Chapter 3

MEASURING THE REGENERATIVE CITY

The regenerative city can measure progress by its ability to achieve regenerative outcomes and build capacity over time. This chapter delves into example indicators that can be used as a starting point for evidence-based planning.

Stockholm Royal Seaport, also known as Norra Djurgårdsstaden, is a former industrial land turned mixed-used district. It is a test-bedding district for developing new solutions and processes for a more liveable and resilient future.

Photo courtesy of Ng Sze Xuan

MOVING THE NEEDLE: INSPIRING AND MEASURING PROGRESS

A regenerative city cannot be built by intention alone. Rather, progress can be achieved by strategically harnessing co-benefits, and further accelerated through the systematic application of metrics, indicators and measurements that enable us to monitor, evaluate and refine our actions.

The Regenerative City Framework in Chapter 2 answered the questions of what a regenerative city is and how to create a regenerative city. This chapter builds on that and turns to the more complex question of **how to assess the regenerative city.**

We present two sets of assessment indicators—outcomes and capacities. Regenerative outcomes, based on the Regenerative City Framework, measure progress in implementing regenerative urban development. Regenerative capacities assess existing conditions and how well the city can harness co-benefits.

When outcomes and capacities are assessed together, a city can measure the extent to which investments in capacity are associated with desired outcomes across the development lifecycle.

Outcomes of the Regenerative City

Tracking outcomes helps cities to understand change. Beyond that, it accounts for the impacts of interventions as well as progress in achieving various goals.

The Regenerative City Framework highlights three key outcomes to track: **liveability**, **resilience** and **resource optimisation**.

To find out more about the outcomes of a regenerative city, refer to page 64 of Chapter 2.

Liveability indicators show the city's ability to achieve a competitive economy, a high quality of life and a sustainable environment. They reflect the underlying systems of planning, governance and collaboration, which create the enabling conditions for urban liveability.

Resilience indicators reflect the ability of a city's people, communities, institutions, businesses and systems to prepare and plan for, absorb, recover from and more successfully adapt to adverse events.

Resource optimisation indicators point to the degree to which material, carbon, water and land are used and kept in continuous circulation to minimise extraction, waste and environmental degradation, while allowing for growth.

To advance local food production and optimise limited land space, urban farms utilise vacant space on top of multistorey carparks and in housing estates in Singapore.
Photo courtesy of Singapore Tourism Board

Altogether, the outcomes indicators provide us with a holistic view into how truly regenerative the city is. They can also act as a guide by articulating the range of co-benefits that the city can unlock, in turn orienting it towards a broader goal: urban development that pursues co-benefits for the entire urban ecosystem.

Over time, tracking these outcomes can also help cities gain a better understanding of regenerative interventions by comparing their before and after impacts. Time enables progressive comparison, allowing cities to understand the effectiveness of their actions and determine where course correction is needed. This is further amplified by a clear understanding of the city's regenerative capacity.

Yokohama's Minato Mirai achieves liveability through integrated planning, where office, commercial and recreational facilities are placed together with green spaces and historical sites. Minato Mirai has also pioneered several circular initiatives in Japan in line with Yokohama's goal of becoming a circular economy.
Photo courtesy of Pmlydon (CC BY-SA 3.0 / Wikimedia Commons)

Hamburg's HafenCity is a mixed-use district that transforms the city's former industrial port. The district is estimated to create 45,000 new jobs while also providing subsidised housing for low and middle-income households.
Photo courtesy of Gunnar Ridderström on Unsplash

Capacities of the Regenerative City

The regenerative city requires an understanding of outcomes and capacity. Guided by regenerative outcomes, capacity indicators support planners and policymakers in creating conditions fit to harness the interdependencies between the urban built and natural environments.

Marina One is a high density complex, integrating 175,000 m² of office space and 1,042 apartments together with a 37,000-m² green space that is home to over 350 different species of trees and other plants.
Photo courtesy of Singapore Tourism Board

Tokyo's Azabudai Hills is a development that leverages density and diversity by integrating multiple uses over 81,000 m² of land area: office, residential, retail and green spaces.
Photo courtesy of William L. McGough (CC BY-SA 4.0 / Wikimedia Commons)

Regenerative capacity is also informed by the concept of "adaptive capacity", established by the Intergovernmental Panel on Climate Change (IPCC) in their Third Assessment Report.[45] Adaptive capacity refers to the capability of the ecosystem or community to adjust to potential damage or impact caused by climate change. It measures the ability of urban ecosystems in the city to take advantage of opportunities and respond to consequences.

Assessing adaptive capacity would therefore help cities to take action to reduce vulnerability and risks. Cities can understand trade-offs through five types of capital: natural, physical, financial, social and human.[46] Natural capital refers to resources such as vegetation, land and water; physical capital includes roads and reservoirs; financial capital is funding that supports adaptation; social capital is the community's capacity to adapt to changing conditions; and human capital points to people as resource. These types of capital outline how capacity is currently measured, serving as a springboard for the development of regenerative capacity.

To find out more about adaptive capacity, refer to Glossary on page 196.

Understanding Regenerative Capacity

In essence, while adaptive capacity measures the latent capability of a city to respond to climate change and inform action to reduce risks, regenerative capacity extends this idea by distilling co-benefits.

Regenerative capacity aims to encourage synergies between the city's urban built and natural environments, advancing a balanced assessment of the urban ecosystem's ability to bring holistic benefits. It comprises three fundamental tenets: **density**, **diversity** and **connectivity**. Each of these represents a systems-based approach to holistic planning for the urban ecosystem. Collectively, they measure how well both the urban built and natural environments can facilitate future regenerative urban development.

Yet, regenerative capacity does not necessarily lead to regeneration. Regenerative capacity, more accurately, provides a preview of how the regenerative city might develop. It must be complemented by an assessment of regenerative outcomes that provide a measure of the actual progress of regeneration.

Vancouver, Canada is working towards building a series of greenways throughout the city, with the goal of ensuring that they can be accessed via a 10-minute cycle or 25-minute walk by every household.
Photo courtesy of Andrew Raun (CC BY-SA 2.0 / Wikimedia Commons)

To facilitate connectivity, Singapore transformed a former railway line into a rail corridor that integrates walking trails and community nodes into an ecological pathway that enables wildlife movement between major green spaces.
Photo courtesy of Singapore Tourism Board

Density measures the concentration of human and ecological activity at a given site or district. It promotes the co-location of land uses in ways that generate shared benefits across liveability, ecosystem health and urban resource efficiency. It also embodies the principles of multi-functionality and integration that underpin low-carbon developments.

Diversity captures the range of human and ecological activities across a site or district. For people, it reflects the vitality and economic competitiveness of the city. For nature, it encompasses biodiversity which signals ecosystem health and the city's capacity to support interspecies interactions. Together, these diversity indicators offer a cross-sectional view of the city's social, economic and ecological conditions that point towards resilience.

Connectivity measures the accessibility of amenities and resources in a site or district, for both people and natural ecosystems. A regenerative city requires urban functions and landscapes to be in productive proximity to facilitate movement and exchange. While mobility for people is enabled by roads, cycling paths, walkways and a public transport network, the natural environment is enabled through ecological corridors and contiguous green infrastructure.

Measuring capacity gives city leaders a point-in-time read of how well-configured the city is to support regenerative processes. It informs where deliberate action is needed to increase the city's regenerative capacity—whether by refining proposed regenerative policies to ensure alignment with existing capabilities or by adjusting planning parameters.

For city leaders and planners, capacity indicators do not just describe the city as it is; they actively shape what the city chooses to do next.

INDICATORS TO MEASURE THE REGENERATIVE CITY

Knowing what to measure is only half the challenge. With a vast landscape of existing frameworks and metrics to choose from, cities must know which indicators are most useful in assessing a regenerative city.

Methodology

Guided by the Regenerative City Framework, the Centre for Liveable Cities and Singapore University of Technology and Design conducted a review of indicators, benchmarking them against industry standards and capabilities.

Drawing from leading assessment tools and metrics, including the World Bank Group's One Health Framework, Singapore Index on Cities' Biodiversity and CityLoops Urban Circularity Assessment Method, the review prioritised indicators that reflect up-to-date scientific findings, that have garnered international acceptance and are relatively easy to use. This process was guided by five key principles.

