URBAN SOLUTIONS

ISSUE 8 • FEB 2016

Building with Nature

A biannual magazine
published by
CENTRE for LiveableCities SINGAPORE

2016 WORLD CITIES SUMMIT

LIVEABLE & SUSTAINABLE CITIES:
INNOVATIVE CITIES OF OPPORTUNITY

WORLD CITIES SUMMIT

10 – 14 JULY 2016

SANDS EXPO & CONVENTION CENTRE
MARINA BAY SANDS, SINGAPORE

The World Cities Summit (WCS) is the exclusive and premier platform for government leaders and industry experts to address liveable and sustainable city challenges, share integrated urban solutions and forge new partnerships.

The 5th edition of this biennial event will be held in conjunction with the Singapore International Water Week and CleanEnviro Summit Singapore.

HIGHLIGHTS

- Lee Kuan Yew World City Prize Lecture and Forum
- World Cities Summit Mayors Forum
- World Cities Summit Young Leaders Symposium
- Plenaries, Thematic Tracks and Business Forums
- Networking events and site visits

In 2016, WCS will explore how cities can plan and govern better to serve their residents and build up resilience through policy, technology and social innovations. Active engagement will produce more opportunities for the public, private and people sectors to co-create innovative and integrated solutions for a more liveable and sustainable future.

CONFIRMED SPEAKERS AT WORLD CITIES SUMMIT 2016

- Mr Tharman Shanmugaratnam, Deputy Prime Minister and Coordinating Minister for Economic and Social Policies, Singapore
- Mayor Donald J Atchison, Saskatoon
- Mayor István Tarlós, Budapest
- Mayor Juan María Aburto, Bilbao
- The Executive Mayor Patricia de Lille, Cape Town
- Dr Han Seung-soo, Special Envoy of the UN Secretary-General on Disaster Risk Reduction and Water
- Mayor Dr Ko Wen-je, Taipei
- Mayor Len Brown, Auckland
- Mr Peter Brabeck-Letmathe, Chairman, Nestle
- Mr Charles O Holliday, Chairman, Royal Dutch Shell

REGISTER EARLY TO ENJOY SAVINGS & START CONNECTING

Registration for the World Cities Summit 2016 is now open! Register today at www.worldcitiessummit.com.sg before the Early Bird discount ends.

More importantly, register early to get on board the Connect@WCS platform where you will be able to make appointments to meet other participants at the Summit – speakers, mayors, senior policy makers, industry leaders, and many more.

For Registration Enquiries, please email to
registration@worldcities.com.sg

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Ministry of Foreign Affairs Leaders in Urban Government Programme

7 — 13 July 2016 | Singapore

The **MFA Leaders in Urban Government Programme** is a 7-day executive workshop and participation at the World Cities Summit targeted at international city leaders. The programme seeks to share knowledge and encourages application of high-density/high-liveability guiding principles in urban development and management. During the programme, participants will use the CLC framework to identify urban solutions and develop a 12-month action plan adapted for the context of their respective cities.

featuring

The **MFA Leaders in Urban Government Programme** will cover a number of modules related to high-density/ high-liveability urban development, reviewed through the lens of the CLC Liveability Framework. Proposed modules and sessions include:

- Participation at the **World Cities Summit 2016**
- Integrated Master Planning
- Dynamic Urban Governance
- Sustainable Environment
- Transport and mobility
- Parks/ Waterways Development

During the Action planning sessions, participants will have the opportunity to work on an urban challenge in their city in discussion with practitioners from Singapore's agencies.

world cities summit

The WCS is an exclusive and premier platform for government leaders and industry experts to address liveable and sustainable city challenges, share integrated urban solutions and forge new partnerships. The theme of WCS 2016 is: Liveable & Sustainable Cities: Innovative Cities of Opportunity.

For more information about the World Cities Summit 2016, see http://www.worldcitiessummit.com.sg

programme details

Date: July 7th-13th, 2016 (Arrival on 6th)

Location: Singapore

Participants' Profile: Mayors and city leaders, as well as senior civil servants, of all major cities

Language: English

Cost: Participants will be covered for the cost of the capability development programme and attendance at World Cities Summit, including accommodation, some meals and daily allowance. Some funds are available for flights.

programme requirements

Participants are requested to propose a project to be implemented over the next 12 months, which will be discussed during Action Planning sessions. The project should be related to city development, such as Planning, Housing, Transport, Waste Management, Greening, Water and others.

application

Application deadline: 1 May 2016

Interested participants should complete the application form and submit a copy to Amanda Yang (amanda_yang@mnd.gov.sg).

It is strongly encouraged for participants to apply early to confirm placement in the programme.

A joint programme by:

CENTRE for LiveableCities SINGAPORE | MINISTRY OF FOREIGN AFFAIRS SINGAPORE | SCP SINGAPORE COOPERATION PROGRAMME

URBAN SOLUTIONS
ISSUE 8 • FEB 2016

URBAN SOLUTIONS is a bi-annual magazine published by the Centre for Liveable Cities. It aims to equip and inspire city leaders and allied professionals to make cities more liveable and sustainable.

Set up in 2008 by the Ministry of National Development and the Ministry of the Environment and Water Resources, the Centre for Liveable Cities (CLC) has as its mission "to distil, create and share knowledge on liveable and sustainable cities". CLC's work spans four main areas—Research, Capability Development, Knowledge Platforms, and Advisory. Through these activities, CLC hopes to provide urban leaders and practitioners with the knowledge and support needed to make our cities better. www.clc.gov.sg

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Temasek Foundation Leaders in Urban Governance Programme

7-11 November 2016

The Temasek Foundation Leaders in Urban Governance Programme (TFLUGP) is an exclusive 5-day mayoral programme. Practitioner-focused and action-oriented, it allows participants to learn how Singapore overcame its challenges through a whole-of-government approach to creating a highly dense yet highly liveable city.

Through seminars, panel discussions, site visits, and dialogue sessions, the Programme will explore the following key themes:

- Integrated long-term planning
- Liveable high-density communities
- Governance & infrastructure
- Sustainable development
- Competitive economy

why TFLUGP?

- **Best Practices and Insights** into Singapore's development strategies
- **Exclusive Dialogues** with past and present Singapore leaders
- **Expert-Mentored Action Plan** for cities to implement over one year
- **Networking and Peer Learning** with experts and participating city leaders
- **Site Visits** to experience urban solutions first-hand

past speakers include

Mr Khaw Boon Wan
Coordinating Minister for Infrastructure & Minister for Transport

Dr Liu Thai-Ker
Chairman, Centre for Liveable Cities Advisory Board

Mr Peter Ong
Head, Civil Service and Permanent Secretary (Finance)

Dr Cheong Koon Hean
CEO, Housing & Development Board

RADM (NS) Chew Men Leong
CEO, Land Transport Authority

Mr Ng Lang
CEO, Urban Redevelopment Authority

Mr Andrew Tan
CEO, Maritime Port Authority

Ms Usha Rao-Monari
CEO, Global Water Development Partners

applications

Cities are invited to nominate teams headed by the city leader (governors / mayors / municipal commissioners) together with two other senior officials responsible for urban planning, development and governance.

Cities should submit a concept paper on a project related to a challenge they wish to implement over a year. Visit www.clc.gov.sg/Training/international.htm to apply.

Application deadline is 1 Oct 2016.

selection criteria

- Fluency in spoken and written English
- Relevance of proposed project to making highly dense cities more liveable

programme fees

S$13,500 (inclusive of accommodation)
Sponsorship from Temasek Foundation is available. Eligibility criteria apply.
See application form for details.

past participants

"All who mentored us this week are the cream of urban planning, sharing real-life, not textbook, experiences."
Rohan Seneviratne, then Additional Secretary, Ministry of Defence and Urban Development, Sri Lanka

"The programme will be useful for the local city planning and administration for a sustainable development of the city of Visakhapatnam."
Burla Ramanjaneyulu, then Commissioner, Greater Visakhapatnam Municipal Corporation, India

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Contents

FROM THE EXECUTIVE DIRECTOR

Nature's Place in the City

The late Mr Lee Kuan Yew, Singapore's first Prime Minister, once said, "A blighted urban jungle of concrete destroys the human spirit." This issue of Urban Solutions, with a special focus on "Building with Nature", explores how nature enhances a city's liveability.

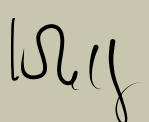
Our experts set the stage in *Opinion*, by discussing biophilia, i.e. humans' affiliation to nature, and the relationship between nature, people, and the city.

In *Essay*, Professor Peter Edwards of the ETH-Centre proposes that the resiliency of natural ecosystems lends itself to being adapted by cities. Professor Peter Rowe of Harvard University explains how a city's identity can be rooted in nature, while Kenneth Er and Dr Lena Chan from the National Parks Board of Singapore describe how biodiversity can thrive by way of city networks. I also contemplate on how our interaction with nature can be expanded to include water, to further enrich city living.

In *Interview*, Chief Minister of Andhra Pradesh, Chandrababu Naidu, shares how Amaravati, the new capital city, will be a green and blue city. Professor Herbert Dreiseitl, esteemed landscape architect, discusses the importance of symbolic capital, or a city's image, and how it will convince city leaders to invest in nature. In *Young Leader*, Søren Smidt-Jensen shares that a green and technology-savvy generation is emerging, while Dr Wei Yang sheds light on how 21st century garden cities give value to the city dweller.

But nature's place in the city is best conveyed through success stories. In *Case Study*, Portland solved flooding with greenery, and Tokyo went back to nature for emissions-free landscaping. Singapore managed to integrate greenery and conserve biodiversity in three diverse scenarios—the building of a hospital, an eco-industrial park, and the most unlikely case, a landfill. Last but not least, Rotterdam in *City Focus* showcases how nature is used to contend with the forces of climate change to create a liveable city.

As the trend towards bigger and more cities intensifies, it is timely to review our vision of a liveable city—is it one with grey towers of concrete and steel, or one that includes green and blue elements? We hope this issue inspires you to lean towards the latter. I wish you all an enjoyable read.



Khoo Teng Chye
Executive Director
Centre for Liveable Cities

Chief Minister of Andhra Pradesh Chandrababu Naidu, at a community planting event under the Neeru-Chettu programme in Hyderabad.

INTERVIEW

N. Chandrababu Naidu

Transforming Cities

In September 2015, Chief Minister of Andhra Pradesh state in India, **N. Chandrababu Naidu**, visited Singapore to encourage companies to participate in the development of Amaravati, the state's future capital. In this interview with CLC adjunct editor Koh Buck Song, Mr Naidu shared his vision of sustainable smart cities, and his insights from working with Singapore to create the Amaravati Master Plan.

"Cyberabad" is a part of Hyderabad city that attracted many investments in Information Technology (IT). What was your strategy in attracting such investments?

In the early 2000s, Andhra Pradesh was not developed—we had low employment, and many other problems. We had a financial deficit, so we had a problem even with regular expenditure. I thought: "How can we develop? How we can create the best economy?" After many brainstorming sessions, I decided on IT.

We started an iconic business district called HITEC [Hyderabad Information Technology and Engineering Consultancy] City that attracted many companies. I went to America, and spent 14 days visiting the corporate heads of companies such as Microsoft. I built friendships and asked them to come to Hyderabad. Everything was built over a period of time—world-class infrastructure, IT companies, and so on. If you create one IT job, the indirect employment created will be five or six jobs, be it the hospitality, transport, or residential and commercial sectors. I named the area Cyberabad.

Will you apply some of these strategies to Andhra Pradesh in the future?

We cannot replicate exactly what we did for Cyberabad, for Andhra Pradesh. Before Cyberabad, our software development was not mature. Over time, that has become a reality. Now in India, we're importing huge quantities of hardware and electronics. I am planning and creating an excellent ecosystem in hardware so that Andhra Pradesh can become a hub for hardware and electronics.

We have a strategic location, with around 1,000 kilometres of coastline. On the east coast of India, ours is the only state with such abundant opportunities. My vision is to promote port-based industries to make Andhra Pradesh a logistics hub. Just like in Singapore, where you built a port, then an airport, and then a city, till it becomes a very dynamic city. And then, to connect everything up, backward and forward integration, at a world-class level.

Hyderabad is not all about technology; there's also a lot of emphasis on the natural ecosystem. Could you talk about its green aspects?

My thinking was that we not only had to create employment and also wealth for the people, but the city must be sustainable. This is important. So, I started to emphasise greenery in public places, and I encouraged families to grow more plants. I used to plant, three to four *lakh* [hundred thousand] trees a day, like a mass movement. Now Hyderabad is one of the best cities, a green city, compared to others in India.

What is the key takeaway in developing Hyderabad, for other city leaders who also want to develop economically vibrant and liveable cities?

Every city has this ambition—the issue is the capacity to do it. In India, there are huge opportunities in the urban area; as we can see all over the world, urban areas can create more economic growth and employment. So, the question is how to make the urban areas more liveable and sustainable, and then you can create wealth and employment for all the people. Every policymaker has to concentrate on urban development.

Recently, India's Prime Minister Narendra Modi set up a sub-committee with nine Chief Ministers, for the Swachh Bharat Mission ["Clean India Mission"]. Now we are working on a report to see how to implement this mission. In Singapore, with waste you are generating energy—it has even become a source of wealth. In India, tonnes of waste lie on the roads everywhere, and create so many problems. This is what we are studying now: to see how to convert waste into energy, manage sewage treatment and how best to use water, just like you do in Singapore with NEWater, which everybody is prepared to drink.

01 The HITEC City in Cyberabad houses many IT parks, such as the iLabs Centre.

02 The coast of Visakhapatnam (Vizag) city offers ample opportunities for the state of Andhra Pradesh as a logistics hub.

01

02

“To build a capital is a rare, once-in-a-lifetime opportunity.”

01

02

This is the new spirit that has been brought in, regarding the treatment of pollution. I am very happy for this. We are planning to also go into this in a big way. We're going to submit a report to the government of India, to create new institutions to do this job—Swachh Bharat, Swachh Andhra Pradesh, Swachh Karnataka, and so on.

One of the big ideas in India is the smart cities plan. What are you hoping to achieve for Andhra Pradesh?

Our Prime Minister has announced the plan for 100 smart cities. Besides giving incentives, they are rating and ranking the cities continuously. So naturally, there will be competition among states and local bodies. This is already happening today. Every city should become a smart city, and also a liveable one. Then employment will take place, a vibrant economy will come, sustainability will be there, and people can enjoy life. So, we are working in this direction. We want to provide better amenities and better infrastructural facilities in smart cities.

Let's talk about Amaravati, the new capital of Andhra Pradesh, and its Master Plan, which aims to become "the people's capital". What does this mean, and what do you hope to see?

In the mid-90s, Hyderabad was not a top-rated city. There was land in Hyderabad but no water, no infrastructure, and no connectivity. Then I started to build it up, one by one. After the bifurcation of Andhra Pradesh state, we didn't have a capital. So now, we are trying to convert a crisis into an opportunity. To build a capital is a rare, once-in-a-lifetime opportunity.

So, I sent a call out to the people, and the people responded very well. In India, land acquisition is a big problem but I was able to acquire nearly 33,000 acres of land with voluntary land pooling. This is historic. Nowhere else in the development of the country has this been done.

I have very good relations with the Singapore government, and I admire this government because of its integrity, efficiency and continuous, consistent development. So I came to Singapore, and requested help to prepare a Master Plan to build a world-class city. There are so many cities today that are very good, but Singapore is a truly liveable city. Other cities may be more beautiful, but Singapore is sustainable and liveable; it has law and order, greenery, shopping, offices, urban transportation, everything. This is how I want to build one of the best cities in Andhra Pradesh.

01 Chief Minister Chandrababu Naidu, and his delegation, visits the Singapore City Gallery where he is shown Singapore's physical transformation over the past 50 years.

02 Chief Minister Naidu interacting with the people of Andhra Pradesh.

What is your vision for Amaravati, which you have been positioned as "the Venice of the East"?

Oh, I am very happy, this is a very good coincidence. We have the Krishna river, which is a perennial river. In recent times, we had a problem with the water supply as some projects upstream were being constructed. But there is the River Godavari that we were able to link to the Krishna river to get plenty of fresh water from the forest areas. Now, I want to build one more barrage at the riverfront of about 30 kilometres at Amaravati. This is the beauty of this city—there is not only very beautiful greenery, but also very fertile land. Greenery will be very powerful, very beautiful. So I want to go for greenery. I can also connect the river to the city, to make this the "Venice of the East". I am planning for aspects including pollution control and beautification. I'm planning for a blue-green city, and taking in the best international consultations to do this job.

How are you ensuring support from the people, including those in rural areas, who have to make this shift to the urbanised future of Andhra Pradesh?

Human psychology is the same, all over the world. The question is: how are we going to inspire the people, and motivate them for better things? If you do well, they will follow you. And at the same time, there is medium-term and long-term planning that you have to do.

In Singapore, you have had only one government for 50 years. The people are supportive because this government is delivering. In India, it is also the same. In the past, I was ahead of the times.

01 Greenery and water will be key features in Amaravati, to become the "Venice of the East".

02 Chief Minister Chandrababu Naidu.

01

> **"Greenery will be very powerful, very beautiful."**

There were some miscalculations, and I lost [an election]. Now, I am balancing everything—how to go about urbanisation, and, at the same time, how to develop villages, even remote ones. My aim is always to keep the people happy, by creating wealth, and then for the poor, to give them sustainable welfare. Ultimately, inclusive growth is my concept, because everybody should rise above poverty.

What are your thoughts of Singapore, especially since you and your delegation have visited Singapore to study aspects of the development of the city?

People say Singapore has a higher cost of living but they know it is peaceful and the economy is good. The place is consistently growing and the people are happy. There is stability and security—anybody can go anywhere, with no fear for public safety.

In Singapore, there is not only beauty, but functionality. Even the parks have become health centres with beautiful greenery and walking tracks where you can spend time and enjoy the space. Everything is well-placed, I would say.

02

As for housing, people all over the world want a house—big or small. If I have a house, after some time, I'd want to upgrade, and then upgrade even further. That is the facility that the Singapore government has given to its people. I really appreciate it. So I am also thinking along similar lines for Andhra Pradesh but we need knowledge to achieve this.

What would Singapore's key contribution be in this area, then?

When there is hardware, you must have the software to match. In both areas, Singapore is very strong, whether in political, economic or social reengineering.

Singapore's government officials' capabilities and bandwidth for management are very good. We want to learn more in areas such as technology and management, ways to revive urban areas apart from Amaravati, and also training for our Indian Administrative Service officers. More capacity-building has to take place. Human beings will have extraordinary strength if you motivate them; if you also give them better skills, they will do wonders.

My idea is that, by getting the best practices around the world, I can make Andhra Pradesh a liveable state. By 2022, we want to be among the top three cities in India; by 2029, we want to be number one, and by 2050, the best destination in the world for technology, infrastructure, and also human resource development, where people enjoy life. I am laying a very strong foundation now. If I implement all my plans, they will have a tremendous impact on the common man.

