City Diversity (2023) Volume 4 Issue 1, *8 pages*.
doi: 10.54517/cd.v2i2.1941

ORIGINAL RESEARCH ARTICLE

References and enlightenment of city biodiversity index in Singapore and Japan

Junhuan Xue, Yuncai Wang*, Chundi Chen

College of Architecture and Urban Planning, Tongji University, Shanghai 200092, China. E-mail: wyc1967@tongji.edu.cn

ABSTRACT

City biodiversity is an important part of global biodiversity conservation, and city biodiversity conservation needs to start with measurement and criteria. This paper introduces the Singapore index and Japanese index, and also introduces city biodiversity index conceptual framework which is developed based on the "driving force–pressure–status–impact–response model". The trend of city biodiversity index development is pointed out, i. e, to build a city biodiversity index of different scales, to build cooperative and shared information infrastructure and to evaluate city biodiversity index itself. At the end, in view of the status quo of city biodiversity index in China and the requirements of urban development, this paper proposes the conception of city biodiversity index development in China from the perspectives of local urban biodiversity, ecosystem service functions and urban management measures.

Keywords: city; biodiversity; index; enlightenment; development conception

According to the world urbanization outlook, by 2050, the global population is expected to increase to 9.2 billion, of which 6.4 billion will live in cities. Cities need to respond to the increase of urban population in the future [1]. Biodiversity can provide human security through ecosystem services. The material and cultural supply of economy and the biodiversity widely existing in cities are also important components of global biodiversity protection. It is necessary to rethink the future development of cities from the perspective of biodiversity [2].

Internationally, the 10th Conference of the parties to the Treaty on biological diversity (cop_10) in 2010 adopted x/22 "on sub national governments. The resolution of the Biodiversity Action Plan of cities and other local authorities encourages the use of urban biodiversity indicators as a monitoring tool to help local governments assess their progress in urban biodiversity conservation [3].

In China, since joining the Convention on biological diversity in 1992, urban planning and biodiversity protection in scenic spots have been included in the China biodiversity protection action plan in 1993; in 2002, the notice on strengthening the protection of urban biodiversity was issued; in 2005, the "National Garden City application and evaluation measures" clearly requires the applicant

ARTICLE INFO
Received: July 6, 2023 | Accepted: August 21, 2023 | Available online: September 6, 2023

CITATION
Xue J, Wang Y, Chen C. References and enlightenment of city biodiversity index in Singapore and Japan. City Diversity 2023; 4(1): 8 pages.

city to prepare the "biodiversity (plant) planning within the urban planning area"; the evaluation standard for urban landscaping issued in 2010 included the protection of urban biodiversity in the evaluation content and attached great importance to the protection of urban biodiversity, but did not discuss and formulate the indicators of urban biodiversity, and the protection of urban biodiversity first needs to consider the measurement standard. Therefore, this paper introduces the widely used indicators of urban biodiversity. The conceptual framework of indicators, as well as the development direction of indicator development, and put forward the concept of urban biodiversity indicator development in China, in order to provide reference for the development of indicators.

Table 1. Contents of urban biodiversity indicators [4-5]

Core components	Index	Indicator type	Japan/Singapore/common
Urban indigenous biological or ecosystem diversity	Proportion of natural areas (sustainable green space) of the city	Status indicators	Common indicators
	Current status of green space (proportion of green space with the potential to ensure urban biodiversity)	Status indicators	Japanese indicators
	Proportion of protected natural areas (guaranteed by law)	Status indicators	Common indicators
	Connection measures or ecological networks to inhibit fragmentation	Status indicators	Common indicators
	Native biodiversity (bird species) in built-up areas	Status indicators	Singapore indicators
	Changes in the number of local species and investigations on the number of species of animals and plants	Impact indicators	Common indicators
	Proportion of invasive alien species	Impact indicators	Singapore indicators
Ecosystem services provided by biodiversity	Water management (water regulation (pervious effect of green space))	Status indicators	Common indicators
	Climate regulation:carbon storage and cooling effect of vegetation or absorption of greenhouse gases by urban greening	Status indicators	Common indicators
Biodiversity management and action	Leisure and education services	Impact indicators	Singapore indicators
	Budget for biodiversity	Response index	Singapore indicators
	Number of biodiversity projects implemented by the city every year	Response index	Singapore indicators
	Does the city have a Biodiversity Strategy and action plan	Response index	Common indicators
	Institutional capacity. Participation and partnership	Response index	Common indicators
	Education and awareness	Response index	Singapore indicators

1. Biodiversity indicators in Singapore and Japan

1.1. Overview of urban biodiversity indicators

The proposal of Singapore's urban biodiversity indicators was put forward by Singapore's minister of national development, Ma Baoshan, at the high-level chapter of the 9th Conference of the parties to the Treaty on biological diversity (COP_9). After a series of expert discussion meetings, it was officially published at the 10th Conference of the parties to the Treaty on biological diversity (cop_10) and adopted by the parties. Singapore's urban biodiversity index consists of two parts: The first part "city Overview" provides the background information of the city; the second part consists of 23 indicators [4]. The Ministry of land and transportation of Japan released a simplified version of urban biodiversity indicators in 2016, which is composed of urban ecosystem and habitat diversity. The ecosystem services that urban residents can enjoy and the action of the city 3 constitute most of the seven indicators [5] (**Table 1**).

