Greening the cities with biodiversity indicators; Experience and challenges from Japanese cities with CBI

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Running head:
Contextualizing CBI indicators in Japanese urban cities

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Abstract

For scientists, and other stakeholders to the biodiversity monitoring systems (including AP-BON), capturing and understanding the status and trends of biodiversity and ecosystem services are a main focus. In the policy/science interface, communicating the complex results in comprehensible ways has been one of the key challenges. Development of indicators, maps and other visualization tools are instrumental for identification, understanding, and to support the relevant policy decisions and processes.

In recent years, different cities have explored the development of such indicators in the urban context through negotiation. Development of indicators for urban ecosystems and biodiversity is illustrated. The potential challenge of application and use of such indicator in Japanese urban contexts are reviewed based on interviews and existing data. This article discusses and reviews the advantages and limitations of urban biodiversity indicators. The review focused on applying the newly developed City Biodiversity Index (CBI). It is modifying Singapore city biodiversity index adjusted as Japanese local municipalities can easily and practically use it. The data is based on research project implemented by the Ministry of Land, Infrastructure, Transport and Tourism, Japan (MLIT).

The existing literature points out that the policy makers tend to emphasize ecosystem services for justification of their policies, while scientists tend to focus on biodiversity. Such twists are not a major problem if the status of biodiversity correlates with ecosystem services. This is true at a global or at a regional scale, but may be different at the local level. For example, the results of studies by the city of Nagoya indicate that ecosystem services correlate with the size of green or open spaces and not with the status of biodiversity. As such, applying biodiversity indicators at different scales can be a contentious issue. In addition, the integration of biodiversity relevant elements to ecological footprint maps is often discussed from the perspectives of local governments.

Keywords: urban biodiversity, concepts and terminologies, ecosystem service, definition, indicators

1. Introduction to urban biodiversity indicator

The year 2007 marked the era of having more than half of the world's population living in cities for the first time in history (UN-HABITAT, 2006). It is also the year when the three major metropolitan areas (Tokyo, Kansai, and greater Nagoya) counted half of the Japanese population.

The use and conservation of urban ecosystems are one of the key challenges facing the globe. The development of indicators is explored in urban contexts to monitor and identify trends. Such indicators are instrumental for the policy makers and civil society as well for decision makings. In addition, indicators are useful for communication for scientists, policy makers and citizens alike. If the trends can be visualized, it can show trends and scenario, also in figures, tables and maps as explored in this project as well.

The OECD (Organisation for Economic Co-operation and Development) lead the initial development of indicators in the 1970s (OECD, 1978). It was pointed out that the indicators were frequently separated from one another depending on their administrative units or data source. Such examples are domain of economics (employment, production, energy), social domain (housing, education), and environmental domain (green areas, water quality). In the context of biodiversity and ecosystems, the Convention on Biological Diversity (CBD) started the discussion of urban indicators in collaboration with the United Nations Human Settlements Programme (UN-HABITAT).

At the ninth Conference of the Parties of the CBD in 2008, the role of local authorities (such as cities and mayors) was discussed. Their roles in implementing the goals of the Convention were adopted (Decision IX/28; cf. SCBD, 2008).

During such discussions, the government of Singapore initiated a round of expert meetings to develop biodiversity indicator specific to the urban context, titled Singapore Index on Cities' Biodiversity (CBI). The government of Singapore used its unique position of being city and a state. It was an open process for external experts to comment (cf. Chan and Djoghlaf 2009). The indicator became an integral part of Plan of Action at the 10th Conference of the Parties held in Nagoya, Japan (decision X/22; see also Plan of Action on Sub-national Governments, Cities, and other Local Authorities for Biodiversity in the appendix). International organizations such as ICLEI (Local

Governments for Sustainability) and the IUCN (International Union for Conservation of Nature) collaborated in the development in addition to the municipalities.

