Keynote Lecture: Urban biodiversity and greening strategies in Singapore

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ABSTRACT

This paper provides an overview of Singapore's 'Garden City' programme and its relationship with biodiversity levels. It defines three landscape periods spanning the development of Singapore from independence till present day. The first two periods, the 'Survival Landscape' and 'Mosaic Landscape' mark the 1960s to the early 1980s, and from then to the late 1990s respectively. Massive urbanisation and infrastructure developments during these periods exacerbated the extinction of numerous native species of flora and fauna and replaced it with a well-ordered and manicured lush green mantle with low biodiversity.

Pressure on limited land of only 680 km² for a projected population of 5.5 million, searching for identity in a monotonous landscape and increasing maintenance costs are challenging the ability to sustain this lush green mantle. This marks the dawn of the next landscape period, the 'Integrated Landscape', where I am suggesting that strategies of 'Local Identity', 'Ecological Design' and 'Consolidation' are necessary to meet these challenges. Biodiversity plays an important role in these strategies by using Singapore's natural biodiverse heritage as a rationale to establish 'Local Identity' and as a tool towards achieving sustainable greenery through 'Ecological Design'. Through the 'Consolidation' of green spaces to maximise land use, more areas can be made available for these natural plant communities to flourish. These strategies can be translated into economic value by packaging the island as a bio-park for ecotourism. The success of these new strategies will depend on the ability of policy makers to 'think outside the box'.

INTRODUCTION

Lying on the southern tip of the Malay Archipelago, Singapore was once covered by a thick and lush green mantle of tropical forest extending throughout its 600 km². Three forest types covered the island: mangroves (13%), freshwater swamp forest (5%) and lowland dipterocarp forest (82%). It has been estimated that Singapore's original biota comprised at least 20 000 species, which is a very rich ecological heritage.

Today, this forest cover has largely disappeared and been replaced by a highly planned and engineered urban environment. Is there a place and even a role for biodiversity in such a highly modified environment? This paper asserts that in this environment, biodiversity still has a valid role in Singapore's greening strategies, culturally, economically and aesthetically.

BACKGROUND TO THE GARDEN CITY

When compared to the long timelines in the rise and fall of nation states, Singapore has a short history of some 40 years since its independence in 1965. Small and vulnerable, without any natural resources, the challenge over the decades has been to accommodate the competing requirements for housing, infrastructure, employment, industry, recreation, training grounds for the armed forces, an airport and a seaport within a very limited land area. The government adopted a centralised and pragmatic approach in urban and environmental planning to create the vision of an orderly, clean and green city.

One major strategy adopted in the 1960s, was to implement a 'Garden City' concept. Greenery in the form of manicured gardens and lawns was seen as essential in providing

a conducive living environment through providing shady comfort, cleansing of the air and complementing the clean and ordered city. This concept unfortunately led to the destruction of large areas of natural habitats, reclamation of coastal areas and offshore islands (Fig. 1), levelling of hills, filling up of swamps and water bodies and canalisation of streams and rivers, hastening the extinction of species. The reason for this is because Singapore's environmental programme has had more to do with the construction of a landscape moulded and fabricated by skills than the preservation of natural vegetation (Savage 1997).

The 'Garden City' has been hailed as a great success in its contribution to adding beauty and a soft touch to urbanity, as well as in advancing environmental standards of cleanliness. This obsession with urban greening has resulted in the planting of more than a million trees covering 2618 ha of parkland and 2360 ha of roadside greenery since 1965. Many exotic (non-indigenous) plant species were introduced and extensively planted in this process. A cursory count of common natives and exotics used would total about 500 species. In the larger context, this success serves as a powerful national symbol showing a clear and visible demonstration of the quality of life and level of development attained.

PERIODS OF GREENING STRATEGIES

The greening of the 'Garden City' can be generally defined into three periods, which are the 'Survival Landscape' 1960s to early 1980s, 'Mosaic Landscape' 1980s to late 1990s, and 'Integrated Landscape' 1990s to present (Tan 2002).

In the 'Survival Landscape', the rapid growth of the city and its infrastructure dictated that only a few select species of trees, shrubs and groundcovers were used. These were affordable, fast-growing and hardy and were planted to achieve a green landscape. 'Standardisation Planting' characterised this initial phase where thousands of plants were enthusiastically planted along roadsides (Fig. 2) based on strict specifications of planting distances (e.g., *Samanea saman* trees to be planted at 18 m centres) and, species allocation to specific structures (*Ficus pumila*, the creeping fig for retaining walls; *Baphia nitida* shrubs for screening; *Bougainvillea* for overhead bridge planters). Similarly selected plant species were liberally used in the parks and open spaces. The natural biodiversity was seen as undesirable while landscape design was based more on satisfying functional requirements than environmental and aesthetic factors.