Watch more here:

https://www.youtube.com/watch?v=k6v05ryvJHA&list=PLGKE0U1p8RxgmoqD3Y6Cz-7C9A7yNUbWw

Prof. Herbert Dreiseitl explaining the process of converting a concrete canal into a naturalised waterway.

INTERVIEW

Herbert Dreiseitl

Cities as Living Systems

German landscape architect and artist **Prof. Herbert Dreiseitl** is known for his groundbreaking urban hydrology projects and research around the world. His design consultancy Atelier Dreiseitl helped implement ABC Waters programmes at Bishan-Ang Mo Kio Park and JTC CleanTech Park, among others. Here, he discusses with CLC Deputy Director for Research Sophianne Araib what building with nature means for cities, and how policymakers can achieve it.

What does building with nature mean to you, and why is it important in urban development?

In the beginning, cities had a very strong connection to the natural environment. They were built in strategic locations with good resources: water, minerals, food. Then, we started having electric lights, air-conditioning systems and so on, and our city has become more independent from nature.

But that's an illusion. In the short run, we might isolate the city from the environment, but to be truly sustainable for future generations, we should be totally connected to the environment. Building with nature is not a new or romantic thing; it's not about being politically green or whatever.

Building with nature is the future. It is a logical consequence of making a city resilient, sustainable and liveable.

We are in a learning process of trying out new systems. Architects are rediscovering more transparent and "breathing" buildings—Singapore has some wonderful examples of green roofs and horizontal green structures. If you think about the Park Royal hotel from WOHA, which has different terraces, we are not at the end of the journey. We are just starting. In the future, we will come up with more environmentally-friendly solutions for the urban fabric, on the building scale, but also in the city context. Our city systems in the future will be much more reconnected to the environment and to nature.

How can cities move from looking at issues from an individual system perspective towards integrating urban systems?

A forward-thinking city has to have a clear understanding of where to go for the future. It's not one particular step, it is bringing different steps together.

For example, Vienna, an old city with a long tradition, has had a lot of challenges, such as flooding from the Danube. In response, the city made a very interesting decision by halting its Master Plan developments. Instead it launched a new project called the "Step Programme", which is based on the idea that we cannot decide today and we don't know what the city for the future will look like. So there is a lot of flexibility and freedom in how a city will develop, and it's a bottom-up approach, not only a top-down one.

Finding consensus and having a common vision needs a very good leadership structure, both top-down and bottom-up. What is the future of the city? Where do we want to see the city in 10 to 20 years? There should be an atmosphere of imagination, of hope.

Cities which have that character—Copenhagen and Singapore, certainly—have a kind of drive and an understanding that certain things have priority. If we say, okay, water has a very high priority or walkability has more priority than big roads—the city becomes an organism which is very much related to the people living in it, rather than a machine that is only functioning for the infrastructure. That vision is a very, very strong driver to make cities successful for the future.

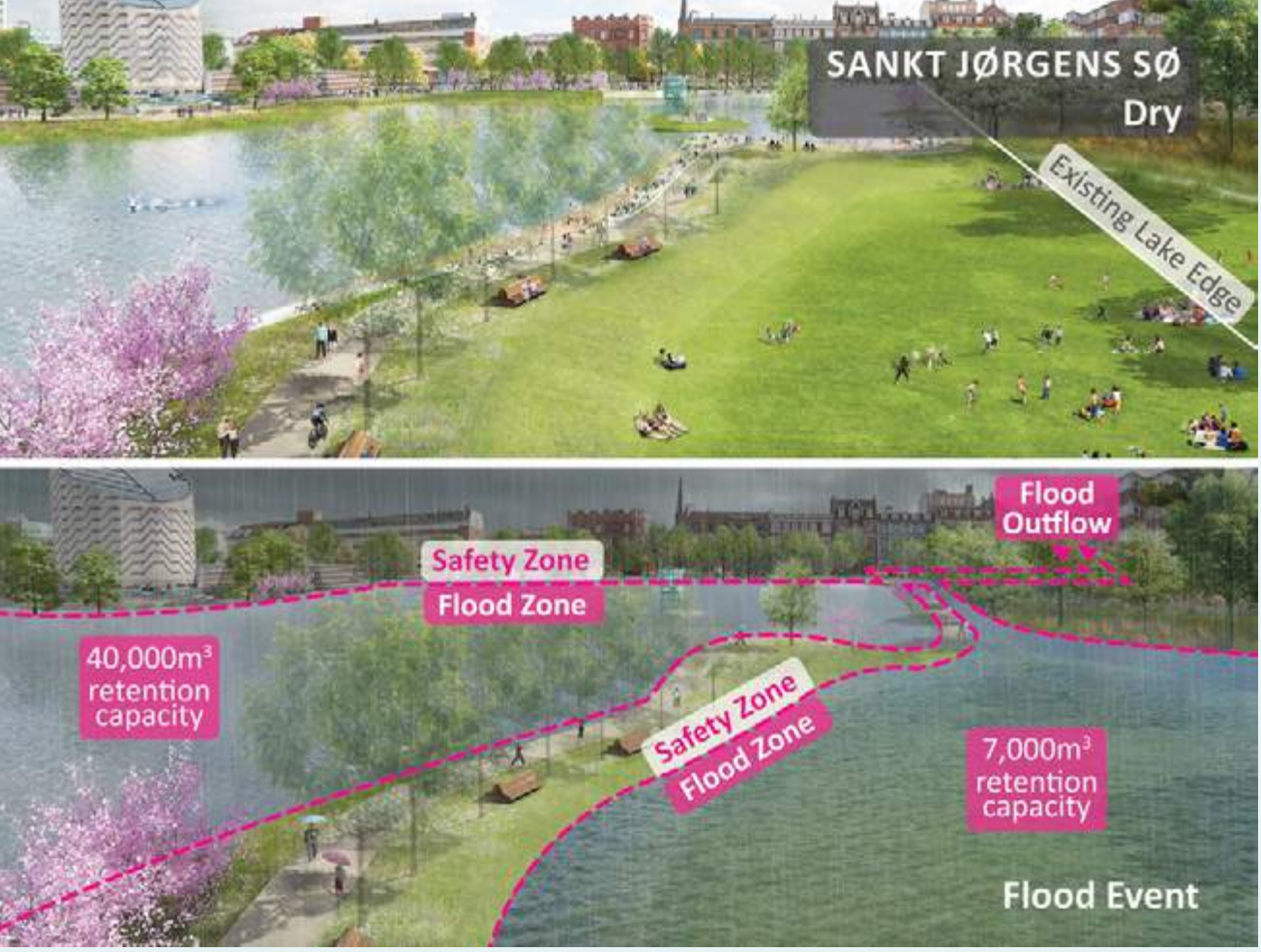
Most cities struggle when talking about nature in the context of cities, because they see it as a choice: nature or development. How do we find that integration when we talk about "building with nature"?

That's a very good question. It even brings us to a deeper question: What do we mean by "nature"?

The natural environment is so intelligent and resilient that we as humans can only mimic this system artificially. So when we talk about building with nature, we are not talking about wild nature. We are transforming it into an "urban nature", which has a totally different signature. A lot of people have the wrong image of snakes, mosquitoes, and bears or lions in the city. That's a totally wrong picture. Building with nature is about bringing natural systems back into the city—giving flora and fauna space to live. Instead of a mono-functional hard-scape, this urban nature creates a soft-scape that increases habitat, biodiversity and improves human health and human well-being.

To create something truly for Singaporeans, Prof. Dreiseitl spent a lot of time observing how the locals used the Bishan-Ang Mo Kio Park before conceptualising its design.

“In the short run, we might isolate the city from the environment, but to be truly sustainable for future generations, we should be totally connected to the environment.”



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What are some cities that have benefited from such an approach?

I have seen cities completely changed. In New York City or Chicago, for instance, investing in green infrastructure has had an enormous effect on stability because people feel more at home. Restaurants and businesses return; there's better air and a balance of heat and cold. Families move into the city so there's better social mix, less crime and vandalism and more security.

Mayor Bloomberg in New York City was very strong in his vision of bringing green into the city by upgrading old and new parks like Battery Park, the High Line and Brooklyn Park. These help to defend the city against superstorms like 2013's Sandy, which could occur more often in future as a result of climate change. Copenhagen is another good example where "blue" and "green" infrastructure, called Cloudburst projects, help to make the city more liveable and resilient against heavy downpours.

What can Singapore do better to become even more liveable and vibrant?

Singapore's strength is that it is extremely organised and very quick in making decisions. The decision process is really professional and systematic, which is a good opportunity to make changes and to implement new ideas. Singapore's vision as a city in a garden is a strong driver of programmes like the ABC Waters Programme Guidelines, which are very much copied in other cities.

01 Renderings of the new park at Sankt Jørgens Sø, Copenhagen, during fine weather and flood event, where the lower parts of the park act as a retention basin during heavy rains. This above-ground recreational solution also saves public money in comparison to the construction of an underground stormwater pipe.

02 Prof. Dreiseitl at the Mainstreaming the ABC Waters workshop organised by the Centre for Liveable Cities, where private and public stakeholders came together to brainstorm the next chapter of the programme.

> **Singapore tends to adopt others' models, so it's not always innovative. It would be good for Singapore to be at the forefront of research. That means having a bit more courage and taking controlled risks. That would be where Singapore could actually do better.**

But there are also some challenges. Singapore tends to adopt others' models, so it's not always innovative. It would be good for Singapore to be at the forefront of research. That means having a bit more courage and taking controlled risks. That would be where Singapore could actually do better.

It's not only a problem for Singapore, but Singapore is in danger of going off the road by being too bureaucratic. Regulations are okay, but when they are too complicated and abstract, they can kill green, resilient and liveable cities. We cannot plan liveability; we cannot say what the next generation will like and what is most liveable for them. We can only provide the conditions to support liveability—we have no idea what the next generation might come up with.

For instance, it's not the fault of older generations that they built monsoon canals that disrupt natural hydrological processes. They tried to do the best at that time but we have different needs now. We have to be able to make mistakes and learn from them; to experiment and to improve. That is a very important driver for making cities really vibrant and liveable.

Singapore could involve people more in the decision-making or planning processes—perhaps in the Asian way of seeking consensus and getting different stakeholders on the same page. This is important because people are standing up for their rights more and starting to articulate their different needs and wishes. Singapore could learn from cities like Vienna on integrating different groups and opinions, and having participatory planning in an intelligent way. This needs to be very professional otherwise you only hear what people dislike: "We don't like this, we don't like that, we want to have that." Instead, you have to get the best voices of the society, which are often the silent ones, to get really the common sense of a society.

Singapore has great responsibility as a leader in Asia. It has a stronger voice on urban solutions than many other cities in Asia so its solutions are not only Singapore solutions but are examples that give hope to many other cities. For example, there are still some covered storm canals leading into the Kallang River at the Bishan-Ang Mo Kio Park—the third phase of the ABC Waters Programme should include the opening up of these canals.

02

What are some of your current projects that develop this sense of biophilia and make it relevant for cities?

My current research at the Liveable Cities Lab [part of Danish planning consultancy Ramboll] is to understand how cities change their policies and politics to be successful—what are the drivers of change? How can I help future generations to better handle climate change and environmental risk? Together with four universities, we studied the value of different forms of capital. For example, when we talk about money, we often think only about real estate values, the price of buildings and so on. But that's actually very, very short-term in terms of value thinking. There is not only the physical capital of money, or of resources in a city, but also symbolic or human capital.

Symbolic capital is the image the city has, for companies to say "this is the right location where I will invest, where I will have my headquarters" and for people to look for jobs, a good environment to raise a family, and a good place to grow old. "Do I have good water, air and mobility systems where we don't have to spend many hours per week sitting in a traffic jam?" This capital has an enormous value. We presented a report of the first outcome in Paris at the COP21 United Nations climate meeting this past December. Mayors were really interested with the report, and found it a good argument for blue-green infrastructure. The key is convincing politicians and private companies of the added value of such infrastructure.

Urban solutions include not only resilience to climate change, but also making cities vibrant for lifestyle and economy—in terms of these different forms of capital. We are trying to convince city leaders, mayors and organisations that it is important to invest in the right direction because not doing so will be much more expensive in the future. We are currently working for cities like Helsinki, San Francisco, Jeddah, and Stockholm.

Projects of the sort you work on, like the Kallang River at the Bishan-Ang Mo Kio Park, often require different government agencies to work across silos. How do agencies overcome the inclination towards silo thinking?

Getting out of silo thinking requires strong leadership combined with a powerful and inspiring vision. This has to be supported by new structural and cultural capacity that can integrate, guide and unify different stakeholders.

Almost all cities have problems of a fragmented administrative structure, including Singapore. When I was working on first design ideas to reconnect and naturalise Rochor Canal, we had a vision, the technology, and the toolset. We would have had enough space to treat the water, improve water quality, increase biodiversity and make the cityscape more attractive. The barriers were the different silos of administration, responsibilities, funding, maintenance, and so on.

This is a problem everywhere. We have to integrate many disciplines and working fields, but vision and leadership are needed. This includes not only the CEOs but the next level of directors who implement the work. If their focus is too narrow, or if the responsibility is high and no one wants to take a risk, we cannot move forward. Fear is never a good teacher. It is better to create courage and give hope.

01 Ramboll is developing an Environment and Social Master Plan for Jeddah, Saudi Arabia.

02 In Singapore, Rochor Canal has been transformed from a smelly eyesore into a vibrant waterway that draws people with its rain gardens, lookout decks and benches.

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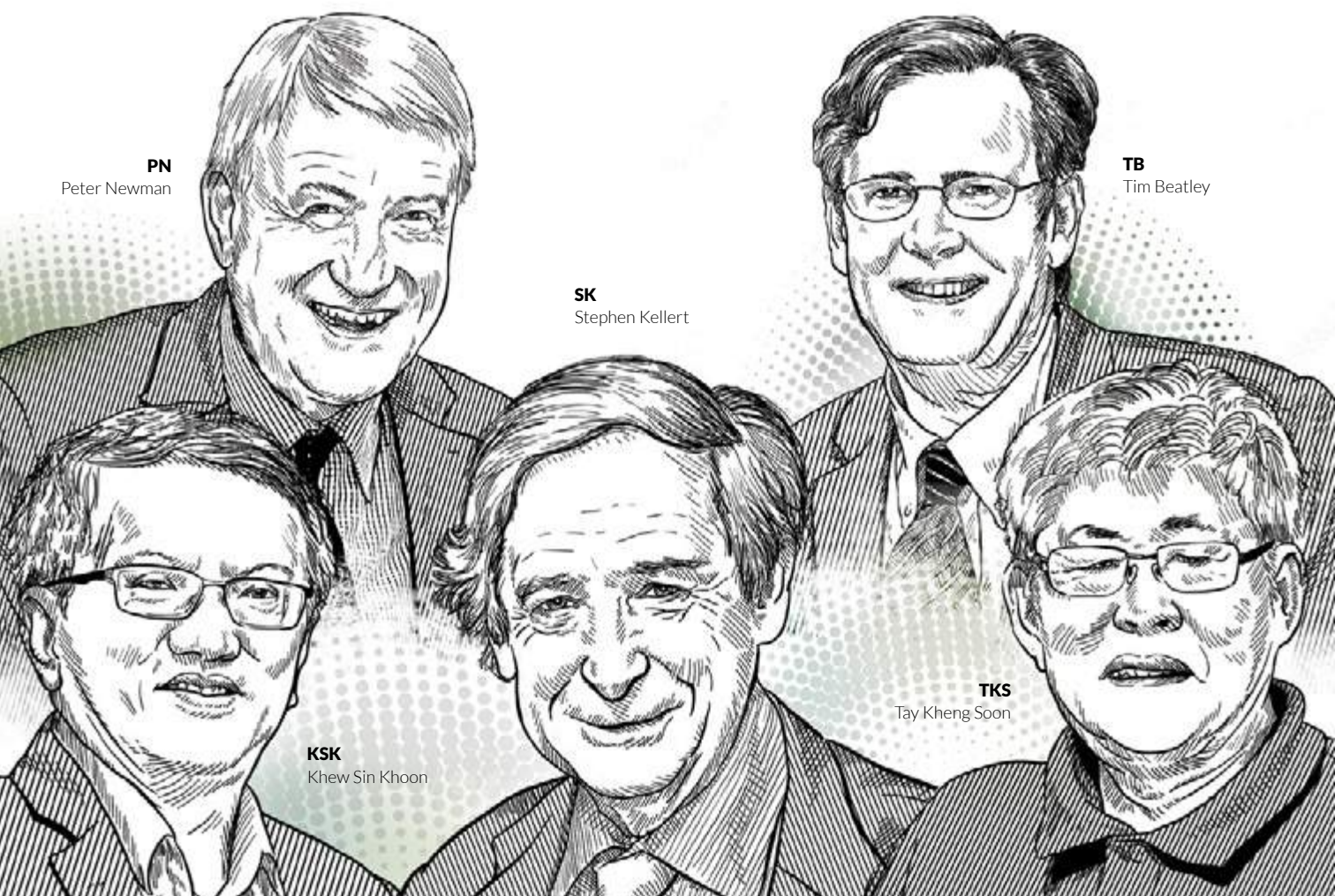
OPINION

Roundtable:
Stephen Kellert, Timothy Beatley,
Peter Newman, Tay Kheng Soon, Khew Sin Khoon

Biophilia: The Future of Sustainable Cities?



Biophilia, the idea that humans have an affiliation to nature, is often advocated as a principle for designing more sustainable and liveable cities. Singapore's National Parks Board and Centre for Liveable Cities explored this in their biophilia symposium last October featuring three foreign experts—**Stephen Kellert** of Yale University; **Timothy Beatley** of the University of Virginia; and **Peter Newman** of Curtin University—alongside two local practitioners—architect and public intellectual **Tay Kheng Soon**, and **Khew Sin Khoon**, President of CPG Corporation and an avid butterfly enthusiast. The following is an edited transcript of their discussion.

Defining Biophilia

SK Is "biophilic design" just another fancy name for nature? If any expression of nature in the built environment is biophilic, then why are we using the term? Fundamentally, biophilic design is ecological. It's not simply putting a plant here or using some natural material there. If we are not creating a habitat or ecosystem—mutually complementary parts that together are greater than the sum of its individual inputs—then we haven't really done anything, in my estimation, that is biophilic. Another point is that our change needs to be experiential and emotional. In order to identify with and take responsibility for places, we need to be deeply connected to them. Biophilia is not simply loving nature—it is an affiliation with nature. The deeper the level of connection with nature, the deeper the respect we have for it and the moral responsibility that will emerge from this feeling of connection. All these are elements of what we mean by biophilia.

Embracing Nature, Warts and All

KSK One human expectation of nature is that we want it to be under our control. For many, the visual aspects of biophilia matter as long as we see greenery, but enjoying nature through a piece of glass is only a clinical interaction. We should get out and enjoy it in all its messiness and occasional danger. There is a wide variety of acceptance of "nature". Biodiversity appreciation is not selective—if you enjoy the butterfly, you must accept the caterpillar. There is an innate fear of biodiversity in people, but you can't select what can or cannot be in natural areas.