1.2. Characteristics and use of indicators

It is not easy to evaluate the biodiversity of cities in different climatic zones with the same standard. Therefore, Singapore biodiversity index is only used as a tool for self-evaluation to grasp the current situation information. It can be scored to guide the protection practice and test the practice results, but it is not used as a city ranking. The three core components of the indicator represent the stock of urban indigenous biodiversity. Whether the services provided by natural resources are sound, as well as the city's response capacity and policy implementation. By 2019, a total of 54 cities around the world have used Singapore's urban biodiversity indicators [6].

Japanese urban biodiversity indicators refer to "Singapore urban biodiversity indicators" and have been improved based on three perspectives:1) The necessity of being an indicator of the status of actions related to the evaluation and protection of biodiversity; 2) The simplicity of obtaining data and calculating methods when using index evaluation in cities; 3)Wide applicability that can be used in cities all over Japan [7]. In the "ranking of Japan's excellent biodiversity cities" [8] released in November 2016, 665 cities across Japan were evaluated based on the simplified version of Japan's urban biodiversity indicators.

1.3. Improvement points of indicators

In Singapore's biodiversity index "the proportion of natural areas (sustainable green space) of the city", except for the natural areas of the city, there is no evaluation of green space affected by human factors, such as parks. Open space. FarmLand, etc. Also did not mention the difference between urban areas and suburbs. It is suggested to consider the distinction between urban areas and suburbs, classify the green space therein, and then evaluate the biodiversity of all kinds of green space. In addition, the indicator "indigenous biodiversity in densely built areas" only considers the total number of urban species and ecosystems, which is greatly affected by the region of the city where it is located. The increase or decrease of the total number of species can be replaced by the increase or decrease of protected species. Moreover, in the ecosystem services part, in addition to the existing indicators, cities should adjust appropriately according to the actual situation, such as increasing biodiversity to alleviate urban flooding. Evaluation of heat island effect.

In terms of Japanese indicators, first of all,

there is a positive correlation between the indicator "green space status" and the indicator "urban ecological network status", so it is necessary to sort out the relationship between the indicators. Second, the relevant indicators of urban action are mainly the evaluation of time series. For example, the evaluation of urban action is higher than that of cities that have made progress in the past, and there is a lack of evaluation of the level of action. Third, it is necessary to carry out graded evaluation of cities. Only by grading evaluation according to the action status of cities, can we effectively promote the action of urban biodiversity protection. Fourth, it is suggested to increase the number of full-time personnel engaged in urban biodiversity protection and the evaluation of cooperation between administrative departments. In the "ranking of excellent cities in Japan for biodiversity", it is found that some small and medium-sized cities have set up relevant full-time personnel, so the score of biodiversity action is very excellent [9]. Therefore, the important factor affecting biodiversity protection action is likely to be the number of full-time personnel; in addition, the cooperation between departments can be evaluated from the aspects of whether the green space system planning with multiple compliance has been formulated.

2. Analysis of biodiversity indicators in Singapore and Japan based on DPSIR framework

2.1. DPSIR framework

The "driving forces-pressures-state-impact-responses model" (DPSIR) framework is for society. A framework for the analysis of environment and its causality, because of its focus on causality, can further clarify the problems and solutions, and there are many use cases [10]. The framework for setting and analyzing urban biodiversity indicators [11] includes the following five elements:population. Economics. Factors such as social activities (driving force), environmental change and pollution load (pressure), biodiversity and ecosystem status (status), biodiversity loss caused by environmental change have an adverse impact on human and ecosystem integrity (impact), and the Countermeasures of the government or non-governmental organizations (response).

2.2. Comparison of indicators between Singapore and Japan

Comparing the framework of Singapore indicators with that of Japan indicators: Singapore indicators not only include indicators of natural environment stocks and ecosystem service flows that reflect the state of biodiversity itself, but also indicators such as habitat fragmentation and the dynamics of changes in the number of animal and plant species. They are roughly the evaluation tool of the "state impact responses model" (SIR) framework; the simplified version of Japanese indicators is a tool limited to SR. To sum up, for the future development of indicators, compared with Singapore indicators as a self-evaluation tool, the simplified version of Japanese indicators that allows cities to compare with each other also has its exploratory significance.

