

The Role of Green Infrastructure in the Sustainable City

A Vision for Singapore

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Held in March 2014, a workshop hosted by the Centre for Urban Greenery and Ecology in Singapore considered the potential for green infrastructure (GI) to integrate a range of sustainability initiatives and inform a comprehensive green plan for Singapore. GI is a system representing the ways in which nature can provide services for urban or rural populations. Such services include flood protection, improving air and water quality, addressing the needs of wildlife, and providing greenways for people to easily and safely move through their communities. GI includes urban forests and parks, wetlands, river corridors, green streets and roofs, road median strips and verges, schools, and nature reserves as well as all scales of vertical landscape (ASLA 2014).

The workshop was held in the context of the ENVision initiative by the Singapore Environment Council (SEC) in early 2014, which sought contributions to a review of the 2009 Sustainable Development Blueprint from a wide cross section of Singapore society. The 2009 Sustainable Development Blueprint was released by the Inter-Ministerial Committee on Sustainable Development (IMCSD) to “outline key targets and initiatives to improve resource efficiency and enhance Singapore’s urban environment for the next 10 to 20 years” (MEWR 2013).

Based on the feedback from ENVision, an updated version of the blueprint, Sustainable Singapore Blueprint 2015, was launched in 2014. The blueprint highlights the strategies and programmes needed for Singapore to achieve “both economic growth and a good living environment over the next two decades” (MEWR 2014).

Overview of Workshop

Participants who attended the workshop represented a cross section of stakeholders associated with land-use design, development, management, or maintenance. The workshop began with reports from attendees on the many sustainability initiatives already undertaken in Singapore. These initiatives all contribute to the sustainability blueprint, which has acknowledged the influence of a broad range of global and domestic challenges to the achievement of a sustainable city.

Participants were reminded that GI provides a range of ecosystem services, which supports the aims of the sustainability blueprint and which are important to the future resilience of Singapore. Understanding which ecosystem services are existing and valued enables areas for improvement to be readily identified. This will maximise the benefits of any changes in the approach to land use or development which may help to fill those gaps. Participants were also asked to identify services with which they were involved as part of their work responsibilities so that potential factors influencing those aspects of GI could be highlighted.

Site visits were conducted during the workshop to Khoo Teck Puat Hospital and the Punggol Waterway Park; both sites provided good opportunities to discuss the ways in which ideas of sustainability had been expressed through their design and management. The landscape of the hospital, in particular, expressed many of the values and services offered by GI, and it is a great asset to support the continuing movement of Singapore towards being a sustainable city.

The final part of the workshop pulled these related threads together in a role-play exercise. Participants were invited to prepare a series of fictitious submissions to the SEC as though they were contributions to the ENVision exercise. The objective was to highlight issues of significance to special interest groups or individuals that could enrich the updated draft of the Sustainable Singapore Blueprint and make a positive contribution to the sustainability of Singapore.

It is important for those responsible for the planning, design, and management of land resources to be clear about those services and their inter-relationships as parts of GI. As landscape architect Martha Schwartz noted in 2011, “our primary role . . . is to understand and synthesise the vast elements of both hard and soft systems that operate on and in our urban landscapes, and then, give shape, form and meaning to the built, physical environments in which we live collectively” (Schwartz 2011, 127).

The Meaning of Sustainability

The concept of sustainability and what it actually means has been contested at least since the release of the Brundtland Report by the World Commission on Environment and Development in 1987. This publication defined “sustainable development” in terms of “inter- and intra-generational equity, the need to include economic and social factors as well as environmental ones when undertaking assessments for development projects and the need for continued economic growth to assist developing nations to achieve sustainability” (Spicer et al. 2011, 1).

The IMCSD defines sustainable development as growth which is: efficient (using fewer resources and producing less waste); clean

(no environmental pollution); and green (preserving vegetation, water quality, and natural heritage).

Daly argues that sustainable growth (or development) is an impossibility, since growth means continually increasing in size and we inhabit a finite, materially closed system: the earth. He notes that "currently the term 'sustainable development' is used as a synonym for the oxymoronic 'sustainable growth' " (Daly 1990, 45). The term "sustainability" rather than "sustainable development" is therefore preferred by the authors to describe measures for humanity to live in the long term within the planet's limits. It was also used this way in the workshop.

Nevertheless, using the term "sustainability" can still be problematic, unless it is expressed within a particular spatial and temporal framework. Such a framework allows the word "sustainability" to be used in an absolute sense (as in "this action is [or is not] sustainable") rather than a relative sense (as in "this action is slightly sustainable"). Defining these frameworks is much more likely to highlight the consequences of a planned action or change, as we would be able to confidently state that a proposal is sustainable within a site, a locality, a nation, or globally, and over a time frame measured in months, years or generations. Clearly, a positive global effect over many generations is the preferred outcome of all development or land-use change.