Japan initiated domestic process in the legal framework as well. Under Article 13 of Basic Act on Biodiversity (*Seibutsu Tayousei Kihon-ho*), local municipalities are encouraged to develop their version of a Local Biodiversity Action Plan (LBCP). However, these processes remain voluntary. The municipalities are not necessarily aware of the LBCP, particularly amongst the smaller scale cities (Chiba et al, 2012).

Integration and mainstreaming of biodiversity elements are underway with more fundamental plans such as Greening Plan (*Midori no Kihon Keikaku*) at the individual Japanese municipalities level. The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) provides the technical guideline relate to biodiversity within Greening Plan since October 2011 (MLIT, 2011). In the guidelines, the elements of ecological networks, such as corridors, buffer zones, establishment of core, central zones and monitoring in the urban contexts are illustrated.

The problem of urban biodiversity is interlinked with land use changes and population in the rural areas. In the 9th Delphi Survey, conducted in 2009, a survey for future technologies, the rural-urban dichotomy and technology was regarded as urgent issue for Japanese society. The urgency was shared by the majority of scientists. The research is periodically conducted every 5 years by the Ministry of Education, Culture, Sports, Science and Technology. The technology related to global warming and risk assessment ranked high as important technologies both globally and nationally. The rural-urban dichotomy and technology ranked uniquely important for domestic contexts for Japan, which included technologies such as "commuting agriculture system" (farming system by commuting people daily who are living in urban areas).

In this chapter, experiences from municipalities in Japan were reviewed with a specific focus on applying the newly developed CBI. The data is based on research project implemented by the MLIT. The Ministry has taken over the trial of Nagoya City for city biodiversity index and is modifying Singapore city biodiversity index adjusted as Japanese local municipalities can easily and practically use it. The MLIT conducted interviews with officials in local municipalities to investigate applicability the tentative MLIT version CBI to Japanese local municipalities.

As described below challenges lie at different levels of terminology (fragmentation, differentiation of human/nature influences), methodology (application at different scales, quantification of ecosystem services) and institutional levels (data split with administrative unit or competing goals).

Lastly, it is to be noted that the purpose of CBI is not to make comparisons or ranking of different municipalities but rather to deepen our understanding of the science underlying the indicators and to improve the CBI in different contexts.

2. Review

2.1 Global Review

There is existing literature on values of ecosystems at global, regional or national levels. A few illustrative examples are listed in Table 1. The widely quoted work by Costanza et al., 1997 was one of the first attempts to capture the global ecosystem services at global scales.

Table 1 Existing literature on values of ecosystems

Objects	Value of ecosystem services	Authors
Global ecosystem services	average of USD 33 trillion per year	Costanza, et al.(1997)
Ecosystem service of wetland	USD 3.4 billion per year	L. Brander and K. Schuyt (2010)
Forests in Japan	JPY 70 trillion per year	Science Council of Japan (2001)
Paddy in Japan	JPY 8,200 billion	Science Council of Japan (2001)
Deterioration of global forest ecosystem services	JPY 220 – 500 trillion loss are expected in 2050	TEEB (2008)

Reflecting these evaluations of ecosystems, needs are raised for specific evaluations on urban ecosystem services.

Under the framework of the CBD, first comprehensive report for such urban ecosystems titled the Cities and Biodiversity Outlook (CBO-1), is currently being drafted. Essence of experiences and lessons learned are shared from international cities. There are several key messages published in the report, summarized as below;

1. Unsustainable urbanization is a critical driver behind global biodiversity loss and ecosystem change.
2. Rich biodiversity can exist in cities.
3. Biodiversity and ecosystem services represent critical natural capital.
4. Urban ecosystems contribute significantly to improved human health.
5. Incorporating biodiversity and ecosystems in urban planning and design helps reduce carbon emissions and enhance adaptation to climate change.
6. Food and nutrition security depend on local and biodiversity-based food systems.
7. Ecosystem functions must be integrated in urban policy and planning.
8. Successful management of biodiversity and ecosystem services includes all levels and all sectors.
9. Cities offer unique opportunities for learning and education about a resilient and sustainable future.
10. Cities have a large potential to generate innovations and governance tools and therefore can—and must—take the lead in sustainable development.