2.3. Urban biodiversity indicator framework

In order to further optimize urban biodiversity indicators, this paper uses DPSIR thinking method to explore the framework of urban biodiversity indicators. First, we need to add indicators that reflect environmental changes and pollution pressure; secondly, the indicators of biodiversity and ecosystem status are set based on the potential capacity of urban

ecosystem. In addition to scoring its soundness, the status evaluation relative to the original biodiversity status should also be added; thirdly, the sensitivity of the index of the number of species of animals and plants is low. For the formulation of appropriate protection policies, it is more important to master the information of rare species and their habitats, which should be reflected in the indicators that have an adverse impact on human and ecosystem integrity; finally, the government's response indicators should reflect the latest international trends, such as biodiversity related strategies. Objectives. Certification system. Ecosystem management policies, and citizens. Biodiversity participation of enterprises, etc.

3. Future development and Enlightenment of urban biodiversity indicators

3.1. Development trend of urban biodiversity indicators

1) Build a full-scale urban biodiversity index. On the basis of carrying out urban biodiversity protection, a full-scale index system should be established. At present, cities. Urban block scale indicator systems are available, but there is a lack of indicators to evaluate the relationship between the city and the region, including the suburban areas that have a direct impact on the city, as well as the more remote areas indirectly affected by urban consumption activities. For example, as an ecological footprint evaluation indicator included in consumption activities, it has been widely used in the evaluation of the city, but it is not involved in the relationship between the city and the region. The regional system has a profound impact on the urban ecosystem, which must be considered in the future urban biodiversity protection. Therefore, it is necessary to build an index of city region relationship. 2) Build information infrastructure for cooperation and sharing. With the extensive and in-depth evaluation of urban biodiversity, in order to form a positive response mechanism between evaluation indicators and improvement measures, it is necessary to improve the evaluation methods. Knowledge and experience related to policy judgment are shared. Take Japan as an example, Kansai 2 prefectures and 5 counties (Shiga. Kyoto. Osaka. Hyogo. Wakayama. Tottori. Tokushima) takes the sharing of biodiversity information in the regional environmental protection plan as the goal, and maps various types of ecological services, including the storage indicators of the ecosystem. Supply index (supply. Adjust services) and the corresponding demand indicators (ecological footprint) and management indicators (measures related to the demand and supply of ecosystem services). Countermeasures) are all shared [11-12]. In addition, cities with similar environmental characteristics should also share knowledge and experience related to evaluation. Such cooperation and sharing need to be supported by national and even world-class information infrastructure.

3) Evaluate the urban biodiversity index itself. The main purpose of using urban biodiversity indicators is to pay attention to whether the measures related to urban biodiversity protection have been implemented, and how the implementation effect is related to management practice. Compared with the evaluation results, the effective operation of measures related to urban biodiversity protection needs more attention. In the process of using urban biodiversity indicators in the future, whether effective practical countermeasures have been formed for the indicators and whether biodiversity protection has been promoted in emerging fields. Industry.

Derivation in culture is a key issue that needs attention [13]. To answer these questions, it is necessary to evaluate the indicators themselves and strive to develop green infrastructure. Compact city and other concepts are closely combined, which is a strong guide to practice.

3.2. Current situation and development conception of urban biodiversity indicators in China

1) China lacks comprehensive and systematic indicators of urban biodiversity. China issued gb/t 50563-2010 evaluation standard for urban landscaping in 2010. In 2011, HJ 623-2011 regional biodiversity evaluation standard was issued. In 2012, ly/t 2004-2012 National Forest City evaluation index was issued. In 2016, the national standard for ecological garden cities was issued. The above standards have a more detailed index evaluation of the local biodiversity of the city, but they have not yet involved the evaluation of ecosystem services. The evaluation of urban management measures is only whether to formulate protection plans, but also lack of full-scale coverage. Complete infrastructure. Pay attention to the urban biodiversity index of the evaluation index itself.

2) Development conception of urban biodiversity indicators in China. The 2015 central urban work conference pointed out that China's urban development has entered a new era of development, and focused on the overall planning of production. Life. The three major ecological layouts improve the livability requirements of urban development, which is consistent with the urban indigenous biodiversity in the urban biodiversity index. Ecosystem services. The content of urban management measures is highly related. Therefore, there is an urgent need to build a set of biodiversity indicators suitable for Chinese cities to adapt to the development of cities in the future. Refer to Singapore indicators recommended internationally and Japanese indicators widely used in Japan, from urban indigenous biodiversity. Ecosystem service function. From three perspectives of urban management measures, we should select measures that can reflect the characteristics of urban biodiversity and meet the needs at the same time. Simplicity. Widely applicable indicators, including city region. City. Urban biodiversity indicators for quantitative evaluation of biodiversity performance at three scales of urban blocks (**Table 2**)[14-16].