OVERVIEW OF REFERENCED ASSESSMENT FRAMEWORKS AND INDICES

Frameworks	• One Health Framework by the World Health Organization[47] • Climate Guidance for Cities by the Science Based Targets Network[48] • Planetary Boundaries Framework by Rockström et al.[49] • The Liveability Framework by the Centre for Liveable Cities[50] • The HDB Biophilic Town Framework by the Housing and Development Board[51]
Indices	• Kunming-Montreal Global Biodiversity Framework by the United Nations[52] • Global Protocol for Community-Scale Greenhouse Gas Emission Inventories by the World Resources Institute, C40 Cities and ICLEI—Local Governments for Sustainability[53] • The Singapore Index on Cities' Biodiversity by the Secretariat of the Convention on Biological Diversity and the National Parks Board[54] • City Resilience Index by Arup and the Rockefeller Foundation[55] • Global Biodiversity Metric by Ramboll[56] • Guide to Inclusion and Health in Public Spaces by the Gehl Institute[57] • Urban Circularity Assessment Method by CityLoops[58] • City Water Circularity Assessment by Arora et al.[59] • Baseline Indicators for Community Resilience by Cutter et al.[60] • Socioeconomic and Built Environment Indicators of Liveability by Martino et al.[61] • Sprawl Indices by Ewing,[62] and Frenkel and Ashkenazi [63]

Principles for selecting indicators

LEVERAGE WELL-ESTABLISHED FRAMEWORKS AND EXISTING DATA

To minimise the need for additional data collection and analysis.

MINIMISE THE NUMBER OF METRICS USED

To ensure that the outcomes and capacity of the regenerative city are adequately measured, without causing reporting fatigue.

ARTICULATE CLEAR GOALS FOR EACH METRIC

To ensure deliberate and meaningful assessments that can inform decision-making.

ENABLE PHASED AND PROGRESSIVE ACHIEVEMENT OF THE REGENERATIVE CITY

To provide adequate guidance for all cities, regardless of whether they are in the early or advanced phases of regenerative urban development.

ALIGN WITH BROADER REGENERATIVE STRATEGIES, WHILE LEAVING ROOM FOR CITIES TO DRIVE PLACE-SPECIFIC INTERVENTIONS

To encourage cities to measure progress in their own trajectories of regenerative urban development.

CASE STUDY

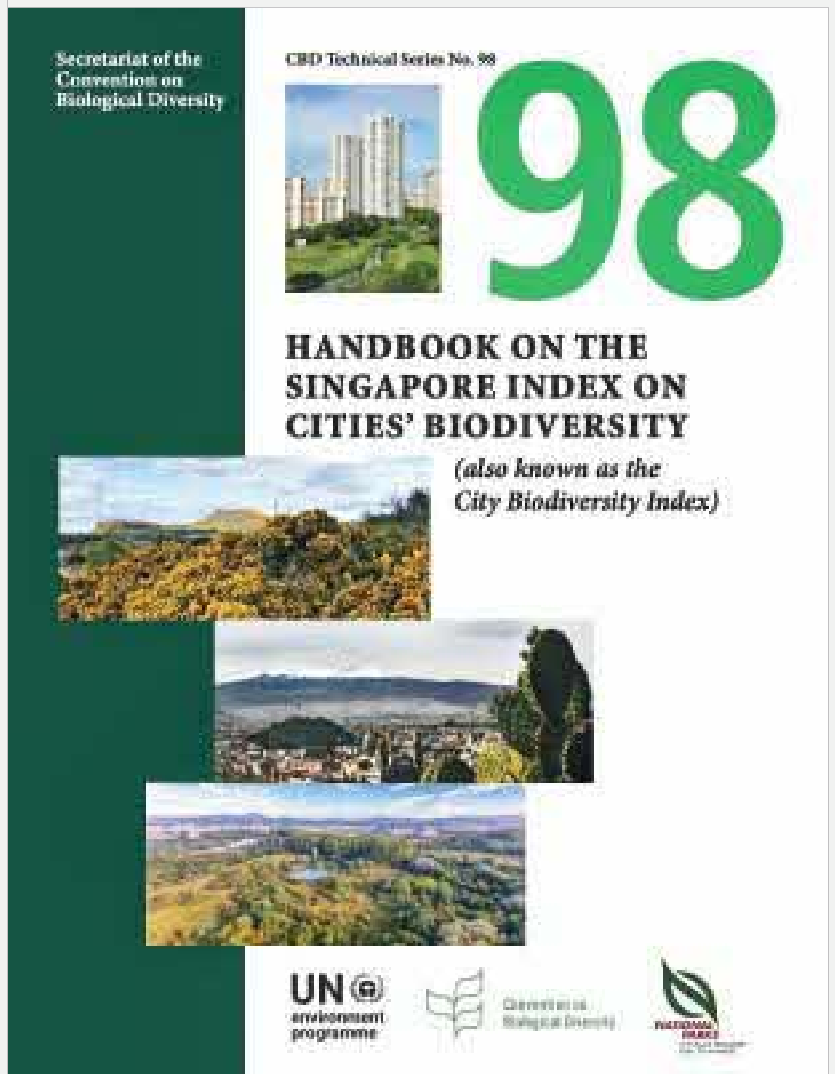
THE SINGAPORE INDEX ON CITIES' BIODIVERSITY

by National Parks Board

Developed by Singapore in collaboration with the Secretariat of the Convention on Biological Diversity and the Global Partnership for Local and Subnational Action for Biodiversity, the Singapore Index on Cities' Biodiversity (SI, also known as the City Biodiversity Index) provides cities with a robust framework to assess their nature conservation efforts.

Through workshops held with international experts, the SI was designed as a self-assessment tool with two parts: the profile of the city as well as 28 indicators spanning the 3 core components on native biodiversity, ecosystem services and governance. Examples of indicators include an assessment of the city's richness of bird diversity in built up areas, the area of habitats undergoing restoration efforts, the ecosystem services (such as recreation and climate regulation) provided by the city's natural assets, as well as the city's budget allocated to biodiversity conservation. Cities score themselves based on the *Handbook on the Singapore Index on Cities' Biodiversity* guidelines published in 2021.

The SI helps cities demonstrate that urban nature can help to achieve the co-beneficial outcomes needed in a regenerative city. Today, 40 city governments, such as Helsinki, Abu Dhabi and Los Angeles, have applied the SI, and academics have applied it to a further 16 cities.



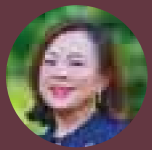
Handbook on the Singapore Index on Cities' Biodiversity.
Image courtesy of National Parks Board

With the aim of deriving a set of example indicators grounded in both evidence and practice, we also looked to the work of industry players. Learning from industry reporting, insights were gained into the plethora of evidence that could be collected to inform decision-making. From utilising data for research-driven innovation to setting targets for leading-edge regenerative developments, the industry offers a pragmatic view of effective reporting that complements the rigour of scientific assessments.

Through this process, a list of example indicators that could be used for assessing regenerative outcomes and regenerative capacity indicators was identified. The list is not exhaustive, but rather a preliminary one intended to be used as a starting point to move towards evidence-based planning that explicitly addresses interdependencies within the urban environment.

By establishing a clear method of assessing indicators across the three regenerative outcomes and three pillars of regenerative capacity, cities gain a framework for understanding co-benefits over time.

OP-ED



A REGENERATIVE TROPICAL MICROFOREST IN THE BUILT ENVIRONMENT: A PATHWAY TO URBAN BIODIVERSITY AND ECOSYSTEM RESTORATION AT CITY SQUARE MALL

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Professor, Engineered Nature-Based Solutions, NUS President's Office

In tropical cities, urbanisation is intensifying environmental pressures, particularly the urban heat island effect, biodiversity loss and ecosystem fragmentation. Conventional urban greening, often reliant on sparse planting and non-native species, has limited effectiveness in delivering meaningful cooling or ecological restoration. In response, regenerative tropical microforests (RTMFs) have emerged as a nature-based solution that integrates dense, biodiverse forest systems into highly urbanised environments.