(Source: key message from CBO-1)

The messages are mixed with a tone of optimism for the potential and sense of urgency for the status quo. In context of Japanese cities, urbanization is frequently pointed out as a cause of destruction. Urbanization is a key element for the future of Satoyama (cf. JSSA Fig 11.13 at p353).

2.2 Examples from individual cities

There are discussions with individual cities as well. Brack (2002) quoted in the TEEB report, analyzed the benefits and costs of plantation in Canberra, Australia. The benefits were estimated to be 20 million to 68 million AUS$ for urban plantation.

The City of Nagoya provides discount interest rate for private land owners with the condition that the owners leave certain portion of their lands as a green area or as a reserve.

As illustrated in Table 2, there are empirical studies with Contingent

Valuation Method (CVM) and conjoint analysis.

Table 2 Empirical studies on economic valuation of ecosystem service

Habitat	Economic valuation of ecosystem service	Authors
Value of park and biotope in school in Japan	Values of park and biotope in school are estimated as JPY 1.29 billion. (23 sites, total 2.4ha)	Yokota, et al. (2004)
Park in city area	Choice-based conjoint analysis was conducted targeting 2,000 households in Setagaya-ku, Tokyo. Marginal willingness to pay for urban park in Setagaya is estimated to be JPY 7,865 / household / year.	Fujiwara, et al. (2004)
Development of green zone	Willingness to pay for developing green zone in Rokko Cordillera in Hyogo Prefecture is estimated to be JPY 8,872 / household / year. Multiplied but number of households (849,364), the overall willingness to pay is JPY 75 billion / year.	Tsuge (2001)

3. Profiles of Cities and Methodology

Structured Interviews were conducted to identify challenges of city biodiversity indicators. Eight different types of cities are selected for interviewees, in consideration of; variety of size, availability of data; population density, etc. Eight cities are Yokohama, Nagoya, Fukuoka, Kitakyushu, Hamamatsu, Kashiwa, Minami-Alps, and Itami.

Yokohama has a population of 3.69 million, and its population density is 8,433.8/km². Yokohama is making an effort to implement the policies of low-carbon, greening, and biodiversity. The coastal areas are urbanized, while there are large-scale forestland and farmland left in the suburbs; the city and the wildness are woven together in a mosaic-like pattern.

Nagoya has a population of 2.26 million, and its population density is 6,935.3/km². The city is made up of metropolitan area in the center and green outskirts as follows: The western area faces the sea and remains tidal mudflats and paddy fields; the eastern area has thickets, irrigation ponds, and wetlands, although development of land for housing has been progressing. As Nagoya hosted Aichi Expo and COP10, citizens are conscious of the environment and biodiversity.

Fukuoka has a population of 1.46 million, and its population density is 4,288.5/km². Though metropolitan, it remains rich in nature. The urban area is set against the backdrop of the Sefuri and Sangun Mountains, and the mountains and forest mingle with the urban area. Fukuoka also boasts coastline and islands of the Hakata bay, the rivers and streams that join the mountains to the Hakata coast, and the irrigation ponds and farms dot the suburban areas. More than half of the municipal area is a natural area, 80% of which is a protected natural area.

Kitakyushu has a population of 980,000, and its population density is 2002.2/km². Although a manufacturing and industrial city, the city is blessed with rich nature. It is surrounded by the sea on three sides, bordered by the Sea of Hibiki, Suou, and the Kanmon Straits; approximately 40% of the municipal area is forest.