Emboldened by the success of this initial greening campaign, Government moved towards a 'Gardenesque Planting' style. This style was characterised by the addition of more beauty and variety with the introduction of more flowering plants and fruit trees. This entrenched an alien manicured garden onto the urban landscape. It was functional but sterile, purely decorative and homogenous in species selection. 'Lollipop' tree planting interspersed with 'islands' of shrubs and lawns of turf characterised this look. In this period, the number of approved species would have totalled less than 300 species.

By the 1980s, an impressive lush green mantle had covered many parts of the island. Greening standards were already institutionalised and were being rigorously applied in tandem with an increasing horticultural estate amongst government agencies and private developments. This gave rise to the 'Mosaic Landscape' characterised by the landscape styles of 'Manicured Mosaics' and 'Themed Mosaics', essentially green spaces designed and planted in isolation of its larger context.

'Manicured Mosaics' centred on the territorial boundaries between government agencies where each had developed their own planting strategies to suit their respective planning and technical requirements, i.e., road reserves, drainage reserves, parks, public housing estates and industrial parks. There was little consideration given to a broader landscape strategy and coordination between designs, thus giving rise to a mosaic of various planting schemes, turf areas and woodlands along administrative boundaries.

In private developments, 'Themed Mosaics' arose from the desire to develop theme gardens within individual development plots mainly because a distinct Singapore garden style did not yet exist. These themes generally changed in relation to the psychological challenges faced in nation building, from a Japanese style exuding confidence over nature, to a Balinese theme where a need arose to rediscover nature, and recently to living with nature in contemporary gardens.

The 'Integrated Landscape' constitutes the next stage in the greening movement. Still in its infancy, it is being shaped by the new challenges brought about by the economic conditions of the 21st Century, and an increasing population.

CURRENT CHALLENGES

After more than 180 years since the founding of modern-day Singapore, 99.8% of the original primary forest has been lost. Natural habitats are now confined to approximately 5% of the total land area of which 3% are protected by law as the nature reserves. The nature reserves primarily comprise of a 164-ha patch of primary forest on Bukit Timah Hill and a larger 2000-ha central catchment secondary forest which functions as a catchment area for four impounding reservoirs. The remaining 2% are nature areas made up of smaller patches of regenerating woodlands and coastal mangroves.

With such poor protection, 26% of vascular plants, 28% of resident birds and 44% of freshwater fishes have already been lost from the originally estimated 20 000 species. Losses will likely continue to occur because the natural habitats today are just too small to support viable populations of many species (Turner 1994) and also because Environmental Impact Assessments (EIA) are still not a legal requirement in Singapore. The continued destruction of elements of nature cannot go on. Will anyone weep when the last forest giant on Bukit Timah Hill disappears? It is clear that active conservation measures must be taken now to protect the last vestiges of natural heritage. The tussle between conservation and development need not be a zero sum game. Surely innovative solutions can be found to achieve a satisfactory balance? This will be strongly supported by the general population judging by the strong outcries over proposed development on nature areas in recent years and the greater awareness of environmental issues amongst the population.

The manicured garden has been functionally very successful in providing much needed shade, softening the hard surfaces of urbanity and helping to cleanse pollutants from the air. However, these 'alien' landscapes that have been imposed look alike through most parts of the island and have been described as 'monotonous', 'uninspiring', and even 'a green desert'. Monotony has been created by the adherence to a small palette of plant species and to standard planting guidelines applied island-wide, resulting in a lack of distinct local and regional identities and absence of strong values assigned to it by people. Greenery is uninspiring because it is still largely seen as a 'gardening' exercise confined within the territorial turf of different agencies, rather than a well integrated and designed master plan covering the island, entire regions and individual townships.

Large masses of greenery are also not seriously exploited together with water bodies on a regional scale for what it can contribute in influencing air movement, mitigating air pollution and cleansing water bodies.

Maintaining and improving the current greenery incurs a high cost, probably about SGD 30 million per annum. Costs will continue to increase as better recreational facilities and varied experiences are built to meet public demand and as new parks, open spaces and roadside greenery come on stream, adding to the extent of the horticultural estate. Despite the continuing political will to have greenery, recurrent costs must be reduced in the reality of the new economic conditions. Clearly, self-sustaining plant communities will be favoured over higher maintenance landscapes.