The CDL MicroForest at City Square Mall in Singapore exemplifies this approach. This pilot project was developed in collaboration with City Developments Limited (CDL), the National University of Singapore (NUS) and the National Parks Board (NParks), and is aimed to serve as a living laboratory to assess how regenerative forests can deliver both environmental and social co-benefits.

The CDL MicroForest at City Square Mall is Singapore's first research-driven regenerative tropical microforest in a retail mall, designed to mitigate urban heat, enhance climate resilience and boost biodiversity.
Photo courtesy of City Developments Limited

In just one year, the forest has grown rapidly, both in density and ecological function.
Photo courtesy of City Developments Limited

Professor Veera Sekaran and Associate Professor Adrian Loo, whose guidance has brought the CDL MicroForest to life.
Photo courtesy of City Developments Limited

RTMFs are designed as dense, multi-layered ecosystems composed primarily of native tropical species. Typically incorporating as many diverse native species where possible across plant habitats like canopy trees, saplings, shrubs and ground cover, they mimic natural forest succession. Their layered structure also enhances ecological resilience, disease resistance and habitat complexity. With planting densities of 6-8 mixed saplings, ground covers and mature trees per 2 square metres, arranged in naturalistic patterns, RTMFs enable rapid canopy formation within three to five years, significantly faster than conventional tree planting systems.

The Forestscapes methodology developed by Professor Veera Sekaran at NUS underpins the RTMF framework. The methodology emphasises rigorous site assessment, including soil composition, drainage, fertility and microclimate conditions, and actively regenerates degraded urban soils using compost, organic amendments and beneficial microbial inoculation.

Unveiled on 10 March 2025 by President Tharman Shanmugaratnam, the CDL MicroForest is Singapore's first research-driven regenerative tropical microforest piloted within a retail mall in the high-density city centre.
Photo courtesy of City Developments Limited

Group photo at the MicroForest (from left to right): Associate Professor Jason Lee, Professor Veera Sekaran, Ms Esther An, Mr Lim Tuang Liang, Ms Kong Manjing, Associate Professor Adrian Loo. First-year findings from the CDL MicroForest underscore the growing interest in "cooling through greening" as a viable approach to enhancing urban resilience.
Photo courtesy of City Developments Limited

Mycorrhizal fungi and nitrogen-fixing bacteria improve nutrient cycling and plant resilience, establishing a strong soil microbiome that supports long-term forest health. Additionally, site design considers sun orientation, canopy light penetration and understorey viability to ensure successful stratified growth.

Ecologically, RTMFs accelerate biodiversity recovery by creating layered habitats that support birds, pollinators and small urban fauna. Over time, natural regeneration through wind and animal seed dispersal increases species diversity and strengthens ecosystem adaptability. Maintenance is minimal after establishment, requiring only early-stage watering, mulching and limited weed control, after which the system becomes largely self-sustaining.

Biodiversity spotted at the CDL MicroForest (from left to right): the Lime Butterfly (*Papilio demoleus*), Six-spotted Zigzag Ladybird (*Cheilomenes sexmaculata*) and Yellow-and-black Carpenter Bee (*Xylocopa flavonigrescens*).
Photos courtesy of City Developments Limited

Early monitoring of the CDL MicroForest demonstrates measurable environmental benefits. Studies indicate localised temperature reductions of up to 5°C compared to surrounding urban areas, with adjacent areas also experiencing cooling effects of 1° to 4°C. Environmental DNA analysis shows approximately 70% higher species richness compared to nearby grass areas, alongside increased bird activity, confirming improved urban biodiversity and ecological function.

Beyond environmental outcomes, RTMFs offer high urban and economic value. By reducing heat stress and improving microclimates, they enhance pedestrian comfort, increase dwell time, and strengthen placemaking in retail and mixed-use developments. They also contribute to climate resilience strategies, support biodiversity targets and align with emerging frameworks such as the Taskforce on Nature-related Financial Disclosures (TNFD). For CDL, the MicroForest strengthens City Square Mall's identity as Singapore's first eco-mall and complements its broader asset enhancement strategy, reinforcing long-term asset value and tenant attractiveness.

Overall, RTMFs represent a scalable and evidence-based model for integrating ecological restoration into dense tropical urban environments. The CDL MicroForest demonstrates that even small urban sites can function as high-impact ecological infrastructure, contributing to climate mitigation, biodiversity recovery and improved human well-being.

Examples of Outcomes Indicators

Spanning across the three key outcomes of liveability, resilience and resource optimisation, the examples of indicators offer the groundwork for an approach towards harnessing co-benefits across urban systems.

Liveability indicators can be categorised into three sub-categories: high quality of life, competitive economy and sustainable environment. Collectively, these indicators give a holistic view of the urban condition.

The list of example indicators links the three sub-categories with patterns of compact urban environments and highlights the importance of integrated, multi-functional developments in enabling liveability. This includes ensuring a diversity of businesses in individual districts and providing quality transport options. These example indicators were also selected to capture the interdependencies of liveability and ecosystem health, like quantifying the physical and mental health benefits that people gain from proximity to green spaces.

CASE STUDY

THE SUPERBLOCK PROGRAMME IN BARCELONA, SPAIN

The improved walkability of the superblocks has revitalised neighbourhoods and imbued them with new life.
Photo courtesy of Cataleirxs (CC BY-SA 4.0 / Wikimedia Commons)

Barcelona piloted its Superblock programme in the neighbourhood of Poblenou in 2016. For Poblenou, the Superblock programme resulted in positive social, economic and environmental outcomes. The reconfigured streets not only diversified mobility options and improved walkability, but have also increased commercial activity by more than 30%.[64] Beyond the neighbourhood, the Superblock programme also catalysed the transformation of an adjacent road, where one of the city's busiest and most dangerous traffic intersections used to be. Known as Glòries Park, the reclaimed space now offers 30,000 m^2 of green space and includes biodiversity nodes, dense native vegetation and family play areas.[65]

EXAMPLES OF LIVEABILITY INDICATORS

Subcategory	Indicator	Metric
High Quality of Life	Life Expectancy	Average life expectancy for inhabitants *From the indicators for life expectancy and healthy life expectancy by the World Health Organization (2021)*
	Resident Retention	Duration of residence in the neighbourhood district *From the Inclusive Healthy Places Framework by the Gehl Institute (2018)*
	Resident Satisfaction	Mean score from standardised resident satisfaction survey *From the Inclusive Healthy Places Framework by the Gehl Institute (2018)*
	Modal Share	Ratio of residents who take public transport, walk or bike to work *From "Urban form and livability: socioeconomic and built environment indicators" by Martino, N. et al. (2021)*
Sustainable Environment	Air Quality	Annual average air quality index *From the Global Air Quality Guidelines by the World Health Organization (2021)*
	Surface Water Quality	Proportion of wastewater generated on-site that is treated before release *From the Urban Environment and Social Inclusion Index by the Data-driven EnviroLab (2024)*
	Safe Drinking Water	Average life years lost due to waterborne diseases from exposure to unsafe drinking water *From the Environmental Performance Index by the Yale Center for Environmental Law & Policy (2024)*
	Ambient Noise	Proportion of residential area exceeding long-term, unhealthy noise level threshold *From an assessment of Environmental Noise in Europe by the European Environment Agency (2020)*
	Green Amenity Access	Proportion of population living within a 400-m walking distance of a park or green space *From the Singapore Index on Cities' Biodiversity by Chan, L. et al. (2021), and A Green & Liveable City: Singapore Urban Design Guidebook by the Urban Redevelopment Authority (2015)*
Competitive Economy	Income Equity	Distribution of household income within the district *From the Urban Indicators Guidelines by the UN-Habitat (2024)*
	Employment Rate	Proportion of working-age population within the district who are employed *From the Principles on Urban Policy Implementation Toolkit by the Organisation for Economic Co-operation and Development (OECD) (2024), and the Inclusive Healthy Places Framework by the Gehl Institute (2018)*
	Local Business	Diversity of business establishment types per district *From "Urban form and livability: socioeconomic and built environment indicators" by Martino, N. et al. (2021)*
	Ground Floor Activation	Proportion of ground floor frontage in active use *From the Inclusive Healthy Places Framework by the Gehl Institute (2018)*

For full elaboration, refer to liveability indicators in the Annex on page 200.