Hamamatsu has a population of 800,000, and its population density is 514 /km². Being the second largest municipal area in Japan, from the Pacific Ocean to the Southern Alps, the city covers a wide variety of environments such as reservoirs, forests, villages, rivers, and sea. It enables us to understand the ties of life in one city. Thanks to the large waterfront areas such as Lake Hamana and the Tenryu River, waterfront vegetation has developed so that abundant fish and birds inhabit the area. This makes Lake Hamana a potential candidate for the Ramsar Convention. While the city has urban areas, 68% of the municipal area is woodlands. Moreover, the city has much farmland, many rice paddies, and abundant Satoyama.

Kashiwa has a population of 400,000, and its population density is 3,516.2/km². Various natural environments remain there, such as waterside areas along the Tone River and other rivers, paddy fields, valleys, spring water areas, forests around shrines and temples, woods around residences, hillside woods, and the site of a castle. On the other hand, urbanization continues, and the loss of nature such as water, greenery, and soil caused by the development of land for housing and road building has led to fears that once-familiar creatures may disappear.

Minami-Alps has a population of 70,000, and its population density is 275.1 /km². The city consists of two regions which are unified geographically and topographically. One region is the basin of the Kamanashi River and the alluvial fan of the Midai River on the western region of the Kofu basin, the other is the Southern Alps mountain range in the upstream part of those rivers. Minami-Alps is famous as a city of mountains and gardens, robed in the verdure of the majestic Southern Alps.

Itami has a population of 200,000, and its population density is 7,877.6/km^2. Located in the south-eastern part of Hyogo Prefecture, the municipal area spreads around the elevated terrace of an alluvial plain. In former times, the region was abundantly blessed with nature, with spreading rural landscapes of Satoyama and, a wide variety of living creatures in its ponds and woods. However, hand in hand with the increase of the population during the era of high economic growth, the landscape has been rapidly replaced by buildings such as business establishments, factories, housing, and public facilities.

4. Results

The results of interviews revealed the challenges and opportunities for developing Japanese version of CBI. The points of the results are as follows:

(1)Needs

- Local government expects that CBI can be used for assessing the progress of local biodiversity strategy, and for giving background for the biodiversity related projects by understanding the strength or weakness of their own cities, capturing the change of biodiversity..
- On the other hand, some cities are negative for introducing CBI. They are concerned about difficulties in improving the results in some indices.
- Local governments expect the guideline published by the national government. They also request the collaboration among different ministries like the MLIT and the Ministry of the Environment.

(2) Expected index

- Local governments prefer the easily understandable indices which do not require data collection and are easily explainable to other departments than the department in charge of biodiversity conservation.
- It is pointed out that the indices using common data (e.g. data owned by national government) are understandable and easily used. Local governments want national government to provide data for CBI.
- The index should not uniformly valuate and compare the status of biodiversity among different cities, but should reflect the situations of each city.
- The index should be used for self-evaluation and should not be used for

comparing different cities.

(3) Comments for specific index

In addition, the interviews collected the opinions on each specific index as shown in Table 3. First, regarding “Native Biodiversity”, local governments mentioned that they don’t have skill and capacity for defining the index, like as difficulty in setting the appropriate distance of patches. They also indicated that it is difficult to collect information on number of species, ratio of native species, etc. In some cases, improvement in these indices are not the result of biodiversity conservation, but just the result of improved monitoring skills or statistical measures. Local government advocated that they cannot use index in a policy making process because they cannot understand relationship between conservation activities and the number of the species.