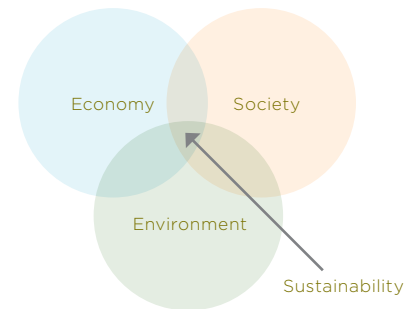
Early work on the nature and contested meanings of sustainability can be explained by considering three different models. Figure 1 shows the "balanced" model, which describes the definition of sustainable development in the Brundtland report (WCED 1987), where

sustainability is equally dependent on and supported by the three main "pillars" of environment, society, and economy. Figure 2, so-called "Mickey Mouse" for its similarity to the silhouette of the famous Disney character, suggests perhaps a more realistic model, where the economy is the driving force, more significant than either society or the environment, which currently are both highly dependent upon economic growth. Last, Figure 3, the "nested" model, shows perhaps an idealistic model, where the environment is accorded its rightful place underpinning everything else, supporting society, which in turn supports economic activity.

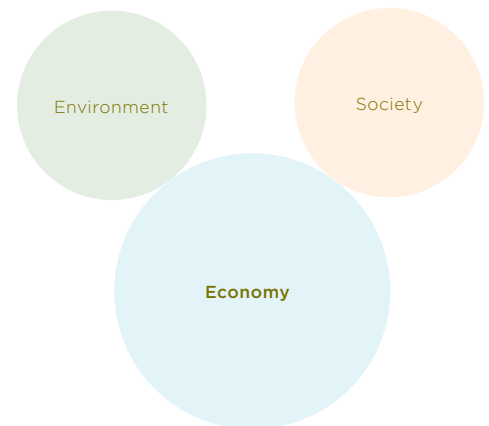
The workshop applied the nested model of sustainability to the concepts of ecosystem services provided by GI. These services are divided into four groups of elements or characteristics:

1. Provisioning (for example, safe drinking water and nutritious food)
2. Regulating (for example, wind and solar protection)
3. Supporting (for example, capture and cycling of nutrients)
4. Cultural (for example, provision for recreation or spiritual activities)

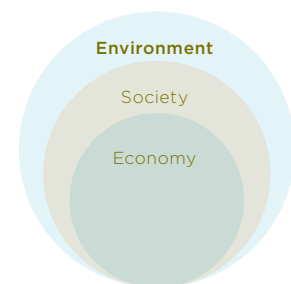
The broad nature of GI has significant potential to be an integrative framework for sustainable Singapore. The site visits provided some good examples of GI elements that contribute to a sustainable city. Khoo Teck Puat Hospital, in particular, highlighted the potential for integrated systems to deliver a wide range of ecosystem services, including the capture and filtration of stormwater en route to Yishun pond, the consumption of mosquito larvae by fish in small ponds, and



1. The Balanced model views sustainability as equally supported by the environment, society, and economy (Redrawn from Bob Willard, 2010, "3 Sustainability Models," July 20, <http://goo.gl/rUCn5a>).



2. The Mickey Mouse model views sustainability as a product most shaped by the economy and less by society or the environment, both of which depend on economic growth (Redrawn from OzPolitic, "Environment, society, economy," <http://goo.gl/uftM5WI>).



3. The Nested model views sustainability as most shaped by the environment, which supports society, which in turn supports economic activity (Redrawn from Bob Willard, 2010, "3 Sustainability Models," July 20, <http://goo.gl/tiHmSK>).

growing food organically on the hospital roof. The capability to grow food and recycle nutrients at the hospital provides a great role model for other public buildings and indeed any building with a flat roof, such as Housing and Development Board flats, private condominiums, or shopping plazas.

Role-playing the ENVision Exercise

Seeking ideas to improve the Sustainable Singapore Blueprint, SEC's ENVision exercise aimed to engage Singaporeans from the private and public sectors, including community groups, schools, non-governmental organisations, and individuals, to review "how we, as a nation, approach our future initiatives for the environment" (SEC 2014). The Sustainable Singapore Blueprint focuses on four strategies:

1. **Boosting Resource Efficiency:** Improving resource efficiency in energy, water, and waste management to be more cost competitive and efficient in the long term.
2. **Enhancing the Urban Environment:** Enhancing the physical environment through controlling pollution, increasing greenery, and cleaning and beautifying water bodies.
3. **Fostering Community Action:** Engaging and encouraging the community to adopt more responsible practices, habits, and lifestyles.
4. **Building Capabilities:** Building technologies and capabilities to realise sustainable development targets, spur economic growth, and export expertise.