Resilience indicators can be broadly grouped into three sub-categories: climate, environmental and social resilience. These indicators aim to give decision-makers a better sense of the city's ability to recover and adapt from shocks and stressors.

Indicators for climate resilience measure the effectiveness of climate change mitigation and adaptation efforts, and reflect the adaptive capacity of the city in the face of climate impacts. Environmental resilience can be assessed by the health of ecosystems; its indicators reflect the cumulative quantity, diversity and quality of non-human life within the urban area and its hinterland. Lastly, social resilience can be assessed through a community-centric lens. Commonly represented by the social cohesion index and civic participation rate, these measurements can provide an indication of people's capacity to deal with potential disruptions.

CASE STUDY

KRANJI COASTAL NATURE PARK IN SINGAPORE

by National Parks Board

A low rock revetment at Kranji Coastal Nature Park installed in 2019 slows wave energy and allows sediments to settle, facilitating the natural regeneration of mangroves and coastal vegetation. By 2025, mangroves have naturally recruited without planting, while a coastal vegetation belt had regenerated landward of the revetment.

Photos courtesy of National Parks Board

Kranji Coastal Nature Park is a buffer park abutting the Sungei Buloh Wetland Reserve, where natural regeneration of mangroves was employed for coastal resilience.

As part of coastal protection efforts, a 400-m-long low rock barrier was implemented to slow down wave energy for sediments to settle and mangroves to recruit naturally along the coast. Landward of the barrier, a 4,900-m^2 coastal vegetation belt was established through a specially curated planting palette to mirror the natural transition from inland forest to coastal and mangrove ones. Over 70 species of plant were selected and planted on site with 1,600 community participants.

The site now buffers against rising sea levels and storm surges, mitigates erosion and expands habitat connectivity within the Sungei Buloh Nature Park Network, demonstrating how nature-based solutions can provide multiple co-benefits in a regenerative city.

EXAMPLES OF RESILIENCE INDICATORS

Subcategory	Indicator	Metric
Climate Resilience	Urban Heat Reduction	Change in mean land surface temperature *From "Landscape configuration and urban heat island effects: Assessing the relationship between landscape characteristics and land surface temperature in Phoenix, Arizona" by Connors, J.P., Galletti, C.S. & Chow, W.T.L. (2013)*
	Flood Risk Exposure	Proportion of area in the district at risk of flooding in 100 years *From Chapter 15 of Climate Change: Impacts, Adaptation and Vulnerability under IPCC AR6 (2022)*
	Runoff Volume Control	Proportion of rainfall retained and reused on-site *From "Evaluating Sponge City volume capture ratio at the catchment scale using SWMM" by Randall, M. et al. (2019)*
	Water Stress	Ratio of freshwater reserves to population size *From "Macro-scale water scarcity requires micro-scale approaches" by Falkenmark, M., Lundqvist, J., & Widstrand, C. (1989)*
Environmental Resilience	Urban Greenness	Area of healthy vegetation cover using the normalised difference vegetation index *From the "Development of a global urban greenness indicator dataset for 1,000+ cities" by Stowell, J.D., et al. (2023)*
	Plant Species Richness	Number of native plant species per survey area *From the Singapore Index on Cities' Biodiversity by Chan, L., et al. (2021)*
	Bird Species Richness	Number of native bird species per survey period *From the Singapore Index on Cities' Biodiversity by Chan, L. et al. (2021)*
	Soil Health	Amount of soil lost through water erosion per year *From "How the EU Soil Observatory is providing solid science for healthy soils" by Pangoes, P., et al. (2024)*
	Habitat Restoration	Proportion of area of restored habitat measured against area of degraded habitat *From the Singapore Index on Cities' Biodiversity by Chan, L. et al. (2021)*
Social Resilience	Civic Participation	Number of urban community resident associations *From the "Critical review of urban community resilience indicators" by Osei-Kyei, R., et al. (2023)*
	Social Cohesion	Extent of the local community's interpersonal trust and institutional trust *From the Guidelines on Measuring Trust by the OECD (2017)*
	Local Environmental Stewardship	Extent of the local community's involvement in the stewardship of the environment *From "LESI: A quantitative indicator to measure local environmental stewardship" by Turnbull, J.W., Johnston, E.L., & Clark, G.F. (2020)*

For full elaboration, refer to resilience indicators in the Annex on page 203.

Resource optimisation indicators can be divided into various groups: land, water, carbon, material and food. Altogether, these indicators measure the extent to which the city is consuming and extracting resources even as it moves towards circularity.

Land indicators favour integrated developments with co-located amenities. Food, water and material indicators—largely characterised as resources that continuously flow throughout the city—draw upon the concept of urban metabolism to provide a scientific basis for the measurement and analysis of urban resource use. Meanwhile, carbon indicators are premised on scientific consensus on carbon accounting methodologies.

CASE STUDY

THE KALUNDBORG SYMBIOSIS IN KALUNDBORG, DENMARK

Developed in 1972, the Kalundborg Symbiosis is the world's first industrial symbiosis, involving 17 public and private partners. The network connects resource and waste streams, creating a circular ecosystem that synergistically leverages residual and surplus by-products across organisations. The co-benefits are multiple. The Kalundborg Symbiosis optimises resources and generates economic growth. It saves 4 million m^3 of groundwater and 62,000 tonnes of residual materials annually, and employs approximately 6,500 people—all while driving the industrial transition towards net zero.[66]

The Asnæs Power Plant forms a key part of the Kalundborg Symbiosis. By-products and waste from the power plant are used by other manufacturers in their own production lines.

Photos courtesy of (top) Johan Wessman / News Øresund (CC BY-SA 2.0 / Wikimedia Commons) and (bottom) Bob Collowan (CC BY-SA 3.0 / Wikimedia Commons)

EXAMPLES OF RESOURCE OPTIMISATION INDICATORS

Subcategory	Indicator	Metric
Carbon	Greenhouse Gas Emissions Intensity	Total amount of CO_2e per resident per year *From the Global Protocol for Community Scale GHG Emission Inventories (GPC) by the World Resources Institute, C40 Cities and ICLEI (2021)*
	Stationary Combustion	Amount of CO_2e from stationary fuel combustion within the district boundary per year *From the Global Protocol for Community Scale GHG Emission Inventories (GPC) by the World Resources Institute, C40 Cities and ICLEI (2021)*
	Transport	Amount of CO_2e from transportation within the district boundary per year *From the Global Protocol for Community Scale GHG Emission Inventories (GPC) by the World Resources Institute, C40 Cities and ICLEI (2021)*
	Agriculture, Forestry and Other Land Use Changes	Amount of CO_2e from agriculture, forestry and other land use change within the district boundary per year *From the Global Protocol for Community Scale GHG Emission Inventories (GPC) by the World Resources Institute, C40 Cities and ICLEI (2021)*
	Industrial Processes	Amount of CO_2e from industrial processes and product use within the district boundary per year *From the Global Protocol for Community Scale GHG Emission Inventories (GPC) by the World Resources Institute, C40 Cities and ICLEI (2021)*
	Waste and Wastewater Emissions	Amount of CO_2e from waste and wastewater treatment within the district boundary per year *From the Global Protocol for Community Scale GHG Emission Inventories (GPC) by the World Resources Institute, C40 Cities and ICLEI (2021)*
	Grid-supplied Energy	Amount of CO_2e from purchased grid electricity and heat per year *From the Global Protocol for Community Scale GHG Emission Inventories (GPC) by the World Resources Institute, C40 Cities and ICLEI (2021)*
Land	Land Use Compactness	Spatial autocorrelation index of built-up density *From "Measuring urban sprawl" by Frenkel, A. & Ashkenazi, M. (2008)*
Water	Water Consumption Intensity	Daily average of potable water consumption per resident *From "Assessing water circularity in cities: methodological framework with a case study" by Arora, M., et al. (2022)*
Materials	Waste Recycling	Proportion of total municipal solid waste diverted from landfills through recycling or reuse per year *From the "CityLoops urban circularity assessment method" by Bellstedt, C. et al. (2022)*
	Building Reuse Rate	Proportion of construction permits for renovation or adaptive reuse per year *From Regenerative by Design: Creating Living Buildings and Cities by Cheshire, D. (2024)*
Food	Local Food Production	Proportion of total consumed food sourced from within the city or peri-urban region *From the Singapore Index on Cities' Biodiversity by Chan, L. et al. (2021)*

For full elaboration, refer to resource optimisation indicators in the Annex on page 206.