Nature reserves, nature areas, parklands and administrative reserves occupy a significant portion of Singapore's land area. In trying to

maintain a balance between competing land use, the planning authorities also have to plan for an anticipated increase in population to 5.5 million. In spite of this, the Government recently demonstrated its continued commitment to greenery by updating the successful Garden City concept to the idea of a City in a Garden. In this vision the area of parklands will be steadily increased from 2618 ha to 4400 ha, the extent of park connectors from 40 km to 120 km by 2015, and encouraging skyrise greening. The additional land required to support this and other uses will invariably exert pressure to develop more nature areas. While various strategies could and are being taken to maximise current built-up areas, it is only a matter of time before many of these areas have to be developed. It is prudent to maximise land already designated for parks, open spaces and administrative reserves.

Clearly, a new vision for greenery is required to complement the myriad needs for a strong economy, recreation, housing and defence against the Achilles heel of limited land resources. Can green spaces co-exist with these competing needs? How can green spaces become more inspiring landscapes?

THE NEW URBAN GREEN

A new vision of a dynamic Singapore with a concern for the global environment has begun to be symbolised in the government's change of the 'Garden City' to the 'City in a Garden'. This paper asserts that an 'Integrated Landscape' style, a new look urban green relying on ecological planning and design solutions should guide this vision. In this new urban green, biodiversity has an important role. The key strategies to achieve this vision are:

1. **Establish 'local identity'** — Creating an island-wide identity by using bio-diversed ecologically-based planting strategies
2. **Ecological design** — Ecological treatment within parks with emphasis on maximisation of land and sustainable designs of varying intensities
3. **Consolidation** — Maximisation of green spaces and recreational opportunities from the ground up to rooftops.

LOCAL IDENTITY

Despite massive urbanisation, original natural vegetation zones are still discernable from the many remnants of woodlands and mangroves scattered throughout the island. It is sensible to utilise natural vegetation associations as a means to understand and create local identity. 'Local Identity' can be defined by dividing the island into ecological treatment zones using Singapore's natural heritage as a guide, through an analysis of existing vegetation communities, geology, soils, climate and urban patterns. These treatment zones can be defined as: Forest Community (native), Coastal Community (native), Rural Community (mix) and Urban Community (mix), each with its own unique planting palette and design layout. This will provide distinctive broad landscape characters throughout the island as well as a higher level of biodiversity. It is preferable that the majority of plants used are native with exotics confined to the more culturally related rural and urban communities.

A step forward in this direction has been taken by the formulation of the Streetscape Greenery Masterplan for Singapore, a plan that uses the natural physical environment as clues to define and guide the planting design of all roads (Fig. 3). One of the major cornerstones of the plan is to increase the variety of plants used, and to plant appropriate plants in environments more suited to their natural growth habitat. Hopefully, the next step forward will be the incorporation of this approach into overall land use planning.

ECOLOGICAL DESIGN

Ecological design is an approach to maximise land and to create more sustainable designs using various ecological intensity levels. This means a less than manicured and ordered look is necessary and where the 'wilder' look of Singapore natural vegetation becomes more prevalent. Ecological intensity can be adapted to the recommended categorisation of parks and nature areas as mooted by the 'Subject group report on parks and waterbodies plan and rustic coast' (2002). The report recommended that nature areas, parks and open spaces be categorised into the following: Category A, natural areas to keep pristine; Category B,

wilderness areas; and Category C, public parks and open spaces (Subject Group 2002).

In Category A, the ecological intensity will obviously be at its highest level. Preservation of the current biodiversity levels and health of the nature reserves will be a priority. Maintenance requirements should be very low as there is already a functioning self-sustaining ecological system. Rehabilitation of disturbed fringes as well as re-introduction of certain fauna species will be important. Such programmes will need to be carefully studied, formulated and executed.

Within Category B areas that are generally regenerating forests, old farmland and abandoned quarries, there will need to be a balance between nature areas and basic recreational facilities. The biodiversity should be maintained or even assisted and by linking these wilderness areas together where possible. However, there are no guarantees that these nature areas will remain as they will be developed when the need arises.