Table 3 Comments on specific category of index

<table>
<tr><td rowspan="7">Native Biodiversity</td><td>Proportion of natural areas in city</td><td rowspan="2">100 m is too long as a unit for the distance between different patches. However, local governments don’t have skill and capacity for defining the index.</td></tr>
<tr><td>Connectivity measures or ecological networks to counter fragmentation</td></tr>
<tr><td>Native Biodiversity in built-up areas (bird species)</td><td rowspan="2">It is difficult to collect information on number of species, ratio of native species, etc. In some cases, improvement in these indices are not the result of biodiversity conservation, but just the result of improved monitoring skills or statistical measures.</td></tr>
<tr><td>Change in number of native species</td></tr>
<tr><td>Proportion of protected natural areas</td><td>Local governments do not monitor the status of protected natural areas. In another case, there are no natural areas under control, or with control policies, and appropriately managed.</td></tr>
<tr><td>Proportion of invasive alien species (as opposed to native species)</td><td>Many local governments don’t have data related to alien species. In another case, cities only have data on specific alien species under specific legal regulations.</td></tr>
<tr><td rowspan="2">Ecosystem service</td><td>Regulation on quantity of water</td><td rowspan="2">It is difficult to calculate the cooling effects. Many local governments want to use data on provisional services as index. They expect to grasp the cultural services to users living outside the cities.</td></tr>
<tr><td>Climate regulation: carbon storage and cooling effects of vegetation</td></tr>
</table>

	Recreational and educational services	
Governance and Management	Budget allocated to biodiversity	It is difficult for local governments to judge to what extent they include the budget into this index. If the scope of the index is clearly defined, local government can work on it.
	Number of biodiversity projects implemented by the city annually	If index has clear definitions, local government can work on this index.
	Rules, regulations and policy – existence of local biodiversity strategy and action plan	—
	Institutional capacity	The scope should be defined clearly. The index cannot be used as a policy making tool.
	Participation and partnership	If the scope is clearly defined, they can work on this index, but it requires a lot of steps to collect information. The number of NPOs promoting biodiversity conservation can be summarized but the number of companies promoting it is difficult to be captured.
	Education and awareness	It is hard to collect information because they have to contact to all schools. The number of participants of events related to biodiversity can be used as index on awareness rising.

(4) Needs for economic valuation of ecosystem services

Many local governments showed the interest in quantitative valuation or economic valuation of ecosystem services. In particular, regarding economic valuation of ecosystem service in green area, they expect to use it to capture the effect of the projects and also to reserve the budget. Recently the transparency is more and more requested. Accordingly, the importance of showing the effect of the projects in a quantitative manner is increasing. Importance of biodiversity is not well known in local governments. If they could show the economic valuation of biodiversity, department in charge of it would come to get budget easily. Local governments also have needs to show the economic loss of degradation of natural capital.

On the other hand, some cities are anxious about the case they are criticized for affecting land price because of showing the data they provided. In such cases, other actors like scientists are expected to conduct economic valuation.

(5) Trial of quantitative analysis of Nagoya city

Nagoya city conducted trial of quantitative assessment of ecosystem service in their city area. Nagoya city conducted it for two model areas. For the first model area, “Hachiryu” green area, among regulatory service, water storage and climate change mitigation are valuated quantitatively. As a result of estimation, 5,352〜7,765m3 of water are stored as ecosystem service of “Hachiryu” green area. 48,110kg of CO_2 (almost equal to CO_2 emission from twenty first century cars) is absorbed annually. Regarding the heat islands effect mitigation, therapy effect, and provision of habitat to living organism, they could be valuated quantitatively. However, these ecosystem services were analyzed qualitatively.

For second model area, paddy in “Nanyo-cho”, groundwater recharge, prevention of flood and water purification is valuated quantitatively. It was revealed that paddy in “Nanyo-cho” have ability of groundwater recharge of 2.57〜3.48 million m3 which corresponds to the amount of water used by 8,540〜11,560 households (four people per household). It also keeps water of 400m3 to prevent flooding, which corresponds to the amount of water used by 1,317 households. Biotope paddy in “Nanyo-cho”(721m2) also absorbs 88.4kg of nitrogen for one season. Similar to the first model area, the heat islands effect mitigation and provision of habitat to living organism could not be valuated quantitatively. However, these ecosystem services were analyzed qualitatively.