Are there solutions? We have to educate ourselves that nature is sometimes messy and unpredictable. We should create in our designs a layered effect: start with a safe environment, layer it with a wilder area, and then an absolutely wild area. Temper that expectation and along the way, educate and engage both the young and the older generation who have lost touch with nature in the urban built environment.

> **...if you enjoy the butterfly, you must accept the caterpillar.**
>
> **Khew Sin Khoon**

SK The inherent problem with parks is that it reinforces a number of dichotomies. One is that humans are here and nature is out there; humans see nature as something to visit occasionally. We need to be able to integrate nature into our everyday lives and bring it into the spaces we inhabit. Another dichotomy is that we tend to think of nature as an aesthetic and recreational experience but there are many layers of our connection with nature and they are all legitimate. Growing things is important, for example. The more levels of connection we have with nature, the more benefits and values we obtain from it, ecologically as well as economically.

The Importance of Organic Growth

PN On my street in Fremantle, Australia, we have a guerrilla gardener who's redone all the verges of every house along the street. This was not allowed but he just did it because he wanted to see more nature —so he rebuilt the street as a rainforest. It's quite remarkable how much cooler and attractive it is now. People love to walk down the streets. The Fremantle council let it happen; it also had a crowdfunding competition for the best ideas to develop parklets—little parks created by local people—and the best three or four received funding to be built. We now have parklets across our city. In New York, there are these little new parks created on empty blocks that the council buys and converts into more permanent features. I think the bottom-up approach to bringing nature back into the city has to be facilitated as much as possible.

SK Bottom-up approaches are slow and difficult for planners and government officials, but it is ultimately the only truly sustainable approach. Singapore is an exception because of the type of government, scale and geography. Architecture is important but most architects are hired hands—99% do what developers tell them to do. Based on the economics of development and the value system, it's a lot easier for developers to clear the landscape, put up a bunch of boxes quickly, and get a return on their investment for the investors who have no stake in the local economy. To change that, we need an enlightened government, which may be efficient in the short run but in the long term tends to be ineffective if people do not support what is advocated. Alternatively, we need a fundamental change in our value system —where people demand a different kind of built environment that ultimately drives development decisions. This is a difficult and slow process. But, that's where inspirational models of innovation become very important. It will take this kind of shift from the bottom-up to change the economics of development to produce a profound transformation in how we design and build the urbanscape.

Biophilia From The Ground Up

TB If we think about the experiences of other leading cities that have made great strides, e.g., places like Chicago, it's often the mayor making things work. Often a lot can happen when you can reach that mayor who can lead to a city-wide policy or programme that can have greater impact, not just a pilot project.

That said, I support the grassroots approach. There are a number of fantastic stories, like the innovative parklets in San Francisco. There were neighbourhoods where citizens had been trying to install sidewalk gardens, but there wasn't a sidewalk garden permit so it wasn't legal for them to do so. It took some activism to change the building codes, making it possible to legally plant a sidewalk garden. Lots can happen if we think about how to empower at the neighbourhood level.

> **"...the greatest power lies with us as we come up with ideas and projects that seed the future."**
>
> Peter Newman

PN I've worked with the Premier of our state three times and the reality is the politicians are swayed by what others think. They are not going to get out there and say "we are going to create a whole new city" because they will not get elected; they will only get elected if they move along with the public.

Instead, the greatest power lies with us as we come up with ideas and projects that seed the future. Biophilia has to start from below. It's not going to come from the planner that produces a new city and drops it down there. It's going to come from below; it's going to come from all of our professions, our scientists and local government working away on how to come up with new sets of regulations, new kinds of facilitating, new ways of financing to enable biophilic urbanism to be mainstreamed.

Thinking Globally

TKS While it is valid to talk about nice little urban gardens, is it arranging the chairs on a sinking Titanic? If you had all the resources, what would you do? I think the first thing is to think of biophilia globally. What is the systemic issue? How do we solve the issue of the relationship between nature and human beings, between cities and countryside, between rich and poor, between monoculture and biodiversity? The previous Secretary General of ASEAN posed this question to architects and planners in our private discussion: "What are you going to do with 400 million poor people in Southeast Asia?" If you don't address that issue, you are going to face problems when they migrate and become refugees. City governments right now answer only to city populations.

> **Bottom-up approaches are slow and difficult for planners and government officials, but it is ultimately the only truly sustainable approach.**
>
> Stephen Kellert

The haze is a clear case. Are we concerned about the development of Sumatra and Kalimantan? If we are not, then we will have to breathe the haze. Should we not, in our own interest, invest in the infrastructural development of China or other places, to improve the livelihood of the rural poor so that they will not do what they are doing now? The issue is complex and goes beyond the biological field; it's a human issue. It's about the organisation of power and resources. Unless we develop the countryside, they are stuck because the export industries are in serious overproduction. The global economy is stagnated, and this is a global issue. This issue of economic stagnation is not going to go away because it is a structural issue. Unless we relate that to biophilia and how we organise human life, we are not going to solve the problem. I urge you all to think beyond the way we frame the questions of human relationship with nature and nature's necessities and so on. You have to think larger. My fear is you are not thinking big picture enough.

> **While it is valid to talk about nice little urban gardens, is it arranging the chairs on a sinking Titanic?**
>
> Tay Kheng Soon

TB There are profound social injustices and inequality in the world. My notion of biophilic cities is one that understands these green interventions and connections with nature as part of uplifting and enhancing the quality of life for everyone. There are lots of examples from the developing world: from food producing

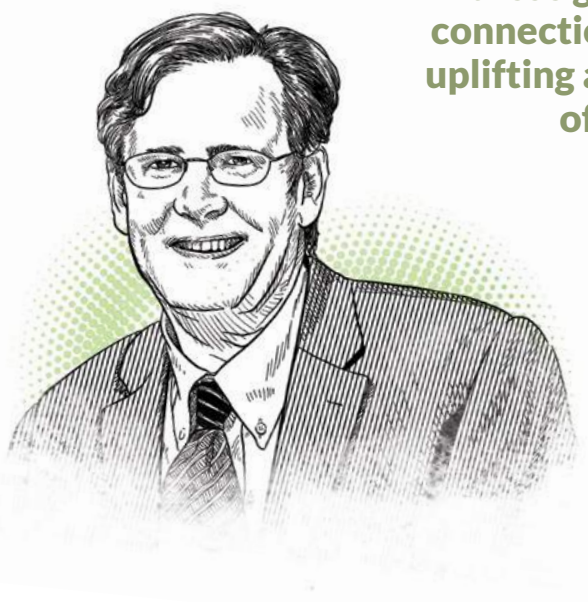
gardens on rooftops in Mexico City to the incorporation of nature to a favela, a redevelopment strategy programme in Brazil—ways that nature can in fact improve the quality of life for all.

TKS One other example is Mondragon in Northern Spain where the economy is co-operatively owned by 100,000 factory workers. They have achieved a kind of balance between their urban settlements and the surrounding natural environment and farms. For me the great inspiration is the Emilia-Romagna area in northern Italy, where the University of Bologna is in the centre of, where the urbanism is not the kind in New York or Singapore and yet there is tremendous quality of life, closely related to the food culture, agriculture, intellectual development, and the design culture. That's the kind of model of a rural-urban integration, which goes beyond the big city intervention we tend to think that biophilia is derived from. I think we need to scholastically look at other examples beyond the big city environments because the interventions in those contexts are actually quite puny. Cuba, for example, is a very interesting laboratory because of the blockade, and yet they have managed to eke out a balance between the rural and the urban. Biophilia is not only about green walls and plants on the window sills. It has to go much beyond that.

Making Singapore More Biophilic

PN People in Singapore are living in a city with a whole series of complex projects. Let's jump in there and provide the option of putting biophilic urbanism into the design of any new building, garden and space, and show that that is the next future thing to do. If you can do that, you can change the world.

KSK I hope to see more efforts in our habitat and ecosystem restoration projects in our parks. NParks is already doing a fantastic job of creating biodiversity reintegration and species recovery programmes for the areas under their charge. For the architects in practice, whenever we can, we need to do that integration for buildings. Community engagement is important too, as well as management strategies.



"My notion of biophilic cities is one that understands these green interventions and connections with nature as part of uplifting and enhancing the quality of life for everyone."

Tim Beatley

Watch more here:

https://www.youtube.com/watch?v=OKwLHrfgl8o&list=PLGKE0U1p8RxjMzvd4FDQVMAQXUaYVxRu4

ESSAY

Urban Systems

Learning from Rainforests

Tropical rainforests are ecosystems that have evolved over millions of years. **Prof. Peter Edwards** outlines the lessons that rainforests hold for cities that are aiming to grow sustainably.

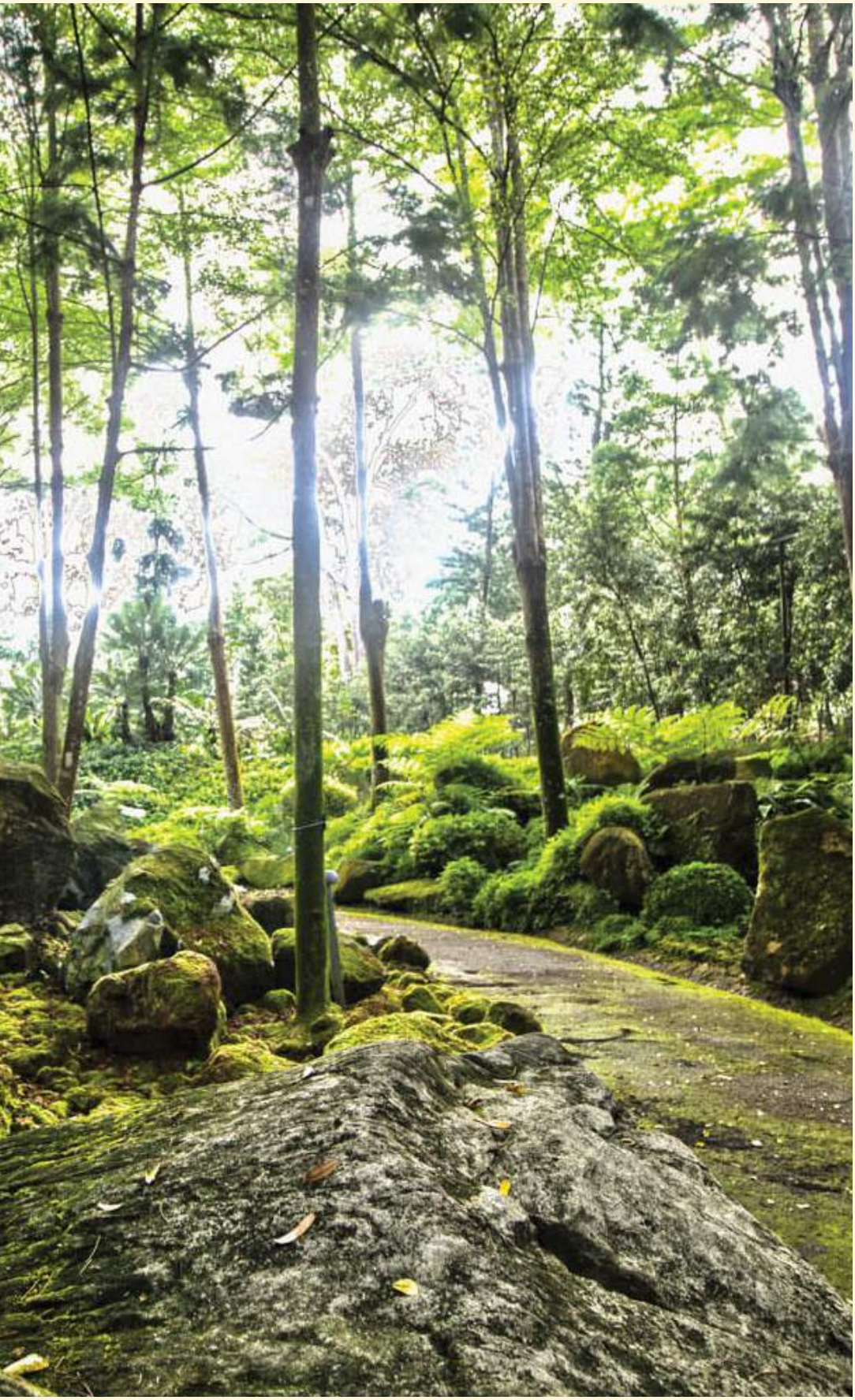
On an ecological timescale, cities are a new invention. Singapore, for example, was founded less than 200 years ago in an area that had previously been tropical rainforest. Indeed, there still remain a few fragments of that original forest, such as in the Singapore Botanic Gardens and in the Bukit Timah Nature Reserve. Each time I visit the fragment in the botanic gardens, I am caught by the thought that those magnificent trees, now in the centre of a bustling, modern city, started their lives in a pristine forest, with tigers and other wildlife roaming in the undergrowth.

What can we learn from tropical rainforests about making cities sustainable? For me, the most important lesson is that rainforests have developed gradually to their present form over many millions of years. By definition, the ecosystems that exist today are those that proved most stable, since those that were unstable have now disappeared. For this reason, it is interesting to ask: what are the features of a stable rainforest ecosystem, and how do urban ecosystems compare in this respect?

Regulating the Environment

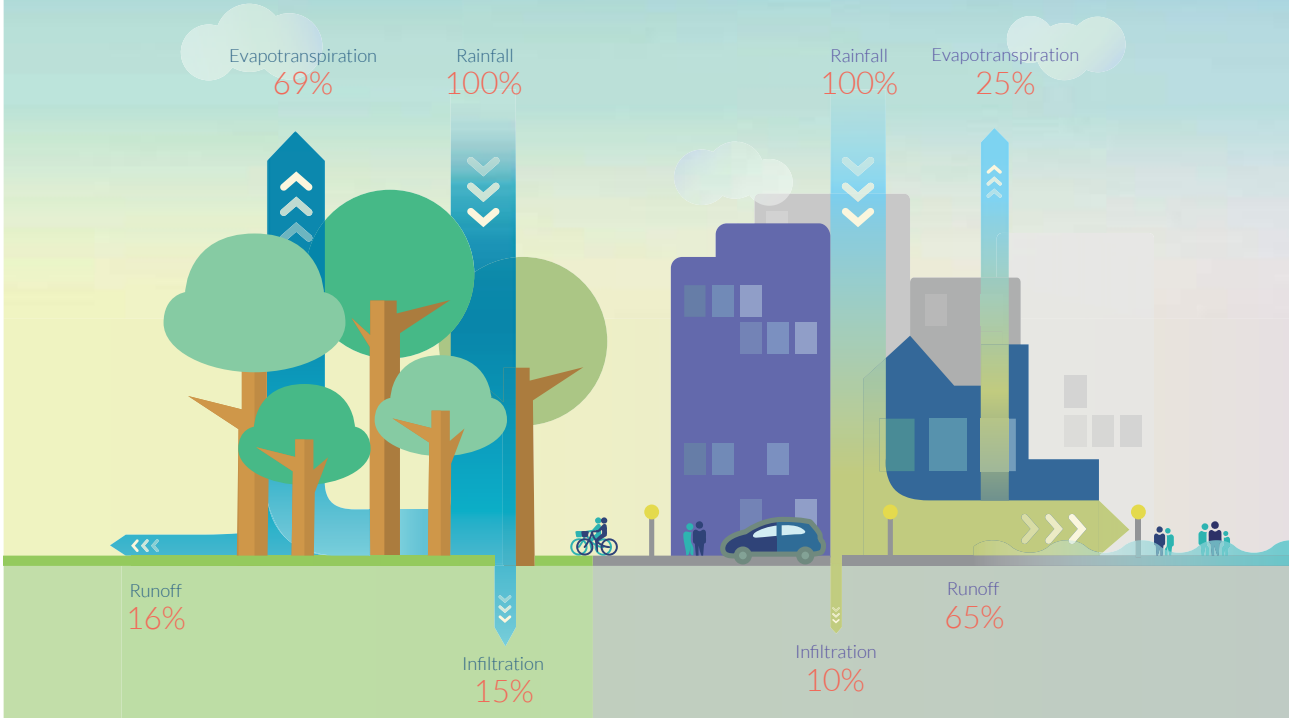
One feature of rainforests is that they regulate environmental conditions. For example, trees cool the air by evaporating water through minute pores in the leaves, in a process known as evapotranspiration. From the studies of rainforests that used to cover Singapore, we know that the amount of water lost in this way was equivalent to around 1,300 millimetres of rainfall per year.

Peter Edwards is Professor of Plant Ecology at ETH Zurich and Director of the Singapore-ETH Centre. He has studied the impacts of human activities upon ecosystem processes in many parts of the world. He has a particular interest in the application of science and technology for better policy and management.



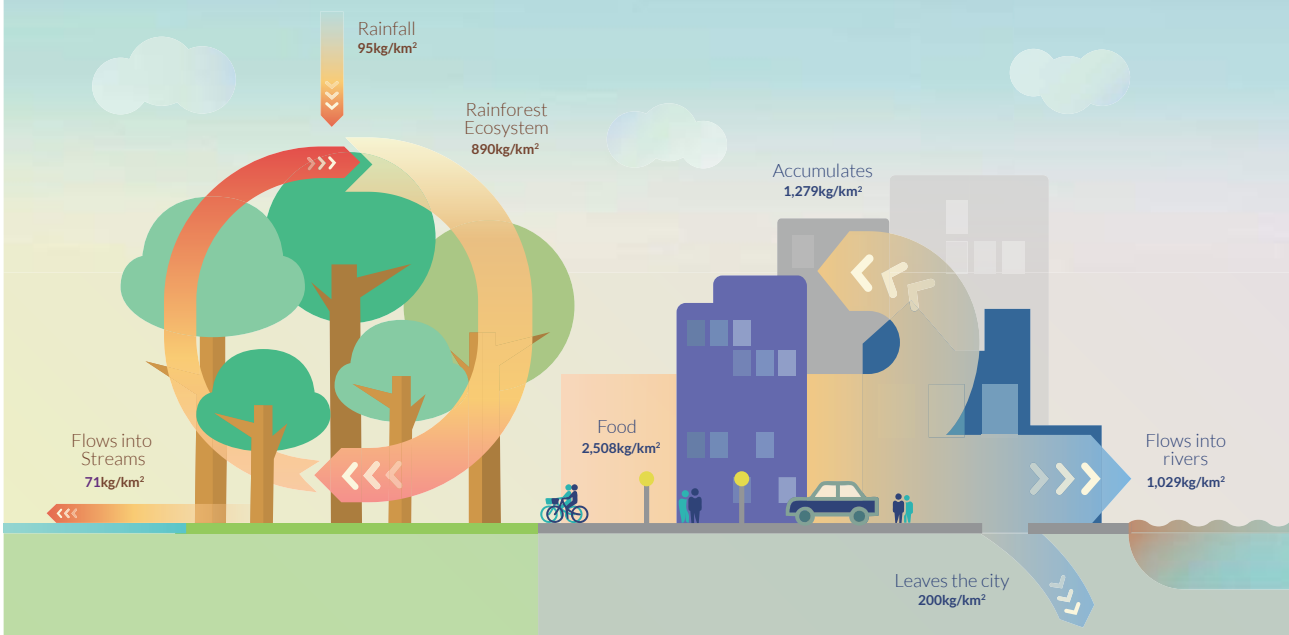
Patches of primary rainforest, at the Singapore Botanic Gardens.