Examples of Capacity Indicators

In a regenerative city, density, diversity and connectivity indicators measure the capacity of the built and natural environments to support regenerative processes. The list includes examples of indicators that are specific to the urban built and natural environments, and reflective of cross-system integration.

Density indicators assess how well the city utilises its land. They look at how the city is able to extract the benefits of urban density, such as supporting efficient information exchange, increasing economic productivity and improving social cohesion. They also reflect a city's stewardship of land to support human and natural ecosystems.

Multiple density indicators have been selected based on their ability to assess individual and combined aspects of the built and natural environments. There are also density indicators that reflect cross-system integration across the two to show how the city is operating as an integrated urban environment. These include measuring shared green spaces, as well as green plot ratios.

CASE STUDY

SKYVILLE @ DAWSON IN SINGAPORE

When planned thoughtfully, densification can generate a range of co-benefits for the entire urban ecosystem. SkyVille @ Dawson, a 47-storey public housing complex in Singapore, showcases how density can enable liveability through the thoughtful integration of nature into housing. Adopting the use of skyrise greenery, the complex incorporates 3 community terraces, each placed at 11-storey intervals, and a sky garden. In a dense environment, these areas are designed to provide community spaces for residents and while accommodating skyrise greenery.

(Top left) SkyVille @ Dawson is designed with (top right) stacked sky gardens connecting the three residential blocks of the complex and (bottom) a commercial plaza that also serves the neighbouring communities.

Photos courtesy of (top left and right) Patrick Bingham-Hall and (bottom) Albert Lim K.S.

EXAMPLES OF DENSITY INDICATORS

Subcategory	Indicator	Metric	Mapping to Outcomes
Built Environment	Gross Plot Ratio	Total gross floor area per site area *From "Urban form and livability: socioeconomic and built environment indicators" by Martino, N. et al. (2021)*	Liveability Resource Optimisation
	Population Density	Total resident population per site area *From Denser and greener cities: Green interventions to achieve both urban density and nature" by McDonald, R.I. et al. (2023)*	Liveability Resource Optimisation
	Impervious Surface Coverage	Proportion of the site area covered by impervious surfaces *From "Denser and greener cities: Green interventions to achieve both urban density and nature" by McDonald, R.I. et al. (2023), the Singapore Index on Cities' Biodiversity by Chan, L. et al. (2021), and Urban Flood Risk Mitigation, InVEST User Guide by Stanford University*	Liveability Resilience Resource Optimisation
	Skyview Factor	Proportion of the visible sky area from a specific point on the ground to the total sky area *From the "Review of methods used to estimate the sky view factor in urban street canyons" by Miao, C. et al. (2020)*	Liveability Resilience
	Frontal Area Density	Proportion of a building's windward façade area to the total site area *From the "Aerodynamic properties of urban areas derived from analysis of surface form" by Grimmond, C.S.B. & Oke, T.R. (1999)*	Liveability Resilience Resource Optimisation
Natural Environment	Natural Areas in the City	Proportion of the total natural, restored and naturalised areas in the city *From the Singapore Index on Cities' Biodiversity by Chan, L. et al. (2021), and the Kunming-Montreal Global Biodiversity Framework (GBF), "2030 Targets (with Guidance Notes)" by the Convention on Biological Diversity*	Liveability Resilience
	Protected Natural Area in the City	Proportion of protected or secured natural areas in the city *From the Singapore Index on Cities' Biodiversity by Chan, L. et al., (2021), the Kunming-Montreal Global Biodiversity Framework (GBF), "2030 Targets (with Guidance Notes)" by the Convention on Biological Diversity, and "Biodiversity needs both land sharing and land sparing" by Selinske, M. et al., (2023)*	Liveability Resilience
	Tree Coverage	Proportion of the district area covered by tree canopy *From "Denser and greener cities: Green interventions to achieve both urban density and nature" by McDonald, R.I. et al. (2023)*	Liveability Resilience
Cross System Integration	Shared Green Space Ratio	Proportion of the site area for shared use (parks, gardens, green roofs, etc.) *From Dense + Green Cities by Schröpfer, T. (2019), and Designing for Biodiversity: The Value of Nature Centric Design by WOHA & bioSEA (2024)*	Liveability Resilience Resource Optimisation
	Green Plot Ratio	Average leaf area index (total leaf area) per unit area *From "Green plot ratio: an ecological measure for architecture and urban planning" by Ong, B.L. (2003)*	Liveability Resilience Resource Optimisation

For full elaboration, refer to density indicators in the Annex on page 208.

Diversity indicators measure the variety and distribution of activities and species found in the district. Diversity brings many co-benefits to the regenerative city—enabling interspecies interaction like pollination and nutrient cycling for nature, and improving social, economic and ecological resilience by reducing reliance on a single system.

This list of example diversity indicators for the built environment includes assessing land use types, mix of housing typologies and range of ground floor uses. These are complemented by assessing the diversity of the natural environment through indicators such as habitat biodiversity and tree species diversity. Cross-system integration can be tracked through indicators that count the number of distinct landscape elements.

EXAMPLES OF DIVERSITY INDICATORS

Subcategory	Indicator	Metric	Mapping to Outcomes
Built Environment	Land Use Diversity	Count and distribution of land use types within the site boundary *From "Urban form and livability: socioeconomic and built environment indicators" by Martino, N. et al. (2021)*	Liveability Resilience
	Housing Typology Mix	Count and distribution of dwelling unit types within the district *From "Urban form and livability: socioeconomic and built environment indicators" by Martino, N. et al. (2021)*	Liveability Resilience
	Ground Floor Use Mix	Count of distinct ground floor use categories per 100 m of street frontage *From the Inclusive Healthy Places Framework by the Gehl Institute (2018)*	Liveability Resilience
Natural Environment	Habitat Biodiversity Value	Biodiversity value scored based on the habitat size, condition, conservation priority and strategic significance *From the Global Biodiversity Metric (GBM) by Ramboll (2024)*	Liveability Resilience
	Tree Species Diversity	Count and distribution of tree species within the site boundary *From the Singapore Index on Cities' Biodiversity by Chan, L. et al. (2021)*	Liveability Resilience
Cross System Integration	Landscape Element Diversity	Count of distinct landscape elements (planter, green wall, pond, etc.) per unit area *From Designing for Biodiversity: The Value of Nature Centric Design by WOHA & bioSEA (2024)*	Liveability

For full elaboration, refer to diversity indicators in the Annex on page 210.

CASE STUDY

KAMPUNG ADMIRALTY IN SINGAPORE

The co-benefits of diversity are evident at Kampung Admiralty, a mixed-use development that brings together multiple users and supports rich biodiversity.[67] It co-locates multiple public amenities and services for the old and young, such as senior living apartments and active ageing hubs, a childcare centre, and dining and retail outlets. This enables intergenerational engagements and cross-programming which can contribute to social resilience. Its terraced building form incorporates over 100 different plant species, with the intention to replicate a small, dense tropical rainforest. In a series of biodiversity surveys conducted in 2024, 218 unique species of fauna were recorded at the site.

Visible from its façade, Kampung Admiralty has a terraced layout that supports biodiversity.
Photos courtesy of (top) Patrick Bingham-Hall and (bottom) Housing and Development Board

Connectivity indicators measure the accessibility of resources for people and animals and contiguity of habitats for flora and fauna. The regenerative city is achieved through productive proximities and connected corridors—mobility networks enable the urban economy to function and people to move seamlessly within the city, while ecological corridors provide vital links for biodiversity and bring people to nature.

Examples of connectivity indicators for the built environment include access to public transport, and availability of key social services and green spaces. The corresponding indicators for the natural environment include fragmentation of landscapes and prevalence of ecological corridors. An example of an indicator that measures cross-system integration is the proportion of active mobility networks that are co-located with green corridors.