4. Conclusions

Urban biodiversity indicators can be used to evaluate different urban land planning schemes and integrate urban managers. Urban residents, eco technology experts and other stakeholders gathered together to make suggestions for protecting the biodiversity of the city. At present, the urban biodiversity index pursues the development of two aspects:on the one hand, it takes simplicity as the main pursuit, and tries to let the government and citizens. Non profit organizations. Enterprises are easy to understand. At the same time, they also attach importance to the ease of obtaining the data required for evaluation; on the other hand, it seeks to promote the optimization of urban biodiversity, and the urban indigenous biodiversity in each stage of the process of "investigation evaluation planning implementation" of urban biodiversity. Ecosystem services. Make correct and detailed evaluation of urban management measures, and continue to improve. In the future, it is also necessary to improve the index content based on the DPSIR model framework.

Table 2. Urban biodiversity index framework of China's development concept

Spatial scale	Indigenous biodiversity	Ecosystem services	Management measures	International experience for reference	Indicator screening criteria
City - region	Including the topography of the city area. River system. Soil. Landscape type. Species status, etc	Reflect ecosystem support. Supply. Adjustment. Cultural services, such as water volume. Climate regulation. Greenhouse gas absorption. Cooling effect. Culture and education, etc	Including the formulation of regional biodiversity planning and the construction of information infrastructure, including input. Education Awareness and other biodiversity actions and participation, including the system of conservation and management. Evaluation of input, etc	Singapore Japan	Necessity index simplicity index applicability index
City	Including the current situation of urban green space. Species present Shape. Current situation of ecological network, etc				
Urban block	Including species status. Population type. Habitat type, etc				

At present, the indicators related to urban biodiversity in China's current standards are not comprehensive enough. It is necessary to establish China's urban biodiversity indicators and apply their monitoring results to territorial space planning in order to optimize the function of biological habitats in cities. The development requirements of maximizing ecosystem services and optimizing management measures.

Conflict of interest

The authors declare no conflict of interest.

References

[1] Chen X. Theoretical research on urban river construction to promote harmony between people and water. Beijing: China Water Resources and Hydropower Research Institute, 2006.

[2] Yu K, Li D. "Renovation" and "beautification" of urban rivers and waterfronts. Modern Urban Research, 2003(5): 29-32.

[3] Li P, Liu W. Landscape design of urban riverside space: Taking Wanquan River in Qionghai as an example. China Urban Forestry, 2012, 10(2): 40-42.

[4] Fu F. Research on ecology-oriented river landscape planning. Chengdu: Southwest Jiaotong University, 2011.

[5] Kang H. Research on the design of urban riverside green space. Beijing: Beijing Forestry University, 2009.

[6] Benedict M, Mcmahon ET. Green Infrastructure: Smart Conservation for 21st Century. US: The Conservation Fund. Sprawl Watch Clearinghouse, 2001.

[7] Benedict M, Mcmahon ET. Green Infrastructure: Linking Communities and Landscapes. Washington: Island Press, 2006.

[8] Evaluation and discussion of Shen Qingji's "Guidelines for Urban Green Infrastructure in Canada". Journal of Urban Planning, 2005(5): 98-103.

[9] Zhang J. Green infrastructure: a systematic solution to urban space and environmental problems. Modern Urban Research, 2009,

24(11): 81-86.

[10] Dong Z. Theoretical framework of river ecosystem research. Journal of Hydraulic Engineering, 2009, 40(2): 129-137.

[11] Benedict M, Mcmahone ET. Green Infrastructure: Smart Conservation for the 21st Century. Renewable Resources Journal, 2002, 20(3): 12-17.

[12] Fu B, Chen L, Ma M, et al. Principles and applications of landscape ecology. Beijing: Science Press, 2011.

[13] Zhu Q, Yu K, Li D. Ecological corridor width in landscape planning. Chinese Journal of Ecology, 2005, 25(9): 2406-2412.

[14] Zhang L. Water system landscape and stormwater system construction in Beichuan New City. Chinese Garden, 2018, 34(1): 136-139.

[15] Dong Z. Ecological restoration of rivers. Beijing: China Water Resources and Hydropower Press, 2013.

[16] Xiao H. Research on the characteristics of urban runoff and the treatment technology of constructed wetlands. Chongqing: Chongqing University, 2010