Cities are more vulnerable to floods



Compared to a rainforest (left), the city experiences much more surface runoff due to the lack of permeable surfaces and greenery, which may lead to floods.

Rainforests have better ecological balance than cities



The fluxes of phosphorus (in kilograms per square kilometre) in a tropical rainforest, and associated with food consumed in Bangkok.

In a rainforest, large amounts of phosphorus are recycled within the ecosystem, with a very small amount entering or leaving it. In contrast, very little phosphorus is recycled in a city, with large amounts being consumed in the form of food or discharged through sewage. The loss of phosphorus means a greater need for fertilisers for farming needs.

And from this we can calculate that the average rate of cooling due to evapotranspiration was about 100 watts per square metre. For comparison, the total electricity demand of Singapore averaged over the entire island is only one fifth of this amount.

A rainforest also reduces the risk of flooding after heavy rain by absorbing and storing water like a huge sponge. This is because each of the millions of leaves in a hectare of forest holds a few drops of water, which, long after the rain has stopped, either evaporate or drip to the ground. And even water reaching the ground is absorbed in the leaf litter and soil, or taken up by the roots, so that only a small fraction of the rain ever reaches the streams and rivers.

These important functions of evaporation and storage, however, are severely disrupted in urban areas. With fewer trees, the air can be several degrees warmer than in a rainforest. Indeed, it is no coincidence that the urban heat island effect in many cities is similar in magnitude, though opposite in direction, to the cooling effect of evapotranspiration in a tropical rainforest. The absence of trees also increases the risk of flooding in urban areas, since impermeable surfaces do not retain rainwater, which flows rapidly to low-lying areas.

Striking a Balance

A second feature of stable ecosystems is that they are in balance with their surroundings. Many ecological studies have shown that the quantities of raw materials —carbon dioxide, water and nutrients— entering a pristine forest ecosystem in rain and dust almost exactly balance those that are lost through leaching and erosion. Nutrients that are in short supply are mainly recycled within the ecosystem, so that growth does not depend upon inputs from the outside. For example, the fluxes of phosphorus and potassium within a tropical rainforest can be very large, yet the quantities of these nutrients entering and leaving the ecosystem are extremely small.

“A rainforest also reduces the risk of flooding after heavy rain by absorbing water like a huge sponge...This is severely disrupted in urban areas.”

So how do cities perform according to this criterion? Not well! When it comes to material flows, most cities are severely out of balance with their environment, being net importers of huge amounts of sand, concrete, metals, plastics, fossil fuels and a vast array of other chemical compounds. As an example, consider the nutrients contained in food, most of which is imported, often over large distances. It has been calculated that 60% of all nitrogen and phosphorus entering Hong Kong, and over half of the phosphorus entering Bangkok do not leave the system. Of greater concern, though, is the fact that because almost none of these nutrients are ever returned to the land where the food was produced, the use of fertiliser becomes necessary. Meanwhile, a large proportion of the nutrients discharged in sewage end up in the sea, where they can cause problems of pollution.

Redundancy Aids Resilience

A third characteristic of stable ecosystems is resilience, which means the capacity to recover from disturbances and shocks. Resilience is harder to measure than homeostasis or material flows, but is an essential property that enables a system to persist and keep functioning despite severe disturbance. In natural ecosystems, resilience has been linked to the presence of more species than are needed to fulfil essential ecological functions.

A typical urban system (left) where essential services are provided by large, highly centralised facilities has little or no built-in redundancy as compared to an urban system that mimics the ecosystem (right) by decentralising essential services and including alternative sources. These include tapping solar power to generate electricity for individual buildings, reducing reliance on the central power supply; composting to reduce the amount of waste going to landfills; and collecting stormwater for industrial use, reducing demand for clean water.

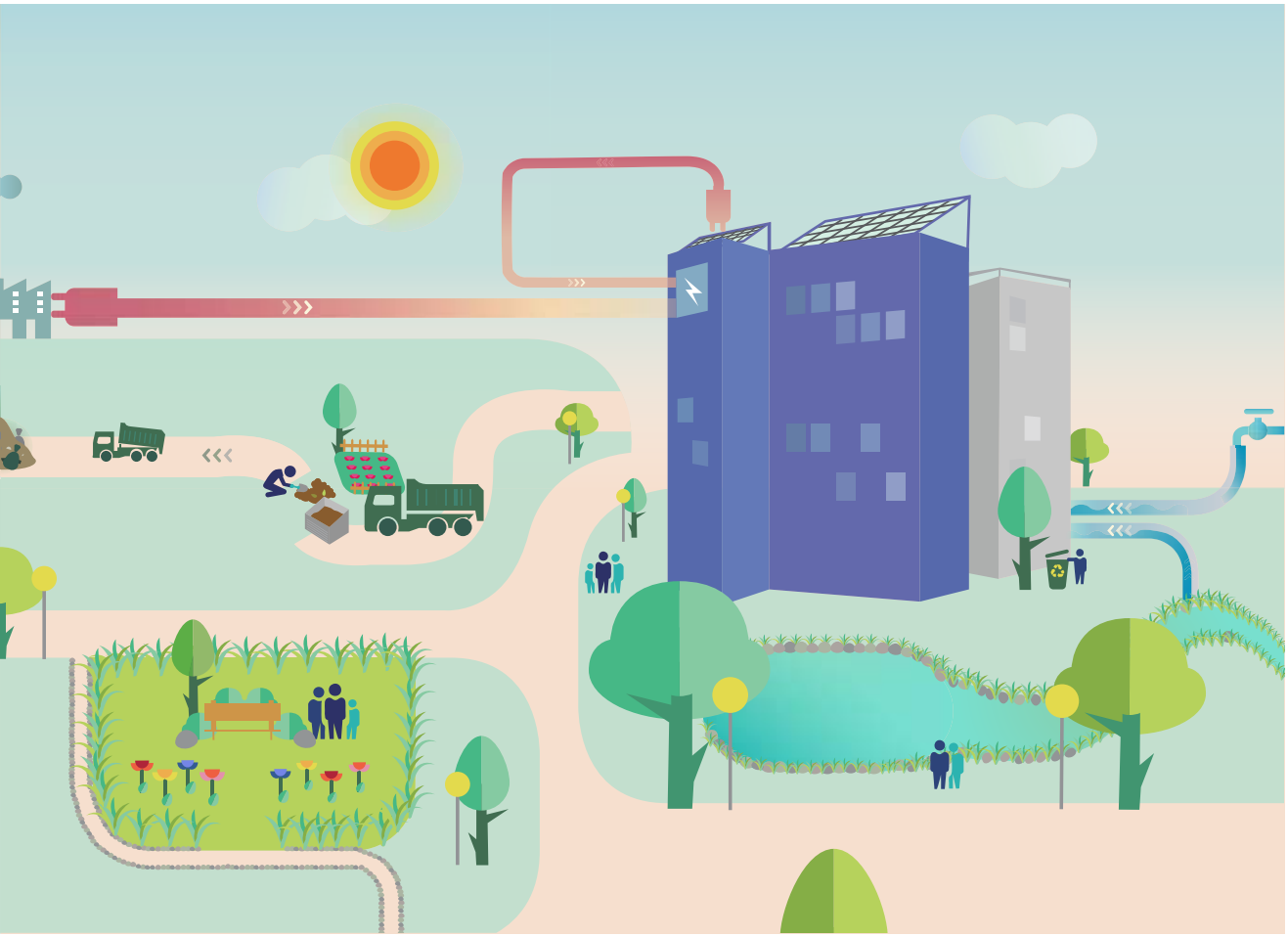
For example, a rainforest ecosystem might support many different species of earthworms in the soil, or several different kinds of nitrogen-fixing trees, or many different birds that feed on insect herbivores. This species "redundancy," as it is sometimes called, helps to make natural systems resilient, because one species can replace another without affecting the functioning of the ecosystem.

The essential services in modern cities include the provision of electricity and clean water, and the processing of waste. In sharp contrast to natural ecosystems, these services are mainly provided by large, highly centralised facilities with little or no built-in redundancy. When one of them fails for some reason, it can cause great disruption in the lives of many people.

Yet major breakdowns in electricity and water supplies and in waste disposal are frequent occurrences in cities throughout the world, with consequences that become increasingly severe as the systems grow larger and more complex.

Learning from Nature

Much can be learned from the study of ecological systems and incorporated into the urban ecosystem. For example, an obvious solution to the twin problems of urban warming and flooding is to plant more trees. Recent studies have shown that a patch of woodland in a built-up area can reduce the average air temperature by as much as 2.5°C, with this benefit extending well beyond the woodland itself. And trees can reduce



surface runoff—by as much as 60% compared with asphalted surfaces. These are big effects and just two examples of how ecosystem services make the urban environment not only more attractive and liveable, but also more sustainable. As for enhancing the resilience of municipal services, this can be achieved by decentralising these services and including alternative sources of supply. Indeed, we are already seeing a significant step in this direction in the case of power generation. With photovoltaic panels becoming cheaper and more efficient, the production of electricity by individual households is becoming a realistic option, while the development of smart grids means that surplus production can be fed into the urban grid.

However, much more can be done. There is growing interest in buildings that can be operated independently of centralised services, including not only the electric power grid but also municipal gas and water systems, sewage treatment systems and storm drains. Such autonomous buildings meet an obvious need in rapidly urbanising areas where infrastructure is poor or non-existent. But there are also benefits for modern cities, where autonomy can reduce dependence on centralised infrastructure while dramatically reducing the costs associated with transporting resources and waste. Perhaps the greatest gain in resilience would be achieved by having buildings that can operate autonomously, yet connected through urban networks, thereby evening out variations in demand and ensuring continued supply despite local failures.

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> **...retrofitting 80% of all air-conditioned buildings in the United States with 'white roofs' would reduce annual energy costs for cooling by US$735 million.**

Ecology teaches us that ecosystems only persist if they are in balance with their environment. Yet cities, as presently conceived, are severely out of balance, and this must change. From being systems that appropriate large volumes of water from lakes and rivers across the region, cities must become systems that recycle their water and even serve as their own catchments. From being systems that import large amounts of chemicals and then dispose of them —whether in the sea, or through incineration, or in landfill sites—they must become systems that recycle materials internally or, in the case of plant nutrients, return them to where they are needed to grow crops. And from being systems that generate heat, and so increase the need for air conditioning, cities must find ways of moderating the urban climate by using new materials, by managing air flow, and by cooling through evaporation.

To some extent, these goals can be achieved by strengthening ecosystem services, for example by planting trees to cool the city and clean the air, or by using wetlands to reduce floods and purify water. However, this will never be enough. We also need to change the urban fabric. The good news is that many types of green infrastructure already exist, which would greatly improve urban sustainability if applied at a suitable scale. For example, "cool pavements" that use reflective materials to reduce the absorption of solar radiation and porous materials to enable evaporative cooling can greatly reduce the urban heat island effect, especially when constructed with a sub-layer that provides a reservoir for water. And the same approach can be used to construct "cool roofs", with considerable benefits for the environment and the economy. In fact, one study estimated that retrofitting 80% of all air-conditioned buildings in the United States with "white roofs" would reduce annual energy costs for cooling by US$735 million.

01 Cool pavements drain water quickly as they are made with permeable tiles that allow water to seep through. The remaining water on the tiles cools the pavements.

02 The green roof at the Education Resource Centre at University Town, National University of Singapore uses native plants to reduce the heat absorbed into the building, reducing the amount of energy needed to cool the building. The plants also serve as filters for rainwater collection. The ERC won the Skyrise Greenery Awards in 2013.

“Perhaps the greatest gain in resilience would be achieved by having buildings that can operate autonomously, yet are connected through urban networks...”

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For many cities, green infrastructure offers the only hope for ensuring a sustainable water supply and preventing floods. Currently, "green roofs" planted with vegetation are widely used to reduce storm-water runoff, and "blue roofs" achieve the same effect using various kinds of flow controls to regulate and retain water. The water that is retained by these structures can be used directly for purposes such as garden irrigation, flushing toilets and recharging aquifers. Indeed, using "greywater" in this way not only reduces the demand for clean water—by as much as half for residential buildings —but also by reducing the amount of wastewater that must be conveyed and treated. As these technologies develop, we will see many more buildings equipped with their own treatment plants for recycling both water and nutrients, and therefore able to operate more or less independently of centralised water services.

In conclusion, the goal of urban sustainability can be achieved, but doing so will require radical changes in how we design, build and manage our cities. And I am convinced that once we have reached this goal, we will have created a system that closely resembles a tropical rainforest ecosystem. Like the rainforest, it will moderate its local climate, recycle limited materials with almost no wastage, and be resilient even to extreme disturbances.

So, as we strive towards this ambitious goal, let us be inspired by the small patch of rainforest in the Singapore Botanic Gardens, as a model of a truly sustainable ecosystem!

01 A Strangling Fig *Ficus kerkhovenii*, in the rainforest at the Singapore Botanic Gardens.

02 At the Osborne Association in New York, the green and blue roof not only aids in stormwater management, but are also a habitat for honey bees that are kept on site.

ESSAY

Singapore's Nature Conservation Masterplan

Networks for Biodiversity

Even as Singapore's population grows and the demands on its limited land increases, the small island-state continues to sustain a surprising trove of native biodiversity. **Kenneth Er** and **Dr Lena Chan** from the National Parks Board of Singapore share the country's strategies in developing a liveable and sustainable city.

On 9 August 1965, Singapore became an independent city-state. When Singapore celebrated her 50th birthday in 2015, the population had tripled and the per capita income had increased by more than 138 times. Singapore has had to allocate space for defence, housing, industries, infrastructure, public utilities, recreation and agriculture, all within an area of 718.3 square kilometres, to create a liveable place to live, work and play.

Yet, amidst this dense built-up urban landscape, Singapore remains richly endowed with native biodiversity: we have recorded around 2,145 plant species, 65 mammal species, 384 bird species, 109 reptile species, 318 butterfly species, 125 dragonfly species, more than 800 spider species, 256 hard coral species, and more than 200 sponge species. We continue to find new species of plants and insects, and rediscover species that were previously thought to be extinct. These biodiversity are harboured in a diversity of ecosystems, including lowland dipterocarp forests, secondary forests, freshwater swamps, grasslands, streams, mangroves, sandy beaches, rocky shores, inter-tidal mud-flats, sea-grass meadows and coral reefs.

How does Singapore defy the conventional wisdom that native biodiversity cannot exist in cities?

(Left) **Kenneth Er** is the CEO of the National Parks Board of Singapore.
(Right) **Dr Lena Chan** is the Director of the National Biodiversity Centre, National Parks Board of Singapore.

The Bukit Timah Nature Reserve, with high-rise residential buildings in the far background.

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Spearheading a Biophilic Ethos

A key factor is the biophilic ethos that the National Parks Board has adopted and is spearheading, to guide the city-state's development towards one of a liveable and sustainable city.

The National Parks Board (NParks), as the government agency responsible for greenery and biodiversity conservation, manages two National Parks, four Nature Reserves, 350 parks, 300 kilometres of park connectors and 3,500 kilometres of streetscape. It also administers 6,700 hectares of Tree Conservation Areas, and promotes skyrise greenery, which includes 72 hectares of green roofs, five hectares of vertical green walls, and gardens in the sky. NParks is responsible for policy formulation, biodiversity data management, and marine biodiversity conservation, including the management of the newly opened Sisters' Islands Marine Park.

All this is based on a vision to create conditions for nature to co-exist with a densely populated city—in short, to create a biophilic city. To guide its work, NParks has systematically consolidated, coordinated, strengthened and intensified its biodiversity conservation efforts into the Nature Conservation Masterplan.

This framework comprises four thrusts:

1. Conservation of Key Habitats;
2. Habitat Enhancement, Restoration and Species Recovery;
3. Applied Research in Conservation Biology and Planning; and
4. Community Stewardship and Outreach in Nature.

Conserving Key Ecosystems

The key objectives of the first thrust are to safeguard and strengthen the core biodiversity areas; secure and enhance buffer areas; enhance and manage additional nodes of greenery throughout Singapore; develop ecological connections and integrate nature with the broader urban landscape.

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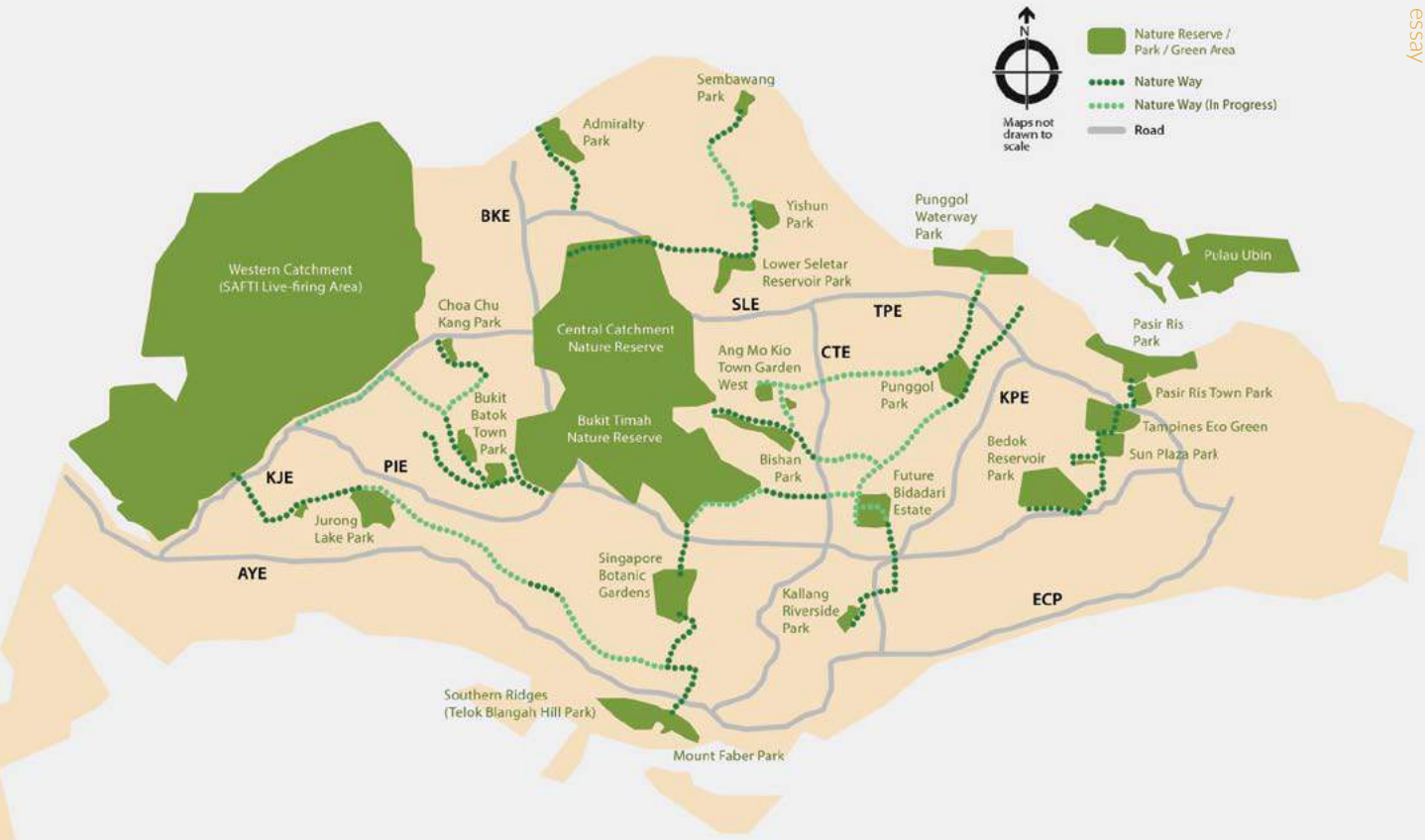
01 The Sisters' Islands Marine Park is a new initiative that aims to give Singaporeans a first-hand experience of the rich local marine biodiversity while safeguarding them.