CASE STUDY

ONE BANGKOK URBAN PARK IN BANGKOK, THAILAND

A regenerative city accounts for varying degrees of mobility, and integrates nature into the urban environment to connect both humans and nature. The One Bangkok Urban Park in central Bangkok connects the One Bangkok mixed-used district to the nearby Lumphini and Benjakitti parks. The 80,000-m^2 urban park also functions as an ecological bridge that connects the urban built environment with the urban natural environment. Such connectivity allows the One Bangkok district to leverage local ecosystem services that the neighbouring parks afford, such as alleviating urban heat, filtering polluted water and managing stormwater.[68]

(Top) The One Bangkok Urban Park is connected to (bottom) Benjakitti Park.
Photos courtesy of Andy Tan

EXAMPLES OF CONNECTIVITY INDICATORS

Subcategory	Indicator	Metric	Mapping of Outcomes
Built Environment	Key Services Access	Average network distance to schools, clinics and retail centres *From "Urban form and livability: socioeconomic and built environment indicators" by Martino, N. et al. (2021), and Building Liveable and Sustainable Cities: A Framework for the Future by the Centre for Liveable Cities (2025)*	Liveability Resource Optimisation
	Walkability	Composite of intersection density, average block length, and land-use mix within a 400-m buffer *From "The development of a walkability index: application to the neighborhood quality of life study" by Frank, L.D. et al. (2009)*	Liveability
	Train Network Access	Network distance to the nearest train station *From "Urban form and livability: socioeconomic and built environment indicators" by Martino, N. et al. (2021), and Building Liveable and Sustainable Cities: A Framework for the Future by the Centre for Liveable Cities (2025)*	Liveability Resource Optimisation
	Bus Network Access	Network distance to the nearest bus stop *From "Urban form and livability: socioeconomic and built environment indicators" by Martino, N. et al. (2021), and Building Liveable and Sustainable Cities: A Framework for the Future by the Centre for Liveable Cities (2025)*	Liveability Resource Optimisation
	Cycling Infrastructure Access	Network distance to the nearest dedicated cycling path *From "Urban form and livability: socioeconomic and built environment indicators" by Martino, N. et al. (2021), and Building Liveable and Sustainable Cities: A Framework for the Future by the Centre for Liveable Cities (2025)*	Liveability Resource Optimisation
Natural Environment	Ecosystem Connectivity	Spatial network analysis of the nearest landscape patch *From "Ecological connectivity in fragmented agricultural landscapes and the importance of scattered trees and small patches" by Tiang, D.C.F. et al. (2021)*	Liveability Resilience
	Effective Mesh Size	Area-weighted mean of unfragmented landscape patch sizes *From the Singapore Index on Cities' Biodiversity by Chan, L. et al. (2021), and "Implementing the connectivity of natural areas in cities as an indicator in the City Biodiversity Index (CBI)" by Deslauriers, M.R. et al. (2018)*	Liveability Resilience
	Access to Nature	Network distance from residential parcels to the nearest park or nature area *From the Singapore Index on Cities' Biodiversity by Chan, L. et al. (2021), and A Green & Liveable City: Singapore Urban Design Guidebook by the Urban Redevelopment Authority (2015)*	Liveability Resource Optimisation
	Ecological Corridor Length	Total length of dedicated ecological corridors *From Land Mosaics: The ecology of landscapes and regions by Forman, R.T.T. (1995)*	Liveability Resilience
Cross System Integration	Green Mobility Co-location	Proportion of active mobility networks (walking/cycling) that are co-located with a green corridor or park connector *From "A greenway network for Singapore" by Tan, K.W. (2006)*	Liveability Resource Optimisation

For full elaboration, refer to connectivity indicators in the Annex on page 212.

OP-ED

FROM GARDEN CITY TO CITY IN NATURE: HOW SINGAPORE'S GREEN-BLUE NETWORKS EMBODY REGENERATIVE URBAN LIVING

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With **CHARLENE NG**
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Singapore's transformation from a nation that had lost 95% of its original forest cover by 1930 to the thriving City in Nature that it is today exemplifies the four key paradigm shifts of the regenerative approach: from avoiding bad to doing good, from trade-offs to co-benefits, from human-centric thinking to fostering human-nature relationships, and from end-of-life to closed-loop planning. Our journey demonstrates that even the most urbanised environments can become net positive for both human communities and natural ecosystems.

Regenerative Principles in Practice

The Nature Conservation Masterplan[1] and City in Nature[2] strategies embody regenerative city principles of systemic thinking, dynamism and ethical stewardship. Rather than viewing green spaces as isolated amenities, we approach our island holistically as an interconnected ecosystem where nature-based solutions create multiple co-benefits across urban systems.

A lowland rainforest and freshwater wetland restoration project on a 10-hectare site led to the delivery of multiple regenerative outcomes—the delivery of clean water to the Swan Lake, refuge for threatened freshwater flora and fauna, as well as an educational site for visitors to enjoy.
Photo courtesy of National Parks Board

(Left) At Pulau Ubin, the restoration of an abandoned prawning pond through assisted natural regeneration has demonstrated that (right) mangroves can recover rapidly when tidal processes are allowed to resume.
Photos courtesy of National Parks Board

Density: Maximising Regenerative Capacity

Within our extreme land constraints, Singapore demonstrates how concentrated restoration interventions can yield disproportionate benefits. Our four nature reserves and expanding nature park networks exemplify the use of nature-based solutions in the city.

The Framework Species Method, where 20 to 40 native plant species are selected to rapidly accelerate biodiversity recovery, has been used to support the creation of integrated, multifunctional developments that serve both ecological and human needs.

The Singapore Botanic Gardens Learning Forest's freshwater wetland restoration showcases this approach well. This single site has created multiple regenerative outcomes: restoring hydrological processes and delivering clean water to the Swan Lake, regenerating lowland rainforest, creating refuge for threatened freshwater flora and fauna, and providing educational and recreational opportunities for visitors to enjoy. By 2026, over 300 hectares of such naturalised gardens and parks will demonstrate how strategic density can optimise co-benefits across liveability, resilience and resource domains.

Diversity: Ecosystem Richness as a Climate Foundation

Singapore's habitat diversity—from lowland dipterocarp forests to mangroves, and from freshwater swamps to coral reefs—forms the foundation for ecological, climate and social resilience.

Our restoration methods demonstrate regenerative dynamism, ranging from assisted natural regeneration like the successful Pulau Ubin mangrove recovery to active maximum diversity approaches for isolated urban sites.[3]

We prioritise keystone species like native figs (*Ficus* spp.), which create circular, closed-loop ecological systems that support diverse fauna year-round. Crucially, we restore all successional stages of the ecosystem rather than focusing solely on climax ecosystems.[4] This approach builds regenerative capacity for unknown climate futures. It recognises that ecological resilience requires complete ecosystem representation, not merely individual species conservation.

Thomson Nature Park.
Photo courtesy of National Parks Board

Connectivity: Living Networks Through Systemic Thinking

Our ecological corridor network, which links Singapore's nature reserves to heartland parks, embodies regenerative infrastructure that operates across multiple scales. Projects like Thomson Nature Park incorporate connectivity planning for species like the critically endangered Raffles' Banded Langur, demonstrating ethical stewardship where both humans and nature act as co-creators.

The vision of every road as a nature way creates integrated developments serving both human mobility and wildlife movement.[5] Taking such a systemic approach, guided by adaptive management principles, enables continuous learning through experimentation and reflection on how urban development affects nature.

Measuring Regenerative Outcomes

Singapore pioneered systematic measurement of urban regenerative capacity through the Singapore Index on Cities' Biodiversity (SI), developed in 2008 with the Convention on Biological Diversity Secretariat. This 28-indicator framework measures native biodiversity, ecosystem services and governance—aligning with regenerative principles of tracking co-benefits for people and nature. *To find out more about the SI, refer to page 156 of Chapter 3.*

Our long-term socio-ecological research programmes, including long-term forest ecology monitoring, provide measurement systems that track regenerative outcomes across decades. This enables true adaptive management, validating strategies through evidence-based assessment. Sites like Bishan-Ang Mo Kio Park, Kranji Marshes and Kent Ridge Park demonstrate measurable regenerative outcomes: microclimate regulation, water management, pollution reduction, biodiversity enhancement and cultural services.