There is a lot more that can be done in the Category C parks and open spaces. Besides providing a varied and exciting range of recreational activities, much of the land allocated to parks and open spaces are planted but remain unused. These can be maximised. They are the obvious crucibles for the regrowth of new communities of forests, swamps and mangroves. Such regeneration of forests and reintroduction of fauna, and not just random collections of indigenous species, provide opportunities for education and research. These will certainly create more random and exciting experiences together with the existing manicured areas, and can begin to replace the lost heritage for a future generation, and possibly, in the process create new places of interest.

The natural communities also contribute positively to the management of parks by decreasing the necessity for pruning, forking, watering, fertilising, and applying of pesticides and insecticides. In addition, the higher quantum of biomass generates more organic wastes that can be harvested and recycled to create much needed compost and soil.

CONSOLIDATION

In ‘Consolidation’, the strategy is to bring together various government bodies to maximise land use for better integration of greenery and exploit opportunities to create unified macro landscapes (Fig. 4) rather than disjointed mosaics of green. Naturally, the unified landscape should follow closely to the planting treatment zones. Parks, open spaces within developments, drainage reserves, road reserves, public and private housing estates, industrial parks, sports complexes, commercial centres and undeveloped land can be linked in many cases, to create a series of large open spaces and a more integrated recreation network.

This strategy can be applied to the park connector system that is the backbone linking major parks together, connecting all adjacent open spaces (developed or undeveloped) into an integrated green network. These integrated spaces could consist of water bodies of soft-banked rivers and canals, regenerating forests and mangroves, nature corridors, linear manicured gardens, adventure recreation facilities, fruit orchards and vegetable gardens etc. This scenario not only maximises land use with multiple functions, it also offers a varied landscape by providing opportunities for different plant communities to establish. In addition, large green masses and water bodies may potentially be created and used to impact the urban environment both visually and in influencing microclimate.

‘Consolidation’ can also be applied to the skyrise greening initiative launched in 2001. In the future, high-density compact city blocks will be built closer and higher, up to forty stories and living spaces will become closer. Greenery at such heights will be confined to protected spaces and a new palette of alpine type plants. On a more practical level at the lower stories, there are extensive areas of flat rooftops that significantly contribute to the heat island effect in tropical Singapore. Mega schemes of a green fabric stretching from the street to rooftops and bridging across developments, will positively cool down the immediate microclimate, lower energy consumption,

provide visual amelioration and contribute an economic value by becoming productive, i.e., herb, vegetable and fruit gardens.

There may be a bonus to all the eco-greening. The integration of all these initiatives can lead to the development of ecotourism and adventure tours. Being easily accessible and a major travel hub, the whole of Singapore can be billed as a 'tropical bio-park', a convenient and interesting way of introducing tourists to the rich genetic heritage of South East Asia during their stay. Besides visiting the well known attractions (the botanic gardens, day zoo, night safari and bird park) tours could include a hike in a rainforest, a boat ride along an estuary, a wade through the mangroves, and visiting skyrise farms, etc.

CONCLUSION

In conclusion, if the new urban green is implemented with as much zeal as was evident in the 1960s at the beginning of the 'Garden City' movement, greenery will continue to form a rich green mantle over the island. The natural heritage of Singapore has an important role to play. Policy makers have to 'think outside the box' and accept changes to entrenched methods of planning, design and management to drive these initiatives forward. This will also drive the process of developing a definitive Singapore garden style.

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Fig. 1 Singapore with projected land reclamation schemes.

Fig. 2 Standard tree planting spacing along roads.

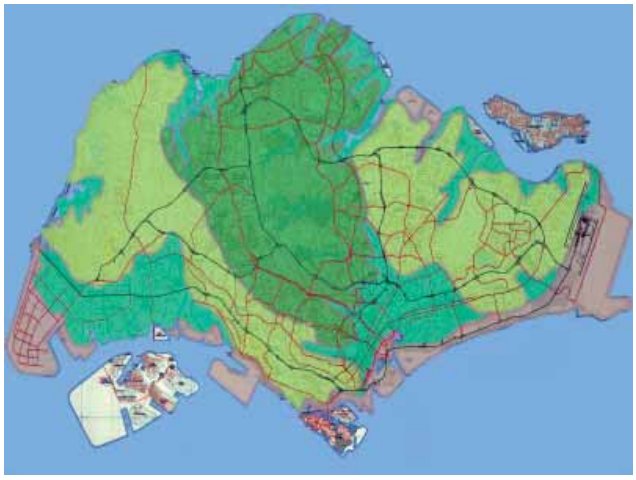

Fig. 3 Streetscape Greenery Masterplan for Singapore.

Fig. 4 The business district. The challenge is to weave a green fabric amongst the high density urban environment.