02 The Nature Ways in Singapore extend from Singapore's core biodiversity areas, and are planted with specific trees and shrubs to facilitate the movement of animals between green spaces, while bringing nature closer to residents.



The core biodiversity-rich areas include the four nature reserves, i.e., Bukit Timah Nature Reserve, Central Catchment Nature Reserve, Sungei Buloh Wetland Reserve and Labrador Nature Reserve, as well as 20 other designated Nature Areas such as Pulau Ubin. These areas harbour the majority of Singapore's native biodiversity and, hence, are the key gene pool repositories and sources.

All these core areas are characterised by different natural ecosystems like lowland dipterocarp forests, secondary forests, freshwater swamps, streams and rivers, grasslands, rocky shores, sandy shores, inter-tidal mudflats, seagrass meadows, coral reefs, open water, etc. Many species are found only in some sites and nowhere else in Singapore.

To accord due consideration to all ecosystems, a Marine Conservation Action Plan was launched in June 2015. One of its key foci is the establishment of the Sisters' Islands Marine Park, which will house the coral nursery for all 255 hard coral species currently recorded in Singapore, such as the Neptune's Cup Sponge and giant clam. Coastal enhancement works are also in the pipeline.

NParks is aware that many rare and critically endangered species are found beyond the core areas. Hence, additional nodes of greenery that are important for biodiversity are enhanced and managed judiciously.

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One such example would be the green linkages that provide ecological connectivity for native fauna to forage and breed, and native flora to disperse to. Parks, streetscape, in particular Nature Ways, Park Connector Network, hectares of green roofs and vertical walls, and other greenery serve this purpose.

Another node of greenery is Singapore's famed tree-lined roadsides. NParks emulated the five strata found in forests by multi-layering the roadsides, and also planted a diversified range of species especially those with colourful blooms and selected plant species that are also good for certain fauna.

Singapore holds a strong stance on securing and safeguarding its biodiversity assets not simply to protect its natural heritage, but also in recognition of the diverse range of ecosystems services provided by them. Too often, humans take for granted the free ecosystem services provided by nature including, the reduction of ambient temperatures by tree canopies, the replenishment of oxygen and absorption of carbon dioxide by plants, the pollination by insects and bats, the dispersal of seeds by birds and animals, and the provision of environments essential for human psychological, physical and mental health. NParks believes that biodiversity through adaptation and mitigation offers the most flexible insurance against the uncertainty of the extent of climate change effects.

Enhancing and Restoring Habitats and Assisting in Species Recovery

The second thrust of the masterplan is focused on the restoration of habitats in a bid to boost biodiversity. Natural sites in Singapore can be degraded as a result of natural phenomena like wind bursts or lightning, or human activities. To maintain the functional integrity of these sites, the physical structure would be repaired through habitat restoration efforts. For example, sites that suffer from edge effects or tree gaps would be planted with appropriate native species. Habitat enhancement techniques can be applied to urban landscapes or biodiversity-impoverished sites, and these works are guided by an ecological framework. The butterfly garden and creation of grasslands on Pulau Ubin are some examples.

The populations of Singapore's endemic species, critically endangered native species, and re-discovered species that were previously thought to be extinct are most likely to be low. Hence, these species need extra help for their populations to reach sustainable levels. Endemic species like the crab, *Johora singaporensis*, is found in Singapore and nowhere in the world. Many of the native orchids also require species recovery actions. NParks has planted food trees for the Banded Leaf Monkey and is monitoring their population. It is heartening to learn that they are reproducing and their numbers are increasing.

01 The Common Palm Civet is a shy, fruit-eating animal that often ventures out of its forest habitat to gardens and roof spaces of buildings in Singapore. This is a mark of the country's success in bringing nature into its cityscape.

02 The Admiralty Nature Way is one example of a multi-layered streetscape that mimics a forest structure. This added complexity favours a diversity of fauna species.

> **...many rare and critically endangered species are found beyond the core areas... additional nodes of greenery [need to be] enhanced and managed judiciously.**

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Strengthening Biodiversity through Applied Research Planning

The third thrust comprises the following initiatives: comprehensive surveys and long-term monitoring of ecosystems and species; quantitative ecological research; the application of up-to-date tools, including geographical information systems, numerical modelling, DNA technology, databases; and science-based policy formulation and management planning.

Surveys of the terrestrial and marine ecosystems continue to lead to the discovery of new species in Singapore, for example, a ginger recently named *Zingiber singapurense*, two Hanguana species, more than 150 species of the Dolicopodidae long-legged flies, and around 100 new marine organisms during the Comprehensive Marine Biodiversity Survey. Our well-trained botanists and zoologists have also been rediscovering species that were previously thought to be extinct. This indicates that we have yet to reach the plateau of the new species discovery curve.

NParks has progressed beyond the check-listing of species. To conserve species better, we recognise the need to understand the intricate inter-relationship of species to avoid tipping points. With the myriad flora and fauna species inhabiting limited natural ecosystems in Singapore, it is inevitable that several of the species will be rare, threatened or endangered. The long-term conservation of these species is in a delicate balance. There is not much room for us to make wrong management decisions. Therefore, conservation practices must be designed with good research and sound science.

> **“[L]ong-term conservation of species is in a delicate balance... Conservation practices must be designed with good research and sound science.”**

NParks relies on improved Geographic Information System capabilities to better understand the distribution of species, identify biodiversity hotspots, map fragmented populations, and therefore, better acquire better ways to reconnect them. Ecological modelling using platforms like agent or individual-based models are useful predictive tools that play an important role in facilitating science-based decision-making.

Involving the Community for Inclusiveness

The fourth and last prong of the masterplan is aimed at garnering community involvement for biodiversity conservation and outreach. Mirroring NParks' Community in Bloom programme for gardening, the Community in Nature initiative is a national movement to connect and engage communities in conserving Singapore's natural heritage.

To ensure greater inclusiveness, NParks works with Resident Committees (volunteers within housing estates), families, corporates, education institutions, research institutions, and government agencies. Active participation can spur communities to be more

01 The Greening Schools for Biodiversity programme trains students to conduct wildlife surveys and use the information collected to create and implement an action plan for further greening and outreach.

02 The *Zingiber singapurense*, a ginger plant new to science, was recently discovered in the Central Catchment Nature Reserve. It shows that there Singapore has not reached the plateau for new species discovery.

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committed to nature conservation, hence citizen science forms one of the cores of the Community in Nature initiative.

The Greening Schools for Biodiversity Programme provides hands-on experience for students to carry out biodiversity surveys, document biodiversity, and enhance habitats around their school environs. The public can also partake in bird counts, butterfly counts, bioblitzs, and other biodiversity exploratory activities led by trained volunteers of all ages. NParks' annual Festival of Biodiversity brings together biodiversity enthusiasts and provides opportunities for the unconverted to experience biodiversity.

Sustaining a Biophilic City

Our surveys have shown that rich biodiversity can still be found in Singapore. Conserving our nature reserves and nature areas, along with the way we manage our parks, Park Connector Network and streetscape, have ensured that we have suitable habitats for native biodiversity to thrive in Singapore. By reaching up the sky with vertical green walls and rooftop greenery or gardens and expanding our conservation efforts to the coastal and marine environments, we have added multiple dimensions to the understanding and practice of a biophilic city. In doing this, we aim to create a biophilia ethos that will guide our development in a densely populated city, making it more liveable and sustainable.

ESSAY

City Narratives

Pursuing Green Agendas

While Singapore is known for its rapid economic rise and stunning transformation into a metropolis, it has also invested in its vegetated and aquatic landscape to create an equatorial paradise. **Prof. Peter G. Rowe**, CLC Visiting Fellow, discusses how a country's verdant aspects can shape its national narrative and what else Singapore could do to extend this.

Nowadays, many accounts of Singapore since it gained independence pay considerable attention to its openness to business, its rapid economic rise, and its strong top-down form of clean government.

Considerable attention is also paid to the scope and character of its highly successful public housing by the Housing and Development Board (HDB), its recent gleaming array of contemporary buildings, its embrace of leisure-time resorts and cultural venues, and, until very recently, its superb transportation infrastructure.

By contrast, far less attention is accorded to Singapore's vegetated and aquatic landscape or so-called "green-blue" elements of its urbanising existence, which also constitutes the "other" natural realm of a city of tropical excellence.

This oversight is perhaps surprising because Singapore is not at all urban in the fashion of other notable cities like Barcelona, Paris or New York. Rather, its overall form is more a case of a "high-rise suburb"—an organic array of building clusters in an otherwise green tropical field.

Although an account of Singapore as being a "high-rise suburb" probably short-changes many admirable features, it is probably closer to the mark than it being a truly urban condition. The oversight is also surprising because it overlooks one of the most significant accomplishments of Singapore in both the creation and conservation of its environment. What the city-state has managed to do with water is probably second to none in the world, for instance.

Peter G. Rowe is a Raymond Garbe Professor of Architecture and Urban Design and Harvard University Distinguished Service Professor.

With just as much greenery as there are high-rise buildings, Singapore is more a "high-rise suburb".

The Role of Water and Green Spaces in a National Narrative

In fact, the verdant aspect of Singapore has been, and continues to be, called upon and incorporated as a part of the city's underlying narrative and officially-projected identity.

Simply judging from appellations that have been conjured up almost from the beginning of the nation, the idea of Singapore as a "Garden City", a "City in a Garden" and, most recently, a "City of Gardens and Water" has remained central.

Both functionally and allegorically, it is a strong and politically promoted dimension of Singapore's identity and one that appears to be assuming an expanded role in plan making.

Take for instance, the ABC (Active, Beautiful, Clean) Waters Programme by PUB, Singapore's national water agency. Its aim is to bring people close to water through aesthetically pleasing lifestyle attractions and to improve water quality on the island. In so doing, the programme's contribution to Singapore's narrative further instantiates the strategic significance of water and particularly clean water to the nation's survival. Also, with 32 major rivers and more than 8,000 kilometres of canals and stormwater drains, it points to the ever-present possibility of inundation and potential flooding.

Moreover, the programme shifts the figurative aspect of the allegory towards naturalised streams in lieu of concrete channels and softens the image of living in spite of nature to one of living in harmony with nature.

In addition, matters of biodiversity on the functional side and tropical exoticism on the figurative and symbolic side further combine to make a case in this "other" dimension of Singapore now as an "equatorial paradise".

Creating an "Equatorial Paradise"

One place where Singapore as an "equatorial paradise" begins to come together is the Kallang River at the Bishan-Ang Mo Kio Park towards the center of the island in what has been a successful conversion of a concrete-lined channelised stream into a naturalised water course with bio-engineered edges and site contouring with swales for stormwater detention in times of inundation, as well as spaces for a variety of recreational activities.

Designed by Atelier Dreiseitl Asia in partnership with CH2M Hill for PUB, the park is three kilometres in length and incorporates 62 hectares of tree patches, water-cleansing biotopes and grassy fields, in addition to the meandering stream itself.

Adjacent to the river is a mix of private and public housing in Bishan estate while the other bank is bounded by Ang Mo Kio town. Other constructed features in the park include the Riverside Gallery, several restaurants, and a raised outlook made from recycled materials from the old concrete channel, and several bridges.

Over time the biodiversity within the park has increased by some 30% and recreational opportunities of various kinds have multiplied significantly. Work will soon begin on the extension of the bioengineering and park-like atmosphere along the narrow corridor of the Kallang River moving downstream towards Marina Bay.

Other PUB projects of this ilk can also be found along the Kallang River at Kolam Ayer and the transformed and beautified narrower reaches of the Alexandra Canal, another former utilitarian concrete drainage channel.

Other aspects of the broader functional narrative and allegory of Singapore as an "equatorial paradise" are prominently on display at both the Singapore Botanic Gardens and the recently opened Gardens by the Bay.

The Kallang River, which once flowed through an unsightly concrete canal, is now a naturalised waterway.

“…Singapore is not at all urban in the fashion of other notable cities like Barcelona, Paris or New York…more a case of a ‘high-rise suburb’—an organic array of building clusters in an otherwise green tropical field.”

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Founded in 1859, the Botanic Gardens, among other aspects, chronicles the transformation from a British tropical colonial garden into a world-class modern botanic center and place of conservation and education.

Located minutes from Singapore's busy shopping district, it occupies a 82-hectare site some 2.5 kilometers in length. Designated as a UNESCO World Heritage site in 2015, it comprises a variety of tropical zones like the Rainforest, the Ginger Garden, the Orchid Garden with the largest species collection in the world, and the soon to be completed Learning Garden focusing on local trees.

In addition to conserving, propagating and displaying significant aspects of a tropical landscape and, therefore, the ingredients of its manifestation in figurative and symbolic aspects of landscapes, work in the Botanic Gardens has also played a significant functional role in Singapore's development. One notable example in the past was to the rubber trade, a key economic activity at one time, by way of pioneering research into plant cultivation. Another was expertise furnished in the early days of the young nation relating to its promotion as a "Garden City".

The Gardens by the Bay, adjacent to the Marina Bay Sands integrated resort, currently encompasses 54 hectares and was planned by a team lead by Grant Associates, following an international competition.

Among other themes, the Gardens embrace interactive displays of botanical species important to both Singapore and to Southeast Asia more broadly, largely housed in two very big greenhouses providing various thermal and moist environments suitable for plant life from various climatic zones. Prominent on the site are also the "supertrees" that house vertical gardens soaring 25 to 50 metres in height, replete with planting, rainwater collection and photovoltaic generation capacity. The arresting, other-worldly and avatar-like appearance of the supertrees clearly add to the allegorical significance of the Gardens and, in turn, to Singapore, although it can also be seen to refer back to the replicas of the giant clubmosses in the Botanic Gardens.

01 The naturalisation of Kallang River continues downstream, in the Kolam Ayer neighbourhood.

02 The Singapore Botanic Gardens' colonial-style landscape was one of the reasons it became the first and only tropical botanic garden on the UNESCO World Heritage List.

03 "Supertrees" at the Gardens by the Bay house vertical gardens replete with tropical flowering climbers, epiphytes and ferns.

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The Power of Narrative-Making

The kind of narrative-making with regard to the natural circumstances of settlement is amply present elsewhere in the world.

Pastoralism, for example, has often been cited and exploited as a cornerstone of American intellectual and artistic experience, particularly when it comes to location of appropriate grounds for human settlement.

Following the conquest of the frontier wilderness, pastoral developments are seen to arise on the way to further progress, or so the story goes. At root, pastoralism derives from the Greco-Roman tradition

> **"There is ample precedent elsewhere for creation of specially-tasked groups being formed solely to accomplish projects and then retiring."**

and has been deployed in juxtaposition to the ills, vice and depravity of the city.

Another offshoot of this tradition can be found in Italy and the distinction between urbs and rus, clearly materialised by a preponderance of hillside towns and surrounding countryside. The sentiments involved there are probably well summed up by Ambrogio Lorenzetti's 14th century allegorical mural titled *The Allegory of the Good and Bad Government*, on display in Siena's Palazzo Pubblico.

There the allegory of good government is encapsulated in a peaceful city that is well organised, commercially prosperous and safe, as well as being nurturing to its citizens. The other message is that such a state of affairs is all due to the virtuous and just rule of Siena's leaders. Equally important is the peaceful countryside depicted by uplifting views of the Tuscan territory replete with villas, castles, ploughed fields and farmers engaged in bucolic pursuits. This aspect of the allegory also extends to the astral forces that govern harvests, ploughing, sowing, stock raising and the like, again pointing in the direction of harmony with nature.

01 & 02 *Allegory of the Good Government* and *Effects of Good Government on Town and Country*, part of a series of frescoes by Ambrogio Lorenzetti, alluding that good governance will result in a prosperous city, and countryside that is in harmony with nature.

03 The success of the Bishan-Ang Mo Kio Park can be further extended by allowing the water channels to go in between the residential buildings, and linking them to other public spaces.

Expanding the "Equatorial Paradise"

Moving forward, the verdant aspect of Singapore as an "equatorial paradise" can be extended further.

A more pervasive infiltration from set piece landscapes like the Bishan-Ang Mo Kio Park, for example, into surrounding neighbourhoods might be undertaken to create a more fulsome network of public open space, alongside of much further transformation of the narrower corridors alongside streams, canals and channels.

Parks like Bishan could also be revisited, particularly along the park edges outside of the hydrologic and bio-engineered profiles, in order to provide for "gardens within the park", as it were. This would not only potentially provide for further diversification of specific support and setting for leisure-time uses, but also extend the allegorical landscape of Singapore's green space undertakings with a stronger East and Southeast Asian focus.

Apart from wilderness sites, some monumental natural features and cultivated agricultural landscapes, the region's main contribution has been sophisticated development of gardens and not park landscapes.

Further amplification of private outdoor vegetated space and surfaces associated with buildings should be undertaken, ranging from the literal manner of the exterior of the rising Oasia Downtown by WOHA, to more prosaic opportunities offered by dwellings in HDB estates.

Lastly, further institutional integration may be warranted in order to avoid the piece-meal appearance of projects in the city that seems to be happening. At present this would need to be across the lines that define the PUB, the National Parks Board, and HDB, among other organisations. There is ample precedent elsewhere for creation of specially-tasked groups being formed solely to accomplish projects and then retiring. Nevertheless, Singapore has and continues to make progress on its "other" functional and allegorical transformation towards an "equatorial paradise".

ESSAY

Stormwater Management

City of Gardens and Water

Singapore's approach to stormwater management has evolved dramatically over the years. CLC Executive Director **Khoo Teng Chye** outlines how urban planners and civil engineers have transformed concrete drains to re-naturalised streams and bioswales that have reduced flooding, improved water quality, enhanced biodiversity and brought people closer to nature. This essay is adapted from a public speech on 27 February 2015 at the "Mainstreaming the ABC Waters Programme" forum, organised by CLC.

Over 5.5 million people live in Singapore on an island of just 720 square kilometres. Despite this high density, it is considered one of the world's more liveable cities. This is due to many factors, but it is its greenery that most distinguishes Singapore from other densely populated cities.

