

CHAPTER 23

Singapore Index on Cities' Biodiversity – A Monitoring Tool for Biodiversity Conservation Efforts

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Cities and biodiversity conservation

Despite occupying only 1–3% of the earth's surface (Liu *et al.*, 2014), cities consume about 60% of total global domestic material consumption (International Resource Panel, 2018). The ecological footprint of cities extends far beyond their boundaries, contributing significantly to biodiversity loss at the local and global levels. This issue is made more pressing by the fact that the majority of the world population will eventually reside in cities and urban areas. The proportion of the world population living in cities and towns is expected to increase from 54% in 2015 to 66% by 2050 (International Resource Panel, 2018). While this forecast presents numerous challenges, with the right measures in place, cities can be part of the solution. As urban populations grow, the role cities play in biodiversity conservation becomes increasingly important. Effective land-use and management of natural ecosystems within urban areas can be mutually beneficial to both residents and the biodiversity that exists within and around the city.

This potential to tap on cities as part of the solution was recognised by the Conference of Parties to the Convention on Biological Diversity (CBD) at its 9th Meeting in 2008. For the first time ever, Parties recognised the role of cities and local authorities in national strategies for biodiversity conservation through Decision IX/28, where national governments were encouraged to engage cities in national implementation of the CBD. During the High-Level Segment, Mr Mah Bow Tan, then Singapore's Minister for National Development, proposed the development of a biodiversity index for cities to benchmark conservation efforts and evaluate progress in reducing the rate of biodiversity loss.

Development of the Index

Following the proposal, the Secretariat of the CBD, in partnership with Singapore and the Global Partnership on Local and Subnational Action for Biodiversity, organised a series of expert workshops in 2009, 2010 and 2011 to develop the biodiversity index for cities. The workshops,

attended by technical experts on urban biodiversity and ecology, international organisations, and city officials, discussed and identified indicators that would enable cities to monitor and evaluate their urban biodiversity conservation efforts. The outcome of the workshops was a User's Manual on the Singapore Index on Cities' Biodiversity (Chan *et al.*, 2014) which provided guidance on how to apply the index.

The Singapore Index on Cities' Biodiversity (or Singapore Index, also known as the City Biodiversity Index) was developed as a self-assessment tool that was easy for city officials to apply, scientifically credible, and served as an objective tool that was unbiased and could be applied by cities worldwide. It was designed to allow cities to benchmark and monitor the progress of biodiversity conservation efforts against their own individual baselines. The trends between periodical assessments of the index would show either an improvement or decline in the effectiveness of biodiversity conservation efforts by a particular city, and could be used to identify specific areas for improvement. It was intentionally designed not to become a tool for comparison between cities, due to inherent differences arising from locality. For example, cities in the temperate region would have an inherently lower biodiversity compared to tropical cities. The different sizes of cities would also mean varying biodiversity richness. A comparative global study of biodiversity in cities would have to stratify cities across several criteria.

The 10th anniversary of the first workshop on the development of the Singapore Index was in 2019. As the biodiversity landscape had evolved over the years since the index was developed, it was timely to initiate a review of the original indicators and to develop new indicators to take into account issues that had arisen, as well as to incorporate feedback from cities that had applied the index. The workshop on the Review of the Singapore Index on Cities' Biodiversity was held in Singapore in October 2019 with the following objectives:

- (a) Develop new indicators to address gaps in the current indicators in the Singapore Index.
- (b) Review the current indicators based on cities' feedback and to improve their applicability.

A Handbook on the Singapore Index on Cities' Biodiversity was published in 2021 (Chan *et al.*, 2021) with detailed instructions on how to calculate the updated indicators in the revised version of the Singapore Index.

Structure of the Index

The index comprises two parts: first, the “Profile of the City” which provides comprehensive background information on the city; second, a city’s self-assessment using the 28 indicators based on the guidelines and methodology provided (Table 1). The scoring of the index is quantitative in nature. A maximum score of four has been allocated to each indicator, and with the current count of 28 indicators, the total possible score of the index is 112 points, where the individual scores of the 28 indicators are summed up to give the total score. The year in which a city first embarks on this scoring will be taken as the baseline year, and future applications of the index will be measured against this to chart its progress in conserving biodiversity.

Part I – Profile of the City

In addition to serving as an introduction, this section captures other relevant and useful information that provides a holistic picture of a city, and places its application of the indicators in the proper context. Here, a city provides information on its location, climate, size, demographics, economic parameters, physical characteristics, and biodiversity features. Expanding further on the biodiversity information, the city can include details of the ecosystems, populations of key taxonomic groups and the conservation status of these species.

Part II – Indicators

The 28 indicators are grouped under three broad components: native biodiversity in the city; ecosystem services; and governance and management of biodiversity. For each indicator, the rationale, calculation methods and possible data sources are stated clearly in a tabular format. Nine indicators have been selected to measure native biodiversity in the city, including proportion of natural areas in a city and changes in selected taxa, among others. Five indicators measure carbon storage and the cooling effect of vegetation and other ecosystem services in the city. Under good governance and management, fourteen indicators are listed, covering cities’ biodiversity budgets, projects, collaborations, and partnerships. A large emphasis is placed on good governance and management to encourage proactive action by city officials who will be the ones applying the index.