(6) Challenges and solution

The study of Nagoya city demonstrates the difficulty of quantitative evaluation of ecosystem services as a practical index of city biodiversity management. If they want to utilize the result as a policy making tool, very locally specific information or assumption are indispensable. Upon quantification of ecosystem services to a particular region, actual measurement of all of the indices is very difficult financially to local governments. Therefore, estimates will be carried out for some indices alone. However, the problem of estimation accuracy occurs because of difference of factors like growth rate of green vegetation and trees, the nature of the soil, the temperature in the region, etc. which are originally different from region to region.

This is also applicable to the economic evaluation of ecosystem services. The MLIT summarized measures for the economic evaluation of ecosystem services for local governments. The result indicated that when using the alternative method, the accuracy of the evaluation of ecosystem services which is a prerequisite for economic evaluation can be problematic. When using conjoint analysis and CVM, there arises a problem that evaluation result in one region cannot be directly used to a different region.

The MLIT, in consideration of the previous trial of Nagoya-city and the results of interviews, is now trying to develop the Japanese version of CBI. The tentative version of it is indicated in Table 4.

Table 4 The Japanese version of CBI

No.	Index	Definition	Measure for calculation (example)
Category: Diversity of ecosystem and habitat			
1	Percentage of green space contributing to conservation of biodiversity in urban areas	The percentage of green space capable of offering habitat for animals and plants, as defined in Urban Green Space Law, in urban areas	The proportion of "plant-covered and water area in green space" capable of offering habitat for animals and plants in the size of city planning area (based on survey conducted by cities) I_1=(size of plant-covered and water area in green space capable of offering habitat for animals and plants)÷(size of city planning area)×100
			Interim method (in the case a city cannot apply the above-mentioned measure) The proportion of "green space" capable of offering habitat for animals and plants in the size of city planning area Calculate according to current condition of land use based on existing Land Use Status Survey in Urban Planning Basic Survey
2	*Continuous* percentage of green space contributing to conservation of biodiversity in urban areas	The percentage of *legally secured* green space capable of offering habitat for animals and plants in urban areas	The proportion of "plant-covered and water area in green spaces" capable of offering habitat for animals and plants in the size of city planning area I_2=(size of *legally secured* plant-covered and water area in

			green spaces capable of offering habitat for animals and plants)in urban areasan areas Survey in
			Interim method (in the case a city cannot apply the above-mentioned measure) The proportion of "green spaces" capable of offering habitat for animals and plants in the size of city planning area
3	Situation of ecological network in urban areas	The situation of development in ecological network consisting of green space capable of offering habitat for animals and plants	Calculate the situation of development in ecological network consisting of green spaces capable of contributing to biodiversity conservation according to following formula $$I_3 = \frac{1}{A_{total}}(A_1^2 + A_2^2 + A_3^2 + \cdots + A_n^2)$$ n: total number of green space A_{total}: total size of green space A_n: size of each green space *Two green spaces with less than 100m distance, not separated by roads, artificially modified rivers or houses or other artificial obstacles, are treated as one space.
			Interim method Define plant and animal species as monitoring species in the situation of ecological network development, and calculate the situation of development consisting of continuous green spaces which offer habitat for such species, using the formula above

4	Situation of the number of animal and plant species living in urban areas	Secular change in the number of animal and plant species living in urban areas	Establish monitoring sites according to major ecosystem in that city and set habitant species as reference species I_4=(increase in number of species by reintroduction and rediscovery) - (number of species extinct) *exclude specified invasive alien species and caution required alien species as defined by Invasive Alien Species Act from the number of species
			Interim method Calculate the change in numbers of endangered species confirmed to have lived in ecosystems and animal, plant habitats which are vital to conserving biodiversity in administrative territory of local government or corresponding city I_4'=(current numbers of endangered species) - (number of endangered species at reference time)
Category: Ecological services			