Roadside greenery, the backbone of Singapore's City in a Garden vision, forms a pervasive green matrix, together with ample parks, nature areas, community gardens and skyrise greenery. Over the span of two decades from the mid-1980s, Singapore's population grew 1.7 times, and its economy 6.6 times. Yet the proportion of green cover—including roadside tree canopies, nature areas and parks—was able to grow more than 1.3 times. This suggests that Singapore's commitment to greenery was critical to helping it improve liveability and avoid the experiences of other developing cities, where quality of life and the environment are often sacrificed during periods of rapid growth.

CLC Executive Director **Khoo Teng Chye** was previously Chief Executive of PUB, Singapore's national water agency, and CEO of the Urban Redevelopment Authority, PSA Corporation and Mapletree Investments. He sits on the Jurong Lake District Steering Committee, and Advisory Committee for the new capital of Andhra Pradesh state in India.

A large part of Singapore's liveability is due to the city's extensive greenery.

What About Water?

Greenery has now been mainstreamed in Singapore. A robust ecosystem of government policies and programmes together with industry and citizen participation supports its development. I believe integrating a blue layer into Singapore's green matrix can boost its liveability to a new level.

Many people are surprised by Singapore's Blue Map of 17 reservoirs and 8,000 kilometres of waterways, inclusive of 32 rivers. In comparison, Singapore's iconic roadside greenery lines much of the road network of just 3,500 kilometres. With such an extensive water network and 2.4 metres of annual rainfall across the island, this ought to be a Venice! But thanks to civil engineers like me, most blue areas became ugly concrete drains, canals and stormwater collection ponds.

From the 1960s, national water agency PUB focused on critical challenges like droughts, floods and pollution. PUB improved water security by diversifying our sources via the four national taps: domestic catchment, imported, recycled and desalinated water. The Singapore River and other waterways were cleaned up, while projects like the Marina Barrage drastically reduced flooding. But much more can be done to tap water's potential as an urban asset.

In the 1980s, the Urban Redevelopment Authority (URA) developed a vision to re-naturalise our engineered waterways. The idea came from Mr Lim Hng Kiang, then a Deputy Secretary in the Ministry of National Development (MND). I helped him set up a Waterbodies Design Panel, chaired by Dr Liu Thai Ker. It was

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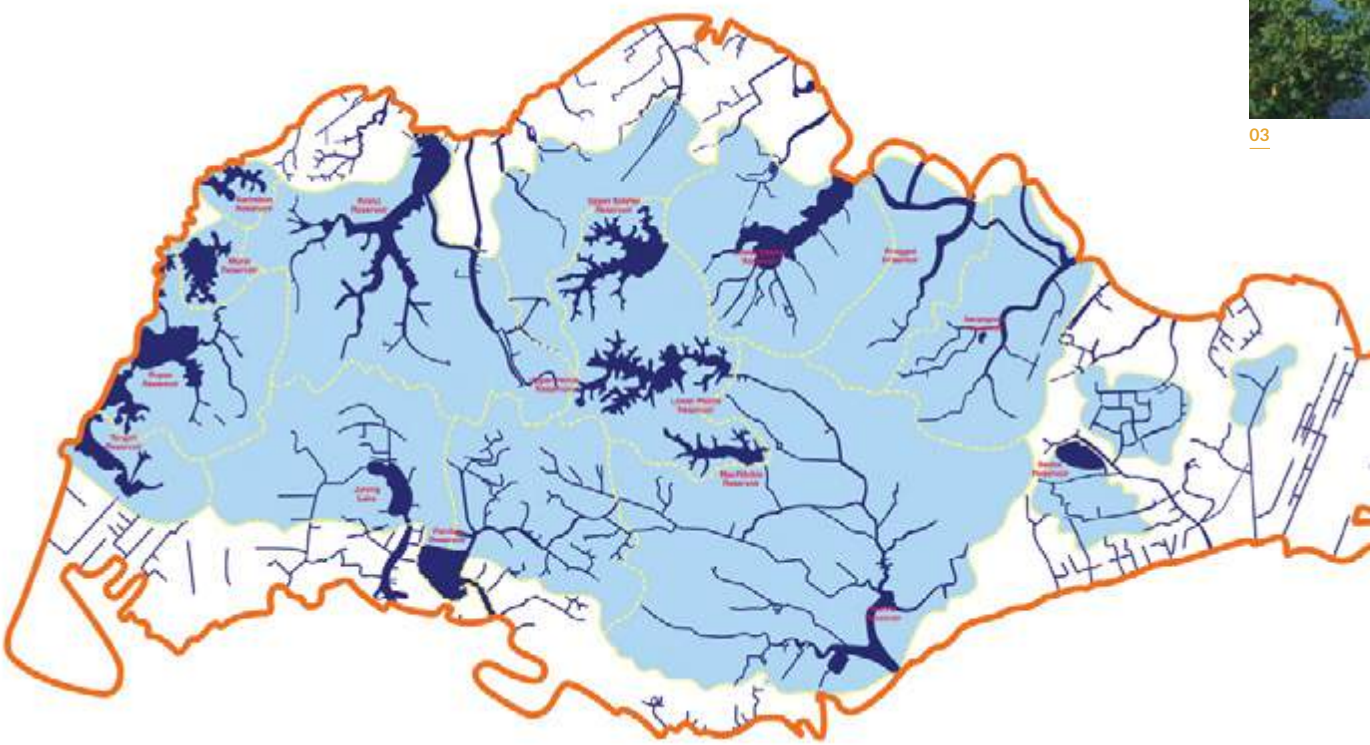
Blue Map of Singapore

Water Catchment



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a whole-of-government effort, involving the Ministry of Environment, URA, Housing and Development Board (HDB), and others.

The Waterbodies Design Panel created some outstanding projects. Amidst the high rise public housing of Pasir Ris town, Sungei Api Api became a scenic river lined with lush mangroves, instead of becoming a typical monsoon canal. In another town, Bukit Panjang, what might have become a bare stormwater pond became an attractive wooded lake. Based on this approach, URA then drew up a Parks and Water Bodies Plan.

But years later, when I had the good fortune to head PUB, I discovered to my horror that implementation had petered out. Inspired by the success of NParks' Park Connector Network, we then started the Active, Beautiful, Clean (ABC) Waters programme in 2006.

01 The Blue Map of Singapore shows Singapore's extensive water catchment areas and waterways.

02 A typical utilitarian stormwater pond in the Bedok neighbourhood.

03 & 04 The Sungei Api Api river in Pasir Ris town and the stormwater pond in Bukit Panjang are some of the projects undertaken by the Waterbodies Design Panel in the 1980s.

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A Decade of ABC Waters

We developed the ABC Waters Master Plan based on Singapore's Blue Map. This plan identified some 100 projects that could be undertaken over 20 years, involving public agencies, the private sector and community. We were fortunate the government, particularly the Ministry of Finance, agreed it was a worthwhile programme to support.

PUB began with three demonstration sites in Bedok and MacRitchie reservoirs and Kallang River, consulting the community to improve the designs. These showed the viability of ABC Waters to other agencies as well as the general public other proof-of-concept pilots were also conducted to test specific ideas, such as the rain garden at Balam Estate, now Balam Gardens—land depressions designed to cleanse rainwater runoff by filtering it through vegetation and soil.

We also cultivated the industry. To incentivise the private sector, a certification scheme was launched to let developers who incorporated ABC Waters design features promote "certified" ABC Waters projects. Design guidelines and engineering procedures were published to establish technical standards. PUB also conducted many seminars and talks to develop capabilities. It partnered the Institution of Engineers Singapore to run an ABC Waters Professional Programme to train and certify professionals, while universities and polytechnics introduced related modules and courses.

We are now 10 years into the ABC Waters programme. PUB has completed some 30 projects so far, like Bishan-Ang Mo Kio Park and Alexandra Canal. Overall, we can look forward to more than 100 ABC Waters projects currently being carried out by PUB, other public agencies and even the private sector such as JTC Corporation's CleanTech Park, Khoo Teck Puat Hospital at Yishun Pond, and City Developments Limited's H_2O Residences.

Momentum is growing, as people start to see the value of these projects. When he toured the ABC Waters Exhibition in 2007, Mr Lee Kuan Yew said "people will support this programme as they will very soon realise that their property value will increase if there is an ABC Waters project next to their home." Anecdotal evidence indicates he was quite right.

> **Mr Lee Kuan Yew said 'people will support this programme as they will very soon realise that their property value will increase if there is an ABC Waters project next to their home.'**

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01 The rain garden in Balam Gardens not only prevents flooding, but also injects beauty in the neighbourhood.

02 H_2O Residences was the first private estate to obtain the ABC Waters certification by PUB.

03 The Alexandra Canal, one of the completed ABC Waters Projects.

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Beyond monetary value, the community can now get much closer to water and appreciate the beauty and nature that comes with it. Unlike monsoon drains, the re-naturalised canals allow children to walk up to the stream, get their feet wet, catch fishes and see all sorts of wildlife, like egrets and otters. They can enjoy the same pleasures their grandparents did in rural streams, but which their parents' generation—like most other city dwellers—rarely experienced. Water sports like sailing and rowing are also enjoying a revival in Marina Bay and other reservoirs.

Indeed, we see many benefits from ABC Waters projects, such as better stormwater management. Conventional drainage engineering generates high peak flows, and lots of land pollutants that wash into canals. ABC Waters design features can slow down and treat the water, making it safer and cleaner. In terms of land use, it is more efficient for traditionally mono-functional water infrastructure to perform multiple roles in a land-scarce city, like combining recreation with water storage. Importantly for Singapore as the population grows, enhancing surrounding views and amenities and providing green and blue relief areas make high-density living more tolerable, even enjoyable. Finally, ABC Waters sites also tend to be rich nodes of plant and animal life and contribute to biodiversity.

What's Next?

After a decade, the ABC Waters projects are still seen as a special feature that's not routinely incorporated in the work of planners, architects and engineers. For example, PUB itself originally designed Marina Barrage as a utilitarian facility, ugly and inaccessible to the public. But URA told PUB this would not do in the heart of our city. With URA's help, PUB redesigned the Barrage with a sweeping green roof, and opened it to the community. It has now become a well-loved destination for picnics and kite flying. With 100 upcoming ABC Waters projects, PUB is going further. Can this be done for all water infrastructure?

01 The green roof at the Marina Barrage has become a popular place for kite-flying and picnicking.

02 The appearance of otters at the Kallang River has drawn people to the Bishan-Ang Mo Kio Park.

“Unlike monsoon drains, the re-naturalised canals allow children to walk up to the stream, get their feet wet, catch fishes and see all sorts of wildlife, like egrets and otters...”

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Another idea is from Kansas City, which has an initiative to build 10,000 rain gardens. Kansas City is comparatively small, so Singapore should aim to have 100,000 rain gardens! As engineers like me tend to worry if all this landscaping can channel water away quickly, we did many experiments. For instance, the rain garden in HDB's Balam Gardens, demonstrated that we could slow down rainwater while treating it. Since then, HDB has done much more. The scenic Punggol Waterway linking two reservoirs is a landmark project at the doorsteps of thousands of families. HDB is also creating an ABC Waters precinct, Waterway Ridges, in Punggol town. Can all HDB towns be designed based on ABC Waters principles?

Turning to private housing estates, why not turn conventional drains into something different using ABC Waters? PUB is piloting this in Windsor Park, one of the first projects of its kind under MND's Estate Upgrading Programme. It introduced features like vegetated swales, retention basins, little wetlands and not-so-wet rain gardens on top of the drains, so you see landscaping instead of concrete drains. Can all residential areas be designed with such principles? Similarly, all roads can be designed with bioswales, instead of concrete drains. We have experimented with it, and PUB is working with the Land Transport Authority to do more.

01 The Punggol Waterway links two of Singapore's reservoirs together, and provides a scenic waterfront for the residents in the Punggol neighbourhood.

02 Proposed ABC Waters elements in Windsor Park, an upcoming private housing estate.

03 The Kranji Marshes, located between the discharge points of PUB canals and the Kranji Reservoir, serves as a natural filter for water entering Kranji Reservoir. It was adopted by the Nature Society of Singapore under the ABC Waters Programme.

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Mainstreaming the ABC Waters

Notwithstanding the success of the ABC Waters Programme, some building and planning professionals remain content with conventional drains, canals, stormwater ponds and other water infrastructure. As a result, great opportunities to develop a more beautiful, biodiverse and vibrant city are missed. In contrast, most Singapore planners and even the public expect landscaped areas alongside roads and buildings as a matter of course, instead of the unremitting concrete that other cities consider normal. Developers and designers are also highly aware of the value of incorporating greenery in buildings, although it often incurs additional costs.

Prime Minister Lee Hsien Loong coined the inspirational phrase "a City of Gardens and Water" when he launched the ABC Waters Exhibition in 2007; he thought more should be done in this area. To realise the exciting potential of ABC Waters, we should mainstream it in our vision for the future. Much has been achieved already. The challenge now is to take it to a new level, creating a much more liveable and sustainable City of Gardens and Water for all to enjoy.

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CITY FOCUS

Rotterdam

In Harmony with Nature

It has become second nature for Rotterdam's urban planners and architects to build and adapt to the environment, due to its geographical challenges. CLC adjunct editor **Arthur Sim** elaborates, with insights from Ahmed Aboutaleb, Mayor of Rotterdam, and Dr Ronald Waterman, CLC's Visiting Fellow in February 2015.

Rotterdam in the Netherlands is home to one of the busiest ports in the world, but its strategic location within the Rhine-Meuse-Scheldt river delta in the North Sea also makes it one of the most vulnerable to flooding.

Measures to tackle flooding have been in place since the 13th century, with the construction of the first dam across the Rotte river, and then the building of dykes. In the mid-19th century, an ambitious plan to manage water levels with canals was initiated. However, severe flooding in 1953, caused by a combination of a high spring tide and a severe European windstorm over the North Sea, resulted in over 1,800 fatalities and damage to close to 50,000 buildings in the Netherlands. It was clear that a different approach to dealing with the effects of nature had to be adopted.

Ahmed Aboutaleb, mayor of Rotterdam, notes that while dykes and pumps previously offered protection against flooding, climate change has exacerbated the extremes in weather conditions, with heavy rainfall now also a concern.

"We are a very low-lying city and water comes from four different sides: the sea, local rivers, the sky and the ground," he says. Recognising that nature changes when climate changes, he adds: "If you are going to adapt, you will have to adapt to nature."

Building with Nature

Adapting to nature has been the main thrust of the city's urban planning strategy since the 1980s. Then, hydraulic engineer Ronald Waterman mooted a plan to reclaim the original coastline through an "integrated coastal policy" that supported economic development and incorporated natural processes.

Called the Waterman Plan, it reduced emphasis on inflexible, concrete structures like dams and dykes, and promulgated flexible structures that co-exist in harmony with the sea, like sandy dunes and beaches, that permits colonisation of marine species.

Arthur Sim is a freelance writer and journalist with 15 years of experience in the fields of real estate, design and architecture. Trained as an architect, he also has a special interest in urban planning and social economics.

Sandy beaches help to preserve Rotterdam's coastline in a more natural way than concrete structures.

Rotterdam is determined to ensure that the city remains vibrant, despite unpredictable weather conditions.

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The expansion of the Port of Rotterdam, called Maasvlakte 2, has been the most ambitious phase of the Waterman Plan. Officially opened in 2015, it spans 2,000 hectares, half of which is commercial space for environmentally sustainable businesses.

Dr Waterman says that his trademarked method of "Building with Nature" is relatively inexpensive, even after accounting for maintenance. "The most time-consuming factor is the decision-making process to convince [all stakeholders]. Also, [ensuring that] required licences fit within the framework of the various laws and regulations," he adds.

With Maasvlakte 2, Dr Waterman introduced a demarcation between port and port-related activities on the northern side, and a nature reserve area on the southern side. "With a new terrestrial nature reserve, a seascape as a breeding and mating ground for marine organisms and an existing terrestrial natural reserve… it is possible to develop plans that strengthen the economy and improve the environment," he asserts.

Flexible Measures that Adapt to Nature

On a more modest scale, though no less innovative, Rotterdam has embarked on a range of "no-regret measures"—initiatives that remain effective even when conditions change—that adapt to nature while reducing floods and sewerage overflows in the city. "We very consciously decided to implement various solutions with different positive side-effects," Mayor Aboutaleb says. These include building water squares, underground water reservoirs, and green roofs.

Of these, water squares, like the one in Benthemsquare, have become very popular. Dirk van Peijpe, director of the urban design firm De Urbanisten that designed the water square, says the challenge was to integrate the management of rainwater with a public space "in a visible and tangible way."

01 Maasvlakte 2 is segregated into port and port-related activities on the northern side, and a reserve on the southern side.

02 Benthemsquare serves as a popular public space, during days of good weather.

03 The Benthemsquare becomes a water catchment area, even during episodes of cloudburst (extremely short but heavy periods of rainfall).

> **Rotterdam has embarked on a range of 'no-regret measures'—initiatives that remain effective even when conditions change...**

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During dry seasons, the water square is a recreational space. When rain occurs, the three-level sunken water square collects storm water and channels it via large stainless steel gutters (that double as skateboard ramps) into basins for treatment. The stormwater does not flow into the mixed sewage system—preventing overflow into the open water system and improving the quality of open water in the city.

As a part of the design process, De Urbanisten conducted workshops with the local community, who requested that water be a visible part of their lives. Apart from incorporating waterfalls (that act as rainfall gauges) and public water fountains, an open-air baptistery with a fountain was also sited next to the church in Benthemsquare. "It's crucial to involve local stakeholders in the process of design. They are the users and have to have ownership of the public space.

We are building with nature and for people," adds Mr van Peijpe.

There are also plans to transform Rotterdam's water edge into tidal parks. The concept has already been tested on the island of Brienenoord by incorporating sloping, soft riverbanks, a new foot and cycle bridge, and improved walking paths. Earlier in 2015, rubble was also deposited into the Meuse river as the base.

Another measure is the green roof. Rotterdam boasts one of the world's largest roof parks that serves as a dyke against flooding. Built over a shopping centre, the park is 800 metres long, 80 metres wide and rises nine metres. Built on former railroad yards, the roof park uses new technologies in roof greening such as lightweight soil, water-buffering and underground horizontal water drainage.

01 Tidal parks will bring nature closer to the people of Rotterdam.

02 Roof parks like the Four Harbour Roof Park inject even more greenery into Rotterdam.

03 Inspired by the Benthemsquare, Rotterdam citizens in the Zomerhofkwartier district gathered to build raingardens.

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> **we are… turning this into a movement that should go through our city, like a 'green wave'.**

Getting Citizens Involved

While many of Rotterdam's projects are large-scale, Mayor Aboutaleb notes that "[m]any small measures can include residents' involvement."

For example, residents participate in Rotterdam's programme of replacing traditional pavements with more permeable or natural options, so that water infiltrates into the soil easily, and increases the city's absorption capacity. Mayor Aboutaleb adds: "The implementation of small measures started about two years ago, and we are … turning this into a movement that should go through our city, like a 'green wave', if you will."