Table 1. Overview of the Singapore Index on Cities' Biodiversity.

SINGAPORE INDEX ON CITIES' BIODIVERSITY			
PART I – Profile of the City	Location and size (geographical coordinates (latitudes and longitudes); climate (temperate or tropical, etc.); rainfall/precipitation (range and average); including maps or satellite images where city boundaries are clearly defined)		
	Physical features of the city (geography, altitude, area of impermeable surfaces, information on brownfield sites, etc.)		
	Demographics (including total population and population density; the population of the region could also be included if appropriate, and for the purpose of placing it in the regional context)		
	Economic parameters (Gross Domestic Product (GDP), Gross National Product (GNP), per capita income, key economic activities, drivers, and pressures on biodiversity)		
	Biodiversity features (ecosystems within the city, species within the city, quantitative data on populations of key species of local importance, relevant qualitative biodiversity data)		
	Administration of biodiversity (relevant information includes agencies and departments responsible for biodiversity; how natural areas are protected (through national parks, nature reserves, forest reserves, secured areas, parks, etc.))		
	Links to relevant websites including the city's website, environmental or biodiversity themed websites, websites of agencies responsible for managing biodiversity		
PART II – Indicators	Core Components	Indicators	Maximum Score
	Native Biodiversity in the City	1. Proportion of Natural Areas in the City	4 points
		2. Connectivity Measures or Ecological Networks to Counter Fragmentation	4 points
		3. Native Biodiversity in Built Up Areas (Bird Species)	4 points
		4. Change in Number of Vascular Plant Species	4 points
		5. Change in Number of Native Bird Species	4 points
		6. Change in Number of Native Arthropod Species	4 points
		7. Habitat Restoration	4 points
		8. Proportion of Protected Natural Areas	4 points
		9. Proportion of Invasive Alien Species	4 points

Table 1. Overview of the Singapore Index on Cities' Biodiversity. (Cont'd)

PART II – Indicators	Core Components	Indicators	Maximum Score
	PART II – Indicators	Ecosystem Services provided by Biodiversity	10. Regulation of Quantity of Water
11. Climate Regulation – Benefits of Trees and Greenery			4 points
12. Recreational Services			4 points
13. Health and Wellbeing – Proximity/Accessibility to Parks			4 points
14. Food Security Resilience – Urban Agriculture			4 points
Governance and Management of Biodiversity		15. Institutional Capacity	4 points
		16. Budget Allocated to Biodiversity	4 points
		17. Policies, Rules and Regulations – Existence of Local Biodiversity Strategy and Action Plan	4 points
		18. Status of Natural Capital Assessment in the City	4 points
		19. State of Green and Blue Space Management Plans in the City	4 points
		20. Biodiversity Related Responses to Climate Change	4 points
		21. Policy and/or Incentives for Green Infrastructure as Nature-based Solutions	4 points
		22. Cross-sectoral and Inter-agency Collaborations	4 points
		23. Participation and Partnership: Existence of Formal or Informal Public Consultation Process Pertaining to Biodiversity Related Matters	4 points
		24. Participation and Partnership: Number of Agencies/Private Companies/NGOs/Academic Institutions/International Organisations with which the City is Partnering in Biodiversity Activities, Projects and Programmes	4 points
		25. Number of Biodiversity Projects Implemented by the City Annually	4 points
		26. Education	4 points
		27. Awareness	4 points
28. Community Science		4 points	
Native Biodiversity in the City (Sub-total for indicators 1–9)		36 points	
Ecosystem Services provided by Biodiversity (Sub-total for indicators 10–14)		20 points	
Governance and Management of Biodiversity (Sub-total for indicators 15–28)		56 points	
Maximum Total:		112 points	

Habitat enhancement, restoration, and the Singapore Index

The availability and quality of habitats is one of the main determinants of how well biodiversity thrives in any environment, and much more so within the urban environment of cities. The Singapore Index has numerous indicators that directly or indirectly measure the outcomes of habitat enhancement and restoration. The following table presents the ways in which habitat enhancement and restoration efforts can be measured by the Singapore Index (Table 2).

