder.
29. Whittinghill, L. J., Rowe, D. B., & Cregg, B. M. (2013). Evaluation of vegetable production on extensive green roofs. *Agroecology and Sustainable Food Systems*, 37(4), 465-484
30. Quesnel, 2011
31. Baranik, D., Foster, M., Sturgis, A., & Uyan, Y. Reaching Worcester Roofs. Study assessing cost and revenue for rooftop greenhouse and water systems.
32. Berger, D. (2013). A GIS Suitability Analysis of The Potential for Rooftop Agriculture in New York City (Doctoral dissertation, Columbia University). Stoudt, A. E. (2015). Redefining urban food systems to identify optimal rooftop community garden locations: a site suitability analysis in Seattle, Washington (Doctoral dissertation, USC).

Next issue, public space

Yuan Lin is intended to recognize the work of landscape architects and to develop a discourse on issues relevant to the Landscape profession within Hong Kong.

The next issue will address issues of public space in Hong Kong, and explore how the nature and meaning of public space has developed, and is evolving, in Hong Kong, China, and other related territories and what impact that has had on landscape practice. For instance this might include issues relating to: changes in the form and volume of pedestrian movement and the occupation of space in the city; the design and management of public space; the internalisation and commercialisation of public space; new definitions of 'public' and collective ownership, etc.

HKILA members and related professionals are invited to submit contributions for the next issue to the Publications Committee, Hong Kong Institute of Landscape Architects. P.O. Box 20561, Johnston Road Post Office, Wan Chai, Hong Kong, (publications@hkila.com)

Contributions should be topical, concise, factual, informative, critical, and not promotional. They may take the form of:

- Articles - opinion pieces containing views / reasoned arguments,
- Reviews - assessments of published books, completed projects, technical details, data, processes, etc.,
- Academic papers - scholarly articles reporting on formal qualitative or quantitative academic research,
- Graphic illustrations or photographic images with accompanying descriptions.

Written contributions should be between 1500-6000 words. They will be reviewed by the editorial team and invited reviewers. All pieces should be written in English using a professional or academic style. References and citations should be used where possible to position the piece with respect to established knowledge within the Landscape discipline. The piece should relate to Hong Kong, where possible, with references to other territories where appropriate.