The workshop was ideally timed for

participants to engage in an imaginary dialogue with representatives from SEC and outline their own vision for a sustainable Singapore. Participants formed small groups to role-play a range of people representing different sectors of Singapore society. These included a low-income family, an elderly citizen, a housewife, a professional consultant from overseas, and a developer. The ideas generated during the role-play exercise by these groups fell broadly into four main themes: existing ecosystem services, urban agriculture, community health, and enhanced education programmes.

Existing ecosystem services

A system to quantify the existing ecosystem services being delivered on "undeveloped" sites would enable better planning and design of any new development or land-use change on these sites to minimise their impacts on services. Identifying what is already there provides an opportunity to build upon existing resources. Development should take second place to preserving existing areas of forest in particular for their biodiversity and habitat values. The potential to link forest remnants through connectors and substantially improve the seamless movement of plants and animals across the island could readily be a development of the existing park connector network.

The economic benefits of retaining large existing trees and areas of forest were also noted. Environmental heritage values were regarded as important as historical buildings or places to the long-term health and vitality of Singapore and its citizens.

Urban agriculture

Urban agriculture is a key component that integrates multiple systems of GI, a concept that could enhance the city's open spaces to build resilience and generate income. Urban agriculture includes woodlots for fuel and fibre production, orchards for harvesting fruits and nuts, and various horticultural and agricultural crops growing at different scales, from large plots awaiting development to the small rooftop gardens and lawn spaces around residential estates.

The multiple benefits of urban agriculture include local access to fresh food at relatively low costs, reduced need for transport to buy food, and integrated composting facilities to recycle household organic waste. Working with local schools, such urban agricultural initiatives not only teach children about practical sustainability but also provide a supply of food for lunch and other programmes.

Community health

Enhanced connectors for plants and animals would also offer pedestrians and cyclists easier and safer access across the island. Opening more cycle ways and water-based recreation areas for physical activity, in association with awareness programmes about biodiversity and other ecosystem services for the community, would enhance community health.

Enhanced education programmes

Elderly people have time and energy to contribute to sustainability initiatives.



4. Lush multi-layered planting at Khoo Teck Puat Hospital.



5. Vegetables being grown on the rooftop as a demonstration organic garden at Khoo Teck Puat Hospital.



6. Roosting birds on Yishun pond, beside Khoo Teck Puat Hospital.



7. Low water levels and dry grass banks at Singapore Botanic Gardens.



8. Parched grass areas at the Ngee Ann Polytechnic campus.



9. Dying epiphytes at Dunearn Road.



10. Dry amenity planting at a pedestrian overpass at Newton Circus.



11. Effects of prolonged low rainfall at Newton Circus.



12. A green wall for demonstration at HortPark, NParks' training and education complex.

Nevertheless, they may still benefit from enhanced education programmes to understand the reasons for certain environmental goals, such as minimising the use of water or conserving urban biodiversity. Combining subsidised solar and wind power generation systems with outdoor seating and conversation areas could not only meet the social needs of this generation, but also reduce the energy costs for their household water heating and air-conditioning. Electric vehicles to shuttle elderly people to local produce markets could round-off an integrated system.

The group that assumed the role of a developer voiced concerns that too much attention on GI would be detrimental to economic activity due to increased maintenance costs and lost opportunities to build on “vacant” land. However, a more visionary approach could easily replace standard “lost initiatives”. For example, a suggestion that captured attention was the idea of developing linear cafés along walkways or cycle ways, to cater to and attract more recreational users, providing food and drinks as a social service but with additional economic benefit.

The workshop was coincidentally held in the aftermath of Singapore’s driest period in 30 years, providing an excellent case study on the importance of water management and conservation and the need to develop resilience against adverse climatic influences. Brown grass and dying epiphytes were constant and graphic reminders of the

vulnerability of our ecosystems to sudden changes in rainfall or temperature. The drought broke shortly after the workshop began, but the consequences of the earlier dry period underscored some of the key points raised during the workshop.

Conclusion

Following the workshop, participants could return to the workforce with a deeper understanding of the role of GI in Singapore and the potential of the ecosystem services provided by GI to contribute to the sustainability of the city. Singapore has many excellent initiatives underway that contribute to enhancing sustainability. However, the workshop identified that there was also potential to achieve a better integration of these initiatives, and GI was useful as an integrating framework.

Considering the city’s sustainability using GI provides an opportunity to accommodate the four groups of ecosystem services and enable different organisations and authorities in Singapore to work together to facilitate a truly sustainable city. As an international leader in the application of infrastructure systems such as GI to a dense urban environment, Singapore would be able to increase her resilience and liveability.

What Schwartz wrote in 2011 is just as important now: “We must grasp the task at hand in its expanse and complexities and step up to the plate in our advocacy of sustainability at the urban scale” (Schwartz

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