CASE STUDY

JTC Corporation | CleanTech Park

Seeing the Forest for Its Trees

When JTC Corporation was tasked to transform a secondary forest into an eco-business park, it chose to take a less conventional approach to minimise the ecological impact of its development on the greenfield site. The result: an innovative and sustainable business park where natural and cultural heritage thrive.

The Challenge

In 2007, JTC, Singapore's lead government agency for industrial infrastructure development, was vested with the responsibility of transforming a 50-hectare plot of secondary forest into an eco-business park, the CleanTech Park (CTP).

The challenges posed for the development were formidable: firstly, JTC had to contend with the "incumbents" of the greenfield site that included decades-old native trees, as well as a thriving population of birds and butterflies. A second challenge was the unusual terrain: the plot sank almost 20 metres towards the centre, resulting in the accumulation of stormwater. A third challenge was the presence of two "dragon kilns", Thow Kwang Kiln and Guan Huat Kiln. Built in the 1940s and 1950s respectively, these bore particular cultural significance as they represented the last of mass pottery production in Singapore.

Conventionally speaking, the project could have been a straightforward, native land-to-industrial park conversion: send in the bulldozers, flatten the land and build the park from scratch. However, this would have harmed the site's biodiversity, disrupted its eco-system, and destroyed the area's rich cultural heritage.

JTC was determined to embrace the challenges by treating the site's original features as assets, rather than limitations. They were set on harmonising two seemingly-uncompromising roles of conservation and development.

Png Cheong Boon is Chief Executive Officer of JTC Corporation, which seeks to create innovative industrial infrastructure solutions to catalyse, grow and transform industries and enterprises. Prior to that, Cheong Boon served as Chief Executive of SPRING Singapore, where he spearheaded the development of the Small-Medium-Enterprises sector.

It was difficult to imagine how this swamp could be part of a high-tech business park.

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The Solution

JTC's first step was to develop a multi-layered "green and blue" master plan. The green master plan adopted the principle of conservation of elements that pre-existed on the site, such as the trees, terrain, and its biodiversity.

With the help of consultants and National Parks Board (NParks), a pre-development assessment of the land was conducted, to identify and retain greenery which would support the biodiversity in the woodlands, such as the Fishtail Palm, Malayan Banyan, Wild Cinnamon and Simpoh Ayer. The grassland was then densely replanted with shrubs and trees recommended by an ecologist, to create a freshwater swamp forest to support wildlife such as dragonflies, butterflies and birds. About 21% of the area's native trees were retained during the construction of the business park. These decades-old giants, along with newly planted fruit trees like figs and other dense vegetation, created a wildlife corridor to provide food and shelter for small animals thriving in the area.

JTC observed a strict minimal land-cut principle to further protect the environment and its inhabitants.

01 Plants like the Simpoh Ayer were retained in CTP, which now attracts birds such as this long-tailed parakeet.

02 & 03 JTC planners worked hard to incorporate this *Artocarpus heterophyllus* (jackfruit) tree into CTP's landscape.

04 The JEG has managed to attract butterfly species such as the Common Birdwing, which is classified as "vulnerable" in the Singapore Red Data Book 2008.

For example, taking the undulating terrain into account, the planners explored several road layouts, before adopting the ring road concept to minimise cut-and-fill and infrastructure cost, as well as maximise green coverage.

Significantly, 10%, or five hectares, of the land was dedicated as a green zone, now known as the Jurong Eco-Garden (JEG). The garden was further developed to meld with the two dragon kilns in CTP, and two art sculptures were commissioned to celebrate the garden's cultural heritage.

After finalising the green layer of the master plan, JTC moved on to the "blue". Instead of filling up the existing pond, the planners adapted the "Active, Beautiful and Clean" or ABC Waters Programme Design Guidelines set by PUB, Singapore's national water agency, and leveraged the park's concave terrain as a natural water collection basin to retain and reuse rainwater. With this estate hydrology plan, runoff is slowed down along the slopes of the business park and retained at several intermediary detention ponds, before finally marshalled into a natural cleansing biotope, which operates as the main cleansing element.

05 "Sculpted Maze", one of the two artworks commissioned by JTC, was created from the clay that was fired from the nearby Thow Kwang Dragon Kiln.

06 Swales help slow down rainwater runoff at the CTP.

“JTC has successfully created a natural, vista-wide storm water management system... About 65% of the rainwater runoff is retained and re-used at the garden.”

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The Outcome

With the aim to promote innovation and entrepreneurship in sustainability, CTP is poised to be a "living laboratory" for the test-bedding of green technologies and policies such as electric mobility and recycling. Yet, beyond planning for energy and cost efficiencies, JTC was convinced that the ecological impact of urban development should also be minimised. JTC's holistic approach in the building of CTP has achieved its vision in more ways than one.

The establishment of the JEG has allowed the park to have two facades—an urban front, as well as a green one. The tree retention and replanting initiatives have resulted in vibrant habitats that sustain a diverse range of wildlife, with a current count of 46 bird, 46 butterfly and 21 dragonfly species, of which seven are considered species of conservation interest.

JTC has successfully created a natural, vista-wide storm water management system for the estate. About 65% of the rainwater runoff is retained and reused at the garden. Rainwater collected and passed through biotopes is combined with greywater from surrounding buildings and recycled. This has helped to reduce the need for CTP to use potable water for gardening and toilet flushing.

CTP appeals not only to the working population within the estate, but also to the bigger community. JEG is open to more than 13 schools and almost 3,000 students, non-governmental organisations and interest groups. For example, Republic Polytechnic students have used JEG to test-bed their floating wetland prototypes, before deploying them at Pulau Ubin. Students from the nearby Nanyang Technological University and National Institution of Education visit the eco-garden frequently as part of their curriculum. Nature photographers and interest groups are now a common sight, while art and heritage enthusiasts are regular visitors to the art installations and the dragon kilns. Recognised for its far-sightedness in design and planning and strong commitment on sustainability, CTP received the first ever Platinum Award under the New Parks category, from the Building and Construction Authority (BCA) in 2011 for the creation of a civic landscape through innovative and sustainable development.

01 The freshwater swamp in JEG not only collects rainwater for use within CTP, but is a scenic spot for the public to enjoy.

02 An aerial image of CleanTech Park, with the Jurong Eco-Garden above it.

CASE STUDY

Portland | Green Streets

Rolling out Green Carpets

Legacy infrastructure can cause problems when a city grows and becomes more dense. The US city of Portland in Oregon uses street and roof greening to help overcome the challenge of legacy drainage systems to better manage stormwater.

The Challenge

The city of Portland, Oregon in the United States is known for being eco-friendly. But in 1991, it faced a lawsuit from a local environmental advocacy group for polluting the Willamette River, which passes through the city.

Since the late 19th century, raw sewage and industrial outflows had fed directly into the river. More importantly, the city had a combined sewage and stormwater system: both were carried in the same pipes that would overflow during heavy rainfall. As Portland grew, more new streets, rooftops and other hard surfaces increased the amount of runoff: even as little as one-tenth of an inch (2.54 millimetres) of rainfall could trigger an overflow.

Despite sewer improvements, about six million gallons of overflows still occurred each year by 1990, enough to fill nine Olympic swimming pools. The city's plan to control these combined sewer overflows included projects to divert stormwater from sewers, expanding sewage pipeline and treatment capacity, and innovative green solutions to manage stormwater such as bioswales and green roofs.

In 1993, it began what is called the Big Pipe project: massive underground pipes and other diversion measures to handle storm runoffs into the Columbia Slough and Willamette River. But while the US$1.4 billion project alleviated overflows, "hard" sewer infrastructure alone would not solve the problem completely.

Grace Chua is an adjunct editor for the Centre for Liveable Cities, and an award-winning journalist whose work has appeared in The Straits Times, Citiscope, FuturArc, and Hakai Magazine, among others.

Flooding at south end of Willamette Park, Portland, in 1996.

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The Solution

In addition to its hard infrastructure measures, Portland also promoted sustainable stormwater management: slowing and treating stormwater with carefully selected and placed plantings, street landscaping, and green roofs. Such green infrastructure helped to mitigate the amount of runoff into the sewerage system. In Portland, these projects were designed to address the region's rainfall patterns of small, frequent storms.

In 2001, the city formed a Sustainable Infrastructure Committee to investigate these alternatives, to limit the impact of development projects on water quality. The same year, Portland implemented a policy requiring new city facilities and city-funded projects to be constructed according to LEED (Leadership in Energy and Environmental Design) green building principles and practices. It also installed and funded ecoroofs—vegetated roof systems with shallow soils and drought-tolerant plants. These low-maintenance roofs slow stormwater runoff, insulate buildings and improve urban air quality; data shared by the city in 2010 found three sample ecoroofs slowed peak flows by 85 to 100% during the most intense downpours.

In 2003, Portland installed the first of two pilot projects in its Green Streets programme. The landscaped curb extensions captured and treated stormwater, and also beautified the neighbourhood. Flow tests conducted by the city ensured water would run through the curb extensions, and found that they reduced peak flow from a 25-year storm event by 88%—enough retention to protect local basements from flooding—and reduced total runoff to the combined sewer system by 85%.

01 This green street project narrows the road and incorporates a zebra crossing to calm traffic next to an elementary school.

02 A traffic island is transformed into a small park space containing a rain garden.

03 Ecoroofs at the South Waterfront. Ecoroofs are so named, rather than the conventional "green roofs", to highlight that they still serve their purpose in the dry season when they are barely green.

03

Following the pilot schemes' success, Portland adopted a city-wide Green Streets Policy in 2007, requiring all city-funded development infrastructure projects to manage stormwater runoff through the incorporation of green street facilities.

Portland's green street initiative included four different strategies. One, modifying an existing planting strip to allow stormwater in and add plantings that absorb and filter water. Two, creating curb extensions where plantings replaced street parking, which helped to shorten pedestrian crossings while increasing permeable surfaces. A third was to use street planters made from concrete boxes, whenever surface planting was not feasible. A final strategy was to identify unused urban spaces that can be transformed into small parks.

All of Portland's projects to divert stormwater runoff, whether "hard" pipe infrastructure or green streets, were paid for largely by development fees and rate increases in utility customers' water and sewer bills.

Meanwhile, the city also offered discounts and incentives for planting trees, installing ecoroofs, and disconnecting home downspouts so that rain fell onto homeowners' lawns rather than into the streets.

In some cases, there were public concerns. These included the loss of parking spaces, the need for private property owners to maintain plantings on their property, the impact on aesthetics, and ensuring that changes to streetscape were safe for street users.

To alleviate concerns, the city's Bureau of Environmental Services worked with key stakeholders. In commercial areas, it minimised parking loss by building planters behind the curb with a step-out zone to accommodate adjacent parking; property owners could select from a list of appropriate plants, which provided a sense of ownership; and with the city's Bureau of Transportation, it made sure designs were safe. For example, pedestrian crossings were often incorporated into green street facilities to improve safety, especially where children travelled to and from school.

> **Pipes alone would have cost US$144 million, but adding green infrastructure projects cuts that to US$81 million.**

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The Outcome

By the end of 2010, approximately 950 green street facilities had been constructed. Data from the city's 2010 Stormwater Management Facility Monitoring Report showed that infiltration facilities, which included green streets, had tremendous potential to manage stormwater flow rates and flow volumes. Under the US Clean Water Act, the state of Oregon in 1994 had ordered the city to cut its overflows to the Columbia Slough and Willamette River. Today, combined sewer overflows have been cut by 97%, thanks to both pipe-expansion and green infrastructure projects.

Meanwhile, homeowners and local businesses have become involved as well. Since 2009, 1,283 households have received credits to their utility bills for planting trees that help filter and slow stormwater, while 135 people have signed on to be Green Street Stewards who weed, water and pick up trash on green streets. And between 2008 and 2013, the city's ecoroof incentive of US$5 per square foot funded 134 projects and some 362,000 square feet (roughly 5 football fields) of ecoroof.

So far, the green projects have paid off. For example, installing sumps or vegetated infiltration facilities that direct stormwater into the ground cost the city US$145 million, or 10.6% of the total Big Pipe project, but dealt with 15.8% of the water problem.

But green stormwater management complements, instead of replaces, hard infrastructure. For example, the city's new Tabor to the River scheme, which began in 2009 and will take about 15 years to complete, includes both sewer-pipe replacements and green-streets projects. Pipes alone would have cost US$144 million, but adding green infrastructure projects cuts that to US$81 million. What's more, by engaging the community, calming traffic and boosting pedestrian safety, sustainable stormwater management is now contributing to the long-term liveability of the city.

01 The ecoroof on Columbia Boulevard Wastewater Treatment Plant Screening Facility, which is a self-sustaining roof that does not need irrigation.

02 At Mt Tabor Park, the Friends of Mt Tabor Park Weed Warriors volunteers remove invasive vegetation and plant native plants, which helps improve the park's habitat and stormwater management function.

CASE STUDY

Singapore | Khoo Teck Puat Hospital

Healing with Nature

Instead of building a typical hospital, the Alexandra Health System created a peaceful, healing and inclusive space that allows people and nature to co-exist. The result is a hospital that is not just a place to go to when one is sick, but also a place of rest, refuge and retreat for residents living nearby.

The Challenge

In 2005, Alexandra Health System (AHS) was tasked to plan the new Khoo Teck Puat Hospital (KTPH) in Singapore's Yishun suburb.

"The government let us choose from nine different sites [but] it was a no-brainer," shared Mr Liak Teng Lit, AHS Group Chief Executive Officer, at a talk in 2012. The chosen site's main draw was the adjacent pond and park. It had the potential to be a welcoming and restful place conducive to healing.

"We were very conscious that our building would not stand out like a sore thumb," said Mr Liak, of their vision of a building that would "humbly" fit in. The management also assured the then Member of Parliament for Yishun that the hospital would not take anything *away* from the residents.

The team knew a large construction project would have an environmental impact on local biodiversity: land clearance could cause local animals to scatter, while construction runoff could pollute the surrounding waters and affect soil quality. The pond was also "not a pretty sight", added Mr Liak. It was, in fact, a bare stormwater collection pond, surrounded by granite and little foliage, "that nobody used".

Hence the management had the challenge of ensuring that the hospital would not just serve patients, but would also enrich the neighbourhood with its architecture and landscaping, at the same time enriching biodiversity of the area.

The original Yishun Pond was a utilitarian concrete rainwater collection point that existed to supplement the water supply of the residential town.

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The Solution

When KTPH embarked on the biodiversity replacement initiative, Mr Liak set a goal of the area eventually hosting 100 species each of birds, butterflies, fish, and plants. It was an especially tall order, as he wanted species native to Singapore and Southeast Asia to boot.

Planting the flora was easier than introducing fauna. To attract butterflies—picky creatures that require very specific conditions to breed—the hospital had to create gardens that enjoyed full sunlight yet were sheltered from strong wind, and have a variety of plants to attract different butterfly species.

To boost survival rates, staff even brought caterpillars home to hand-feed them thrice a day until they metamorphosed. KTPH decided not to use broad-spectrum insecticides, which kill caterpillars. Signs were put up while staff were trained to explain to the public that critters like caterpillars, millipedes, worms and even bees are harmless and welcomed on the hospital grounds.

Four distinct freshwater environments were created within the grounds to rear fishes and attract insects like dragonflies. With so many water bodies within the hospital, the management made sure that good water management facilities were incorporated into the building blueprint. This would manage the water cycle—from the collection of rain run-off to the disposal of excess or polluted water. There was also a need to train their maintenance crew to deal with mosquitos.

01 Hospital staff had a hands-on involvement in the successful establishment of butterfly gardens within the compound.

02 The management believed that a hospital that luxuriated with greenery would help patients to recover more quickly, so they set out to achieve this.

To boost survival rates, staff even brought caterpillars home to hand-feed them thrice a day until they metamorphosed.

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01 Marshlands were introduced along the edge of Yishun pond to create a natural-looking habitat that attracts wildlife, hence enhancing the area's biodiversity.

02 The award-winning rooftop community farm is a bustling space where volunteers from all walks of life gather to tend to their crops.

02

From 2006 to 2011, as part of PUB's ABC (Active, Beautiful, Clean) Waters programme, the PUB and KTPH, in collaboration with the Housing and Development Board and the National Parks Board (NParks), transformed the once barren pond and the park nearby into a lush, health-promoting and welcoming garden for patients and residents of Yishun. A barrier-free lakeside promenade was built to connect the hospital's central courtyard to the garden, while a footpath for walking and jogging was upgraded. Inter-generational fitness corners were built, and benches and spaces were introduced around the garden to spur social interaction.

Another placemaking initiative was launched when KTPH heard that a group of community farmers was about to be displaced from their community farm plots, and it offered them rooftop space to pursue their interest.

Creating this rooftop farm required a strong commitment from KTPH's management. Glenn Bontigao of Peridian Asia, the company in charge of KTPH's landscaping, said: "A rooftop garden is a concept that usually gets axed when value engineering comes in. It is difficult to maintain not only because of the manpower it requires, but also because of the logistics issues related to its location. You have to bring in soil, material, tools and people."

In this case, the architects made the rooftop accessible with stairs and lifts, so that materials could be easily transported to and from the farm.

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The Outcome

The efforts to create lush gardens and thriving ecosystems in and around the hospital have paid off.

KTPH now has achieved the target of 100 species of fishes, while there are now 24 species of dragonflies. The butterfly species count has also risen dramatically from three to 60. Sixty-six native species of birds have since called the hospital their home—bringing their cheerful bird song to the hospital complex. At the Yishun Pond, nine wetland species, including the threatened Purple Heron and Black-crowned Night Heron, have been spotted.

Dr Ho Hua Chew of the Nature Society of Singapore, who was involved in the introduction of nature to KTPH said: "Experiments have shown that patients recover faster in environments with greenery. I'm quite sure that, if nothing else, the depression caused by being hospitalised will be lifted if the patients can see flowers and butterflies and hear birds singing."

The removal of physical barriers between the hospital and adjacent park and pond has led to people moving freely between the two areas.

Patients and their families gather by the pools in the gardens while Yishun residents drop by to use the cafeteria and retirees practise *tai chi* on the level platform beside the Yishun Pond. The one-kilometre path around the pond is a popular jogging and brisk walking track because of its flower trails, pebble shores and mini wooded area. Dr Ho added: "I have never seen people feel so welcome in a hospital environment."

01 Who would have thought that a hospital can provide such a pleasant environment for staff, patients, and even members of the public?

02 KTPH's barrier-free design has made the hospital grounds a welcoming place for visitors and residents living in Yishun.

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CASE STUDY

Tokyo | Ecomowing

Greener Grass with Goats and Sheep

A construction company is realising its vision of biophilic cities by sending in goats and sheep to "mow" the urban landscape.

The Challenge

Japan's Edo period (1603-1868) is known for its culture of sustainability, especially for its successful reversal of forest depletion. As a result Tokyo developed a vast waterfront space and greenery. But with the rise of urbanisation, the greenery in urban Tokyo dwindled. To address the loss of biodiversity, the Tokyo Metropolitan Government developed a "10-Year Plan" in 2006 with the aim to surround Tokyo once more with water and greenery. To contribute to the conservation of biodiversity in Japan, Kajima Corporation, a construction company, introduced the concept of building "Kajima Biophilic Cities" where humans and wildlife can both thrive. It has proposed to use goats and sheep to "mow" the green space to reduce cities' environmental load.