Table 2. Ways habitat enhancement and restoration efforts can be measured by the Singapore Index

Indicators	Habitat enhancement and restoration effects
1. Proportion of Natural Areas in the City	This is a direct measure of how much natural areas a city has, and habitat enhancement and restoration would directly increase this figure.
2. Connectivity Measures	Connectivity between patches of natural areas in the Singapore Index is measured using specific criteria. Habitat enhancement and restoration can either help to merge patches under these criteria, or to physically connect patches.
3. Native Biodiversity in Built-up Areas (Bird Species)	This indicator measures biodiversity amidst the most urban areas. Enhancing and restoring habitats within such spaces would provide new areas or larger spaces and new sources of food that birds would be able to take advantage of.
4–6. Change in number of species in three taxa	The provision of new habitats presents opportunities for plants and animals that may not previously have been present in the city to take up residence by creating conditions that are conducive for them.
7. Habitat Restoration	This indicator directly measures the proportion of habitats restored as well as the types of habitats restored.
8. Proportion of Protected Natural Areas	Protected Natural Areas are areas of particular importance for biodiversity that are protected for the purpose of conserving it. Restoring or enhancing the existing habitats may help to improve the survivability of the important species for which it was originally protected, or to provide buffer areas to absorb some of the external impacts or re-direct human activities from the main Protected Area.
9. Proportion of Invasive Alien Species	Some invasive plant species can take over entire areas that were previously forested areas. When such areas are cleared, habitat enhancement and restoration can help to prevent the invasive plants from re-establishing, and thus contribute towards the eradication or management of these invasive species.
10. Regulation of Quantity of Water	This indicator measures the proportional area of permeable surfaces, including natural areas, or “effective impervious areas”. Habitat enhancement and restoration have the potential to increase the area of natural permeable surfaces that can contribute towards this indicator.
11. Climate Regulation – Benefits of Trees and Greenery	This indicator is a direct measure of the tree canopy cover in a city, and if trees are planted in the habitat enhancement and restoration efforts, they would eventually contribute towards this indicator.

Table 2. Ways habitat enhancement and restoration efforts can be measured by the Singapore Index (*Cont'd*)

Indicators	Habitat enhancement and restoration effects
12. Recreational Services	This indicator measures the provision of green spaces available to residents of a city for recreational purposes. Habitat enhancement and restoration efforts create new areas that can then be made available to residents for recreation and thus contribute directly towards this indicator.
13. Health and Wellbeing – Proximity/Accessibility to Parks	The proximity and accessibility to parks are important elements of city planning that ensure green and blue spaces are available to all residents for recreation. Strategically planned habitat restoration and enhancement can increase the coverage of green areas that are accessible to the residents of a city.
16. Budget Allocated to Biodiversity	The budget allocated to biodiversity conservation purposes indicates a city's commitment towards this cause, and the budget used for habitat enhancement or restoration projects would contribute directly towards this indicator.
20. Biodiversity Related Responses to Climate Change	Habitat enhancement and restoration efforts can contribute to the implementation of plans for biodiversity-related responses to address climate change in the areas of adaptation, mitigation, or ecological resilience.
21. Policy and/or Incentives for Green Infrastructure as Nature-based Solutions	Habitat enhancement and restoration efforts can contribute as provision of green infrastructure in compliance with the policies, regulations, and incentives for nature-based solutions.
22. Cross-sectoral and Inter-agency Collaborations	Appropriate sites for habitat enhancement and restoration efforts are not always parked neatly under the jurisdiction of a single agency, and such efforts would involve coordination between various landowning agencies as well as the agency in charge of biodiversity or habitat enhancement. This also encourages the mainstreaming of biodiversity conservation.
24. Participation and Partnership: Number of Agencies/Private Companies/NGOs/Academic Institutions/International Organisations with which the City is Partnering in Biodiversity Activities, Projects and Programmes	Habitat enhancement and restoration projects provide an opportunity for engagement with a range of diverse organisations, in terms of land use permissions, design of the area to be enhanced or restored, engineering expertise, or even conducting tree planting activities as part of the project.
25. Number of Biodiversity Projects Implemented by the City Annually	This indicator is a count of the biodiversity related projects that the city is directly involved in. Habitat enhancement or restoration projects would contribute directly towards this indicator.

Table 2. Ways habitat enhancement and restoration efforts can be measured by the Singapore Index (*Cont'd*)

Indicators	Habitat enhancement and restoration effects
26. Education	Sites that have undergone enhancement or restoration can provide potential venues for schools to bring students on educational field trips, as part of the implementation of the curriculum, and directly contributing towards this indicator. Students can initiate habitat restoration and enhancement projects in their school grounds so that biodiversity conservation can be incorporated into the school curriculum in an active way.
27. Awareness	Sites that have undergone enhancement or restoration can provide potential venues for outreach events, which would facilitate this indicator directly.
28. Community Science	Citizen scientists can partake in habitat restoration and enhancement in numerous ways, through biodiversity monitoring activities, photography, etc. Sites that have undergone enhancement or restoration can provide potential venues for citizen science projects, thus increasing available opportunities and contributing directly to the indicator.

Conclusion

Cities, by their nature, will have had to clear significant portions of the original habitats that once existed in the area. Remaining habitats tend to be exposed to impacts that are associated with urbanisation, and have limited space in which they can expand. Thus, it is only with active human intervention that these habitats would be able to expand and thrive, to better provide ecosystem services to the residents of the city. With habitat enhancement and restoration efforts being highly relevant to the indicators of the Singapore Index, it shows that such activities are important in relation to conserving the remaining biodiversity of a city. For cities that place biodiversity conservation as a priority, the ability to track concrete outcomes of their habitat enhancement and restoration efforts would go a long way towards validating the initial investment in such activities.

References

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