Community as a Regenerative Enabler

Regenerative cities depend on collective agency and whole-of-society involvement. Community participation in our Forest Restoration Action Plan and One Million Trees Movement embodies stakeholder partnerships that create collective shifts in values and trust. From the Raffles' Banded Langur Working Group to volunteers supporting invasive species clearance, early stakeholder engagement demonstrates regenerative reciprocity—recognising that long-term ecosystem health requires active community stewardship.

Science as a Regenerative Foundation

Our restoration efforts integrate ecology, conservation biology, hydrology, engineering and social sciences, embodying holistic planning approaches. Collaboration with institutions like the Singapore University of Technology and Design has demonstrated how smart systems and modelling support future-proofing and adaptability. Tools like the "5-star system" and "recovery wheel" enable data-driven design and holistic tracking of co-benefits, while long-term monitoring infrastructure enables the regenerative principle of long-termism.

(Left) The critically endangered Raffles' Banded Langur, one of only three non-human primate species native to Singapore, finds refuge in Thomson Nature Park. Rope bridges across Old Upper Thomson Road allow these langurs to move safely between the nature park and Central Catchment Nature Reserve. (Right) Thomson Nature Park also served as the site of a Hainanese Village in the 1930s to 1980s. Parts of the old road network and remnants of homes have been preserved in the park as well.
Photos courtesy of National Parks Board

A Possible Model for Regenerative Development

Singapore's systematic approach to habitat restoration provides a replicable model for high-density cities pursuing regenerative development. Our contribution to the United Nations Decade on Ecosystem Restoration 2021–2030, and to platforms like the World Cities Summit, position Singapore as a living lab for regenerative approaches.

We have shifted from restoring to former ecological states to building climate-resilient ecosystems that leverage interdependencies, flows and loops to adapt to evolving challenges. This paradigm shift recognises that regenerative cities are complex, dynamic systems capable of thriving in climate-changed and resource-constrained futures.

Singapore's City in Nature vision proves that urban development can be optimised for co-benefits, to create more good for both people and the environment. Through systematic habitat restoration, pioneering assessment tools and long-term research validation, we have created living infrastructure that enables true regenerative urban development—providing a scientifically-grounded model for cities worldwide seeking to become net positive forces for both human communities and natural ecosystems.

Once a working railway line connecting Singapore to Malaysia, the 24-km Rail Corridor has been rewilded into a living ecological thread through the heart of Singapore. Stretching from Woodlands in the north to Tanjong Pagar in the south, its rewilded stretches link green spaces across the island.
Photo courtesy of National Parks Board

The Rail Corridor has also become one of Singapore's most cherished green passages: a place where joggers, cyclists and families share the trail with native wildlife.
Photo courtesy of National Parks Board

ENDNOTES

[1] National Parks Board, *Nature Conservation Masterplan* (Singapore: National Parks Board, 2015), https://www.nparks.gov.sg/docs/default-source/resources/2015/nature-conservation-masterplan.pdf.

[2] National Parks Board, "City in Nature: key strategies", last updated 11 February 2025, https://www.nparks.gov.sg/who-we-are/city-in-nature-key-strategies.

[3] Robert Teo, "Chapter 20: Mangrove Restoration in Pulau Ubin", in *Handbook on Habitat Restoration: General Principles and Case Studies in Singapore*, ed. Lena Chan, Daniel Ng and Lim Liang Jim (Singapore: National Parks Board, 2023), 249–253.

[4] Successional stages refer to the sequential phases through which an ecosystem develops over time, from bare or disturbed ground through the establishment of progressively more complex plant communities. In contrast, a climax ecosystem refers to the stable, self-sustaining community that represents the endpoint of ecological succession; for example, a primary tropical rainforest.

[5] Lee Jia Hwa, Jason Yong Wai Weng and Oh Cheow Sheng, "Chapter 7: Nature Ways—Habitat Enhancement in Streetscape for Biodiversity", in *Handbook on Habitat Restoration: General Principles and Case Studies in Singapore* (Singapore: National Parks Board, 2023), 76–89.

OP-ED

DENSITY, DIVERSITY, CONNECTIVITY: PLANNING SINGAPORE AS A REGENERATIVE CITY

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When Singapore's pioneering urban planner Dr Liu Thai Ker passed on recently, many of us paused to reflect on his enduring wisdom. He often said that to build a city, one must have the heart of a humanist, the mind of a scientist and the eye of an artist.

Cities are living organisms that outlast their planners. Our responsibility is to design systems that continue working decades after we are gone—especially in a future when populations age, economies restructure and climate conditions shift unpredictably.

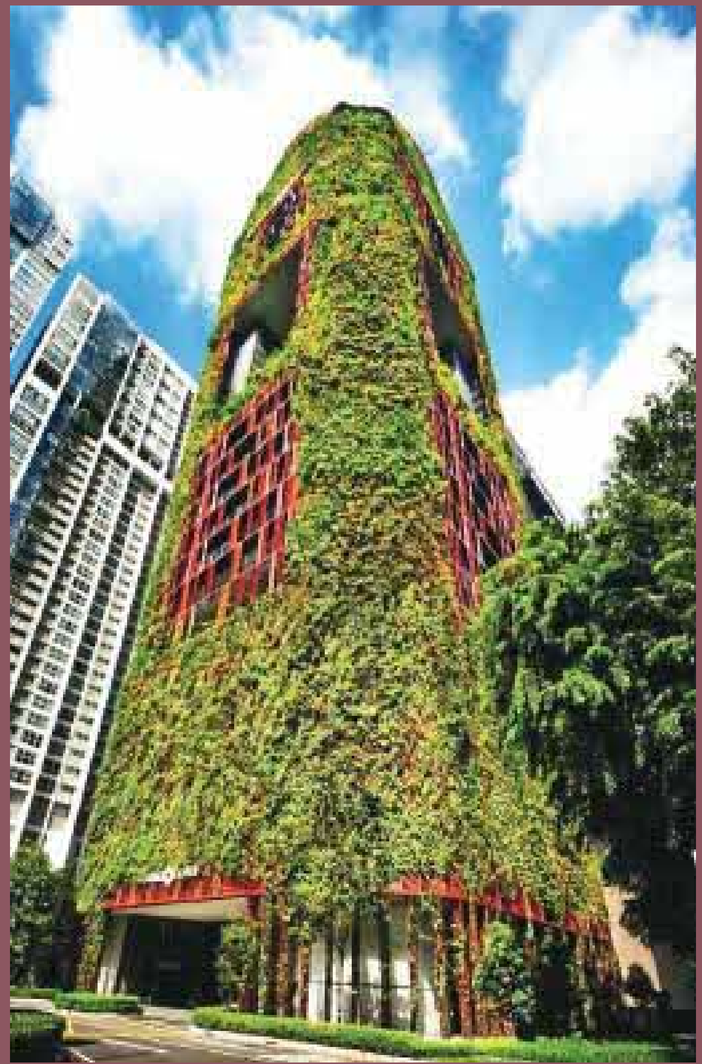
In Singapore, the principles of regenerative urbanism have long guided our planning practice. Over decades, we have consciously applied the concepts of density, diversity and connectivity to plan and shape how our city functions socially, economically and ecologically.

Density: Intensification Without Compromising Liveability

Density is often (wrongly) associated with dystopian skyscrapers and congested living environments. But when it is thoughtfully applied by planners, density means co-location and convenience, bringing homes, jobs, services and amenities closer together so that more people can benefit from them efficiently. In Singapore, intensification through progressive redevelopment allows our limited land to support a growing population, more jobs and better amenities.

Urban infrastructure, such as rail lines, drainage systems and digital networks requires large upfront investments. Singapore's compact form has allowed us to build a comprehensive Mass Rapid Transit network and district systems such as **Marina Bay's district cooling**, serving a much larger population with a smaller footprint and in a more cost-effective manner.

Density also creates space for nature. By building up strategically at selected locations (e.g. near transport nodes), we can set aside land elsewhere for nature reserves, parks, waterways and ecological corridors which are essential for biodiversity and climate adaptation. Through the Landscaping for Urban Spaces and High-Rises (LUSH) programme, we also embed greenery into buildings to cool the city and enhance well-being.