Kajima's environmental engineers were inspired by a picture of sheep grazing in New York City in the early 20th century. This led them to think of replacing machines with goats and sheep. "Also, we've seen and heard about it from overseas. Management of green space using animals isn't a rare thing in Europe. [In 2010], there was already the service of rental goats and sheep for grazing in the US," said Mr Yuta Sone, one of the engineers.

Mechanical mowing is noisy, emits carbon dioxide and discharges waste. The engineers were confident that the animals could do the job with a lot less environmental impact.

Grazing, however, is not a common sight in urban Japan. Urban dwellers rarely see goats or sheep except in zoos or ranches in rural parts. The urbanites' lack of familiarity led to initial concerns about the noise, smell, and containment of the animals when the idea was proposed. A trial was necessary to show that urban grazing is a safe and reliable method of green space management with many environmental advantages.

Mechanical mowing is noisy, emits carbon dioxide and discharges waste.

01

The Solution

In 2010, the engineers launched the urban grazing trial in a Kajima-owned apartment in Tokyo with three goats. The green space was the lawn in front of the apartment. The three goats were brought in from a suburban farm to trim the 1,000 square metres of lawn in spring, summer and autumn. Each time, they stayed for three to four weeks, and slept under the apartment's porch. The trial, which lasted three years, gave the engineers ample data and knowledge on urban grazing. Mowing performance and the effect on vegetation were studied closely. The experimenters also tested different ways of tethering that would secure the goats while they are grazing, without entangling or loosening the ropes. Most importantly, the residents' responses were evaluated with surveys before and after the trial.

Before the trial began, the engineers met residents to explain the benefits of ecomowing and to give them a chance to interact with the animals. Nearly half of the residents expressed concerns with the possible smell and noise from the goats that would graze so near their homes. A year later, a follow-up survey showed that these concerns were gone. This is because goats that feed solely on weeds versus goats in zoos and ranches that eat concentrated feed, do not smell, explained Mr Sone. To their surprise, the urbanites also found the goat droppings to be odourless.

In addition, "Goat Festivals" were held once or twice a year at the apartment that allowed residents to get to know their "mowers" better. They could pet and feed the tethered goats, while enjoying fresh goat milk.

01 Goats are tethered while grazing to keep them from wandering off.

02 & 03 Goats and sheep become the highlight of the area.

02 |

| 03

01

The Outcome

Before the trial, the green space was managed with the use of brush cutters once or twice a year. The frequency was not enough to prevent the growth of large perennial weeds. An added advantage of ecomowing was that the goats' constant grazing ate up the leaves of large perennial weeds, preventing the transfer of nutrients to the roots of the weeds.

After the first year of the experiment, there was a significant change in the vegetation. The biomass of tall perennial weeds such as the Canada goldenrod, an invasive alien species, decreased dramatically, while indigenous short cover plants (Japan's native bent-grass) began to flourish.

It turned out that the ecomowing, which achieved the triple zero goal—zero noise, waste and CO_2 emissions—did not just control the growth of vegetation but also created a positive psychological effect for residents.

Through surveys, the experimenters found an increase in the residents' conversations regarding nature, and more than 70% of the dwellers said that the presence of the goats made the landscape more natural and also gave a relaxing effect. Events such as the "Goat Festival" allowed the urbanites and their children to come in contact with the animals in an urban setting. Such opportunities are highly valued for those living in densely populated residential areas with limited access to natural environments.

In a later trial, Kajima employed sheep to graze its solar plant. It found that sheep, which do not like jumping to high places like goats, were suitable, as they would not damage the low-lying solar panels. They were also a safer option when compared to mechanical mowing, which could also damage the panels.

Since then, Kajima has gone on to conduct urban grazing in other green spaces such as parks, riverbanks, temporary vacant land after the demolition of a building, construction sites and even rooftop gardens. "Although it was for a short period of time, we have done grazing on top of a building in Ginza, a place like Orchard Road (Singapore's shopping strip)," said Mr Sone.

While grazing presents an appealing and eco-friendly alternative to mechanical mowing, Mr Sone admitted that for now, ecomowing is still more expensive due to the costs incurred such as transporting the animals into urban areas each time they are needed, as well as fencing or tethering needed to contain the animals safely. To lower the costs, there is a need to cluster grazing sites so that the animals are easily transported.

"We're now trying this with sheep in Komae, a small city in west Tokyo. The sheep has been moving around the city to parks, riverbanks, shrines and staying at various urban farms from July this year."

01 Sheep are suitable for grazing near low-lying solar panels because unlike goats, they do not like jumping to high places.

02 A goat interacts with its visitors.

> **...ecomowing, which achieved the triple zero goal—zero noise, waste and CO_2 emissions... also created a positive psychological effect for residents.**

02

CASE STUDY

Singapore | Pulau Semakau

Growing the "Garbage of Eden"

As a fast-growing island city-state, Singapore has little space on its mainland for its rubbish. Its innovative solution was to build one of the world's earliest and cleanest offshore landfills—an island that today harbours flourishing ecosystems from mangroves to reefs.

The Challenge

In 1992, one of Singapore's last two landfill sites, a dumping ground in the western region of Lim Chu Kang, reached its maximum capacity and was closed. The other landfill, a 234-hectare site at Lorong Halus in the north-east, would run out of space in 1999.

Singapore, like any small country or city with a burgeoning economy, faced a trash problem. First, as it grew, it generated more and more waste. In 1970, about 1,300 tonnes of solid waste were disposed of each day; by 1992, this had ballooned to about 6,000 tonnes a day. Already, Singapore was incinerating its trash to generate some energy and minimise the space required for dumps. Yet more and more space was urgently needed for housing, industry and other uses. In fact, planners had already approved a new landfill site in the northern farming area of Punggol, and government agencies had begun to engage local farmers to acquire their land when the area was abruptly earmarked for housing instead.

So Singapore had to find alternatives—quickly. An offshore landfill was one possibility. The island-state already had expertise in land reclamation, which it had carried out along its coastlines since the 1960s. But in order to deposit incinerated waste offshore, it would need to ensure that pollutants would not leach into the surrounding seawater. What's more, the government was aware that converting islands to landfills encroached on precious natural space. So it aimed to find a solution that would not only fulfil the need for a landfill but also preserve the natural environment and enable the space to be open for public recreation.

Grace Chua is an adjunct editor for the Centre for Liveable Cities, and an award-winning journalist whose work has appeared in The Straits Times, Citiscope, FuturArc, and Hakai Magazine, among others.

Rubbish truck of the Ministry of the Environment at a rubbish dump in the 1970s.

01

The Solution

After feasibility studies, the Singapore government approved a proposal to construct an offshore landfill in 1994, one of the world's earliest. It would involve enclosing the space between two islands south of mainland Singapore, Pulau Semakau to the west and Pulau Sakeng to the east. The 350-hectare landfill would take the sludge and ash left over from incineration, as well as waste that could not be burned. Work began in 1995.

To contain pollution and protect nature, engineers, academics and contractors had to work together to come up with innovative solutions in the design, building, and operation of the landfill.

The seven-kilometre perimeter bund between the islands was lined with impermeable membrane, marine clay, and rock layers, to keep leachate in and the surrounding waters free of pollution. Any leachate generated would be treated at a plant on site.

The landfill's original design kept a narrow channel between Semakau and Sakeng, but experts determined that the channel's hydrodynamics meant all the mangroves on the east side of Semakau would not survive the resulting tidal changes. So engineers constructed the perimeter bund, and replanted 13.6 hectares of mangroves to replace those that had been removed to build it. The replanted mangroves would serve as biological indicators of leaking waste.

The replanting was an effort on an unprecedented scale—but that effort that was nearly scuppered after a 1997 oil spill released 28,000 tonnes of oil into the surrounding waters. The team of engineers, experts and contractors considered their options, including washing each leaf with detergent, but decided to let nature take its course, and more plants survived than expected.

During construction, screens were also installed to avoid smothering nearby seagrass and corals with silt. And after a study trip to the world's largest landfill, Fresh Kills Landfill in New York, it was decided that waste should be transported in an enclosed system to minimise dust and windblown waste.

At first, a container system was considered, but it would have cost too much. The team eventually decided on a 3,000-tonne covered barge—a method that was more costly upfront but cleaner and more efficient in the long run. The incinerator ash and non-incinerable waste are discharged in an enclosed building, and compacted in landfill cells pumped free of seawater. When filled, the cells are covered with a layer of earth, allowing grass and trees to take root naturally over time.

In all, the landfill cost some S$630 million. In April 1999, it began operation, enabling the last mainland landfill at Lorong Halus to close after it was filled.

01 A barge like this transports incinerated ash and non-incinerable waste to Semakau every night.

02 Singapore's four waste-to-energy plants and the sea route connecting the network to Semakau Landfill.

Besides being a clean and odour-free landfill, Semakau also harbours flourishing natural ecosystems like mangroves, seagrass meadows, and coral reefs, as well as rich biodiversity...

01

02

The Outcome

Today, more than 2,400 tonnes of incineration ash and non-incinerable waste are transported on barges to Semakau each night. In July 2015, a second phase of development was completed, comprising a single, 157-hectare landfill cell into which ash is directly discharged. Corals from the development site were transferred to a marine park at Sisters' Islands, while fish there were released into the open sea.

Besides being a clean and odour-free landfill, Semakau also harbours flourishing natural ecosystems like mangroves, seagrass meadows, and coral reefs, as well as rich biodiversity from sea stars to herons. Knobbly Sea Stars, large, colourful sea stars once common to Singapore waters but later decimated by habitat loss and the aquarium trade, are now a common sight again in Semakau. Meanwhile, the National Parks Board re-introduced fireflies—seldom seen on the mainland—to Semakau's wetlands.

Since 2005, Semakau has been open to the public for recreational activities such as guided nature walks, sport fishing tours, and stargazing. It is a test-bed for new innovations, such as a floating wastewater treatment plant, and in future, renewable energy solutions such as a micro-grid that integrates multiple energy sources. And it has received international acclaim—in a 2007 story for *New Scientist* magazine, journalist Eric Bland dubbed the landfill "Garbage of Eden."

At current waste disposal rates, the landfill is expected to last till 2035 or beyond. But Singapore will not be resting on its laurels. Instead, it urges people to reduce and recycle, to extend the landfill's capacity as far as possible into the future.

01 Healthy mangroves growing by the perimeter bund at Semakau testify to the safeguards installed to prevent waste in the cells from contaminating the sea.

02 Knobbly Sea Stars, which can grow to 35 centimetres wide, are the main attraction for visitors to Semakau.

03 Members of the public can explore the reefs at low tide in guided walks like this.

04 Catching the sunrise at Semakau.

03 |

04 |

YOUNG LEADER

Søren Smidt-Jensen

Smart and Green First-Movers

Søren Smidt-Jensen is Head of Urban Development and Landscape at the City of Frederikssund, Denmark. In an interview with CLC's Nicole Chew, he shares how Denmark's largest urban development project, Vinge, is revealing a new generation of urban dwellers who value both nature and technology.

WORLD CITIES SUMMIT | YOUNG LEADERS

The World Cities Summit Young Leaders is a select group of change-makers from diverse sectors who shape the global urban agenda at the annual World Cities Summit Young Leaders Symposium.

Søren Smidt-Jensen on...

His New 'Vinge' City

Vinge is the largest urban development project in Denmark currently. It's the last area that can be developed at such a scale, and will be constructed on a greenfield site with its own train station. It will have about 20,000 people living there, hopefully in 10 to 15 years, with about 4,000 jobs in the area. "Vinge" means "wing". So the 370 hectares are in the shape of a wing; in the middle is the green heart. A green belt runs from the green heart and splits into several corridors, moving out into the business districts and the housing areas. It will be a purely electrified and smart grid-ready city.

Letting Nature Solve Problems

We want to create a town where nature and biodiversity thrive. The aim is to see the diversity of the species living here and to interact with it. You can use it for recreational use, but it's actually the nature that has priority.

Vinge is located in an area where several species, such as certain frogs, are protected. So we needed to plan around the areas where the frogs are. Some areas also fall under European Union protection. So the architects considered how to work around these areas. It's not just a flat green field; the topography includes small hills and natural basins, and is complicated to work on. Vinge also includes a wet, low-lying area, so there's really a need for innovative landscaping to work with the rain. The way that that green area is planned and is being used is very innovative.

It's not through changing nature, but really through planning the city, the buildings and the roads and the various other activities in the city around nature.

Some of the green areas will look a little bit wild, and that's the whole idea—it should look very much a living nature. Also, this means the maintenance can be greatly reduced. We let nature solve it by itself. For instance, you only need to cut it once every year compared to more than 20 times if you want it to look like a golf course.

Leveraging Smart Technology

The digital platform can be used by the community to constantly monitor energy consumption, rainfall, humidity and whatever is relevant for them. We are also trying to create a very good social environment, through various digital platforms, to make it attractive even before the city is built. In fact, this has been mobilised by those who have already bought a place here—they are extremely active and innovative in creating the future city. I think this is part of a strong tendency where citizens expect to be co-creators of the city they live in.

"Tesla" and "Yoga" Residents

We began selling the first 59 plots in September 2015 and by early December they were sold out. What struck me was that the average age of the people who put up a bid was 36 years old. More than half live in Copenhagen 40 kilometres away, and the rest is from the city here. We actually succeeded in attracting people to this new way of living, especially the younger generation from the mid-80s onwards, who typically aren't interested in moving out from the big city, but are now interested in this unique combination of nature and smart city. We have the "Tesla-segment" interested in the high-tech version of living green, as well as the "Yoga-segment" concerned with deep ecology and collective living. Both groups—and those in between—think this is a great place. The pioneers have a very strong vision about Vinge, and we are working closely with them to see how we can achieve their ideas.

When you decide to move to Vinge, you are moving to an area where the nature as well as the technological solutions is special. You're part of a pioneer culture.

YOUNG LEADER

Wei Yang

Garden Cities: Nature's Gift that Keeps on Giving

Dr Wei Yang is the Managing Director of Wei Yang & Partners Ltd. She leads large scale regeneration and low carbon master-planning projects in the United Kingdom and China. In an interview with CLC's Nicole Chew at the WORLD CITIES SUMMIT MAYORS FORUM 2015 in New York City, she shares how the 100-year-old concept of the garden city has been updated for today's needs.

Dr Wei Yang on...

Returning Land Value to the Community

The garden city concept was mooted by British urban planner Ebenezer Howard 100 years ago. We are re-inventing it for the 21st century by having the private sector, the public sector and the community work together, in a form of a garden city land trust.

The most essential part is to capture the land value through development, and return that value to the community while developing long-term stewardship within the community. Because the corporation hands the land and the essential infrastructure to the community to manage over the long term, the land value captured stays in the community, benefitting the locals.

For example, in Letchworth, the world's first garden city, the people own the land, and through different community programmes, they grow their own food, and have their own markets. Howard's idea was to encourage local business to thrive in local communities. In the 21st century garden city, modern technologies, like the smart grid, should be integrated, so people can live and work in the same place and have more time to enjoy life.

Celebrating Life in Garden Cities

I think a garden city is designed for people to celebrate life. The essential part is to develop the city to a human scale, and have this great integration between human and natural environments; to create a culture of the place and a sense of ownership for the local community.

In our current city model, we test[ed] a financial model to ensure that not all gains go to private developers. Our model tested that if we have a development of a 100,000 new homes, 30% will be affordable homes. About 10,000 new jobs will also be created, to ensure people can live and work together, and the place is connected by an efficient public transport system.

Networked, Higher-Density Garden Cities

A lot of people think garden cities are low-density, garden suburbs but they can be in different forms, either high-density or low. Garden cities should be seen as a system, a series of garden cities, complementing the larger city and connected by high-speed public transport.

Land constraints can be seen as opportunities if we look at it creatively. For example, there are a lot of cities developing vertical landscape features; also, people think that integrating the natural environment into a city needs to be done on a big scale, but it doesn't have to be so. The key thing is for the natural environment to be connected; it needs to be part of a network.

How Planning Innovation must be Systemic

I think the obstacle is still the current planning system because some authorities say, "Let's do something totally innovative", but still stick to the current system. If we really want to introduce an innovative model, we need a new system to endorse that.

Planning systems should encourage and enable good development. But many planning systems focus more on development control issues, to make sure nothing bad happens. This actually slows down development.

At the Mayors Forum, everybody was talking about the housing shortage, which is now a global crisis. So we need new mechanisms to make sure things happen in a speedy way and also with quality, to help people to fulfil their life.

Watch more here:

https://youtu.be/D-_rTxM6bsc

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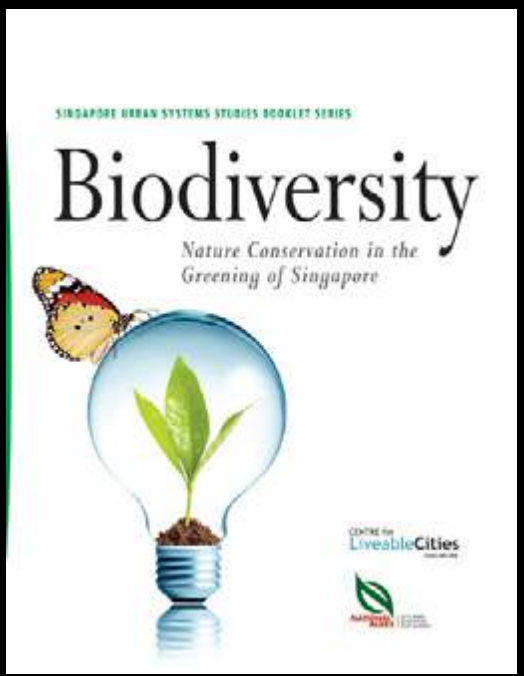

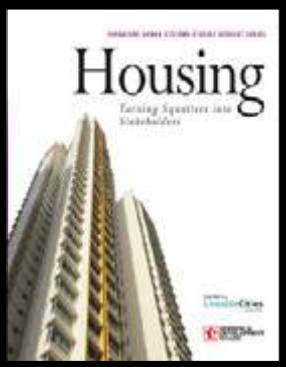

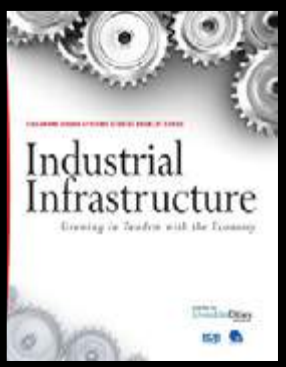

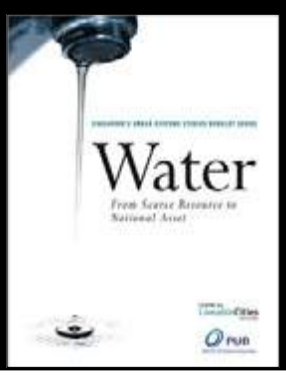

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