5	Situation of ecological services	The situation of regulating services, cultural services, and provisioning services accrued by conserving urban biodiversity, and by conservation, management and utilization of animal and plant habitat	Estimate quantity of ecological services. In addition, utilize regional characteristics and calculate unique indexes defined by local governments. Local governments set objectives and evaluate the results i) Effect on global warming (absorption of greenhouse gas from urban greening) ii) Cooling effect of green spaces (canopy covered area by green spaces, etc.) iii) Water regulation (filtration effect of green spaces) iv) Purification of water and impact on ecology (water quality of rivers) v) Provision of cultural services (per person size of index 2) vi) Utilization of green area (annual trend of citizen's visit to green spaces) vii) Educational use of green spaces (annual numbers of green spaces visit by children under 16 hosted by schools)
			Interim method On more than or equal to 2 items from above mentioned ecosystem services and calculate the change in results between two given points in times
Category: Cities' activities			
6	Situation of consideration in urban	Situation of consideration on conserving urban	Count the numbers of following activities implemented in the cities

	administrative planning for conserving biodiversity	biodiversity in plans formulated by local governments on green conservation, greening promotion, conservation of biodiversity and natural environment conservation, situation of actual implementation in such policies	3 activities on current situation study, analysis and evaluation e.g. 1) The local government do own survey concerning distribution and habitat situation of green covered areas animals and plants 2) Conduct surveys on situation of legal regulations for protecting ecosystem, animals and plants, and on plans and projects related to developing ecological network 6 activities on goals, policy of green spaces settings and formulation of policies e.g. 5) Set policies on ecological network development for conserving biodiversity and on green spaces distribution 6) Developed more than or equal to one policy for conservation, regeneration and creation of green covered area and water which make up ecological networks 5 activities on implementation and follow up study e.g. 14) Reflect the results of check and evaluation of policies on plans and policies
7	Situation of participation by residents	Situation of participation by residents and	Count the numbers of following activities implemented in the cities

	and corporations in conservation of biodiversity in urban administrative planning	corporations in each step of formulation, publication, implementation, check and evaluation on plans positioning considerations on conservation of urban biodiversity	2 activities on formulation and publication of plans e.g. 1) Implement efforts to reflect opinions from residents 6 activities on implementation and follow up study e.g. 3) Conserve, regenerate, create and manage green spaces offering habitats for animals and plants according to plans in cooperation with various stakeholders such as NPOs, residents, corporations, education and research institutions and experts, and p 7) Grasp continuously implementation status of policies as well as performing check and evaluation on effects in cooperate with various stakeholders such as NPOs, residents, corporations, education and research institutions and experts.

The current version is a just tentative one and the MLIT has a plan to improve it by pilot implementation with collaboration with local governments. It is expected for the MLIT to revise it to be more useful for practical city biodiversity management.

5. Conclusion

Biodiversity conservation in cities is one of the key elements to achieve the Aichi Biodiversity Targets. As mentioned in Decision X/28, indicator is indispensable to promote biodiversity management in cities. However, the trials of Nagoya-city and the

MLIT revealed that development and implementation of practical index is very difficult. One of the obstacles is difficulty of quantitative valuation of biodiversity. City management required dependable and robust indices as evidence of valuation for explanation to stakeholders. As this study shows, there are many existing studies on quantitative valuation of biodiversity, but the results of the valuation are diversified because of the different assumptions. The assumptions depend on local conditions. Many of indices, in particular indices for ecosystem services in Japanese version of CBI developed by the MLIT required estimation based on local specific conditions. Accordingly various studies for different local conditions definitely contribute the development of index.

However, the study shows that the inconsistency of the interests between policy makers and scientists also prevents improvement of indices. The existing literature points out that the policy makers tend to emphasize ecosystem services for justification of their policies, while scientists tend to focus on biodiversity per se.

CBI should be improved for practical implementation. The MLIT also declared that they would modify Japanese version of CBI as applicable to Japanese conditions. Scientists are requested to conduct more studies on valuation of ecosystem services in local specific conditions and contribute more for conservation of city biodiversity.

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