The Oasia Hotel Downtown features sky terraces and cascading lush planting integrated into the building form, providing green visual relief for guests and employees.
Photo courtesy of Patrick Bingham-Hall

Diversity: Designing for Change

Cities go through cycles. Economies rise and fall. Technologies disrupt industries. Diversity in urban form helps cities stay resilient through these changes.

In practice, this often takes the form of mixed-use neighbourhoods. Singapore's **Jurong Lake District** (JLD) exemplifies this approach, where commercial, residential and recreational spaces are being developed around a major transport hub. JLD will be a model sustainable mixed-use district, aiming to achieve net zero emissions for all new developments by 2045. Smart infrastructure initiatives such as district cooling, solar power deployment and super low-energy buildings can help to optimise resources, reduce the district's carbon footprint, and improve health and well-being.

Integrated developments illustrate another aspect of diversity. For example, the new Bukit Canberra integrates sports facilities, healthcare and greenery within a single precinct. These uses are deliberately arranged to complement one another. For instance, sports and eldercare facilities sit side by side, creating opportunities for shared activities and intergenerational interaction. Such planning strengthens social bonds while supporting physical and mental well-being.

In newer neighbourhoods like Springleaf and Lentor, we are shaping development around nature from the outset. Urban design is guided by natural topography, existing greenery and ecological corridors that are linked to the Central Catchment Nature Reserve. These neighbourhoods also provide shaded streets, permeable surfaces and water-sensitive landscapes to create cooler environments.

Interrelated uses in Bukit Canberra are organised based on four key areas: greenery, water, food and health.
Image courtesy of DP Architects

Connectivity: Binding the City Together

Connectivity is more than roads and rails. It structures how people, goods, energy, information and nature flow through a city.

At the macro scale, innovation districts anchor Singapore in flows of trade, talent and knowledge. Clustering universities, research institutions and firms in areas such as one-north, the Jurong Innovation District and Punggol Digital District generates knowledge spillovers that support emerging sectors like clean technologies, advanced manufacturing and artificial intelligence.

Within the city, rail expansion and transit-oriented development concentrate growth around public transport nodes, reducing private vehicle dependence and carbon emissions. The Rail Corridor, once a freight line, has been transformed into a continuous green spine for walking, cycling and biodiversity—demonstrating how connectivity can restore ecological and social value.

At the neighbourhood level, pedestrian networks, cycling paths and park connectors encourage low-carbon mobility while improving well-being. We also carry out environmental studies to identify ecological corridors and guide the development of eco-links which allow wildlife to move between habitats, integrating nature into our urban fabric even as we develop.

The 24-km Rail Corridor repurposes an old freight line into a continuous green and mobility spine, linking neighbourhoods while restoring ecological and social connectivity.
Photos courtesy of Urban Redevelopment Authority

From Sustainable to Regenerative City

For cities, being regenerative means moving beyond sustaining what we have today to restoring ecological, social and economic capacity. Density allows infrastructure to be used more efficiently while setting aside land for nature. Diversity creates neighbourhoods where different activities and communities can co-exist and evolve. Connectivity supports low-carbon mobility, knowledge exchange and ecological networks that allow people and biodiversity to move through the city.

Dr Liu reminded us that planners must be humanists, scientists and artists. I would add that we must also be gardeners—cultivating conditions for growth, resilience and renewal. If we do this well, the seeds we plant today will shade many generations to come.

DEVELOPING A REGENERATIVE CITY SELF-ASSESSMENT TOOL

The value of the indicators outlined in this chapter can only be realised when they are applied together and operationalised as part of urban development processes. The desired regenerative outcomes of liveability, resilience and resource optimisation are too often treated as separate goals handled by separate agencies, measured by separate protocols and funded through separate budgets. However, the regenerative approach is a systems approach. The planning and design of urban interventions must be done in an integrated manner to maximise co-benefits across all three regenerative outcomes while building a city's regenerative capacity in a resource-constrained environment. Here, we present the outline of a Regenerative City Self-Assessment Tool (RCSAT) that when fully developed can make this integration possible by giving practitioners a shared tool and framework to measure and track action.

Dar Ramani Huria gathers community members to create maps of Dar Es Salaam. By mapping relevant features, the project aims to help previously neglected areas better prevent and respond to the city's yearly floods.
Photo courtesy of Ramani Huria, Flickr

What the RCSAT Does

The RCSAT can serve practitioners by making regenerative outcomes and capacity visible, measurable and actionable through three key functions.

The RCSAT creates a common language across sectors. Urban planners, ecologists and financiers each bring rigorous methods to their domains but they measure and prioritise different things. By offering a unified set of indicators across the key outcomes of a regenerative city, the tool bridges fragmentations in the reporting landscape and enables all to have a shared understanding of the city's overall regenerative performance and capacity. This enables more holistic assessment and decision-making, and gives diverse stakeholders a common goal and basis for prioritising action.

The RCSAT enables longitudinal tracking. Regenerative developments unfold over time and their impacts are not always immediately visible. Outcome indicators that are assessed over time reveal whether regenerative interventions are really achieving their intended effects and how long meaningful change takes to emerge. Capacity indicators, when tracked over time, reveal how well the city is building its ability to facilitate and sustain regenerative processes over time. Such longitudinal data offers cities an evidence-based feedback loop for them to iterate and evolve. At the same time, such measurements give decision-makers an empirical foundation to value and justify long-term regenerative investments.

The RCSAT supports better decisions. Beyond tracking what has happened, the tool can inform what should happen next. Enabled by science and technology, simulation, modelling, and analysis can be built off the RCSAT to assess the performance of proposed interventions before they are implemented. This enables city leaders to conduct options analysis, stress-test interventions, and direct resources towards interventions that generate the broadest regenerative returns. The RCSAT can also expand conventional cost-benefit analysis approaches by making the range of co-benefits legible and comparable. This operationalises the integrated decision-making needed to maximise the co-benefits that a city can achieve.

Who the RCSAT Is For

The RCSAT is primarily targeted at city leaders, urban planners and policymakers making decisions at the district scale. Its value lies in the holistic view achieved through aggregating key indicators across urban functions. In doing so, it aims to support strategic and long-term decision-making.

The tool is also equally designed for the domain experts that city leaders, urban planners and policymakers work with: urban designers, ecologists, civil engineers, architects, and social and behavioural scientists. All of these stakeholders contribute to the whole from within their respective areas of expertise. By bringing decision-makers and domain experts into a shared assessment framework, the RCSAT creates the conditions for a collaborative ecosystem that enables regenerative urban development.

Where the RCSAT Works Best

The RCSAT is best optimised at the district scale. This is the scale at which urban systems intersect, and co-benefits become visible and attributable. Nature-based and biomimetic solutions amplify resilience across a district in ways that building-level solutions cannot achieve. Low-carbon, integrated developments support connectivity and enable liveability when integrated at the neighbourhood level. Circular flows become viable when the loop is closed across shared infrastructure. These synergies are difficult to capture at the building scale, while they become too diffused and difficult to attribute at the city scale. Therefore, the district is where regenerative strategies produce their most legible returns.

Citizens can contribute to measuring environmental outcomes. This can involve counting animal species and tracking their changes over time, contributing to how conservation efforts are carried out.
Photo courtesy of National Parks Board

The RCSAT is a work-in-progress but this outline aims to establish the framework for an integrated evidence-based regenerative practice. The indicators discussed in this chapter provide a rigorous and informed starting point: a clear articulation of what to measure, distinguishing between regenerative outcomes tracked longitudinally to reveal the impacts of interventions, and regenerative capacity assessed cross-sectionally to reveal a city's readiness to support regenerative processes.

While preliminary, the sketch of the tool aims to inspire cities to apply a common basis for understanding and improving their regenerative performance. While the tool is imagined to be as broadly applicable as possible, it must also be grounded in the climate, culture, governance and urban context of where the tool is applied. Getting this right will depend on extensive collaboration among city planners, ecologists, urban designers and local communities, as well as the availability of transparent and comprehensive datasets. We continue to work towards an initial release of the RCSAT. As the tool is applied across case studies and refined through use, the relationships between regenerative capacity and outcomes will become clearer, the understanding of the social and ecological processes that link them will be better understood, and the evidence base will become deeper. As the science of regenerative cities advances, the case for regenerative approaches to urban development will also become harder to ignore.