CITY BIODIVERSITY INDEX – KOCHI
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# Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>ABD</td>
<td>Area Based Development</td>
</tr>
<tr>
<td>ABS</td>
<td>Access and Benefit Sharing</td>
</tr>
<tr>
<td>AMRUT</td>
<td>Atal Mission for Rejuvenation and Urban Transformation</td>
</tr>
<tr>
<td>BMU</td>
<td>Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety</td>
</tr>
<tr>
<td>CBI</td>
<td>City Biodiversity Index</td>
</tr>
<tr>
<td>CBSE</td>
<td>Central Board of Secondary Education</td>
</tr>
<tr>
<td>CDP</td>
<td>City Development Plan</td>
</tr>
<tr>
<td>c-hed</td>
<td>Centre for Heritage, Environment and Development</td>
</tr>
<tr>
<td>CMFRI</td>
<td>Central Marine Fisheries Research Institute</td>
</tr>
<tr>
<td>CNHS</td>
<td>Cochin Natural History Society</td>
</tr>
<tr>
<td>CoP</td>
<td>Conference of Parties</td>
</tr>
<tr>
<td>CSML</td>
<td>Cochin Smart Mission Limited</td>
</tr>
<tr>
<td>CSO</td>
<td>Civil Society Organisation</td>
</tr>
<tr>
<td>CUSAT</td>
<td>Cochin University of Science and Technology</td>
</tr>
<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
</tr>
<tr>
<td>EPiP</td>
<td>Export Promotion Industrial Park</td>
</tr>
<tr>
<td>ICLEI South Asia</td>
<td>ICLEI - Local Governments for Sustainability, South Asia</td>
</tr>
<tr>
<td>ICSE</td>
<td>Indian Certificate of Secondary Education</td>
</tr>
<tr>
<td>IKI</td>
<td>International Klimte Initiative</td>
</tr>
<tr>
<td>INTERACT-Bio</td>
<td>Integrated subnational action for biodiversity: Supporting implementation of National Biodiversity Strategy and Action Plans through the mainstreaming of biodiversity objectives across city-regions</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>ITes</td>
<td>Information Technology enabled Services</td>
</tr>
<tr>
<td>IUCN</td>
<td>International Union for Conservation of Nature</td>
</tr>
<tr>
<td>KINFRA</td>
<td>Kerala Industrial Infrastructure Development Corporation</td>
</tr>
<tr>
<td>KMC</td>
<td>Kochi Municipal Corporation</td>
</tr>
<tr>
<td>KSSP</td>
<td>Kerala Shastra Sahitya Parishad</td>
</tr>
<tr>
<td>MULT</td>
<td>Multi-user Liquid Terminal</td>
</tr>
<tr>
<td>NBS</td>
<td>Nature based Solutions</td>
</tr>
<tr>
<td>NBSAP</td>
<td>National Biodiversity Strategy and Action Plan</td>
</tr>
<tr>
<td>NGO</td>
<td>Non Governmental Organisation</td>
</tr>
<tr>
<td>PBR</td>
<td>People’s Biodiversity Register</td>
</tr>
<tr>
<td>PCCF</td>
<td>Principal Chief Conservator of Forests</td>
</tr>
<tr>
<td>SBB</td>
<td>State Biodiversity Board</td>
</tr>
<tr>
<td>SCBD</td>
<td>Secretariat for the Convention on Biological Diversity</td>
</tr>
<tr>
<td>SPV</td>
<td>Special Purpose Vehicle</td>
</tr>
<tr>
<td>ULB</td>
<td>Urban Local Body</td>
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The City Biodiversity Index (CBI), also known as the Singapore Index was developed after the ninth meeting of the Conference of Parties (CoP) in 2008, when it was acknowledged that cities and local bodies have a role to play in the implementation of a country’s National Biodiversity Strategy and Action Plan (NBSAP). The purpose of the index was to consolidate the available biodiversity-related indicators at the local level, which could then help cities to evaluate and benchmark their biodiversity conservation efforts.

The CBI scoring is quantitative in nature. A total of 23 indicators make up the index, measuring a city’s native biodiversity, the ecosystem services provided and biodiversity governance. Scores range between zero to four points for each indicator, with a maximum overall score of 92. The index is meant to allow the city to visualize their progress in conserving biodiversity with every application of the index. The first year is considered the baseline against which cities can then chart their subsequent evolution.

According to the Secretariat for the Convention on Biological Diversity (SCBD), some of the benefits that cities derived from the application of the index include “a) the process facilitated capacity-building in biodiversity conservation, b) the indicators also function as biodiversity conservation guidelines, and c) assistance in setting priorities for conservation actions and budget allocation through quantitative scoring”.

The City Biodiversity Index for Kochi was developed under the Integrated subnational action for biodiversity: Supporting implementation of National Biodiversity Strategy and Action Plans through the mainstreaming of biodiversity objectives across city-regions or INTERACT-Bio project. Funded by the Federal Minister for the Environment, Nature Conservation, and Nuclear Safety, (BMU) through the International Klima Initiative (IKI), the four-year project is being implemented by ICLEI South Asia in collaboration with the Centre for Heritage, Environment and Development (c-hed) in Kochi. Kochi Municipal Corporation is a project partner.

Summary of the Scores

The Kochi City Biodiversity Index, 2020 has been prepared based on the SCBD endorsed user manual for CBI updated in 2014 (SCBD, 2014). The city scored a total of 45 out of 72 for the 18 indicators. Since this was the baseline year the indicators 4-8 were not considered in the analysis, thus reducing the maximum possible score from 92 to 72.

- The first section on “Native Biodiversity in the City”, contributed to a score of 17 out of 20 as only 5 indicators were taken into consideration. This is a robust score and contributes significantly to the overall score. It is important to highlight that the city scores 17 points in this section primarily because of the contribution of Kochi’s backwater area which cover a significant percent of the overall area of the city.
- Indicators 11-14 which relate to “Ecosystem Services Provided by Biodiversity in the City” contribute a total of 6 out of a possible 16 points. Once again the score in this section is primarily due to the contribution of the backwater area to the various indicators. Urbanisation and industrial activities are responsible for a shrinking of green spaces and the deteriorating health of the city’s green-blue infrastructure.
- Indicators 15-23 which correspond to “Governance and Management of Biodiversity in the City” contributed to a score of 22 out of 36 points. This indicates that though the city needs to strengthen mechanisms in biodiversity governance and management, concrete steps such as the development a Local Biodiversity Strategy and Action Plan (LBSAP), including biodiversity concerns into their municipal budget etc. are being taken up proactively.

Figure 1: Kochi Municipal Corporation City Biodiversity Index 2020 at a Glance
PART 1 – Kochi City Profile

The city of Kochi (76°14’E and 76°21’ E and 9°52’ N and 10°1’ N) is the largest urban agglomeration of Kerala and is situated in the district of Ernakulam (refer Figure 2). It is spread over an area of 107.13 km² (Government of Kerala, 2006). Kochi has a tropical climate with intense solar radiation and abundant precipitation. The annual variation of temperature in Kochi region ranges between 22°C and 32°C, and a more or less uniform temperature exists throughout the year. Rainfall varies from 1,500 mm to 2,000 mm during the south-west monsoon and 400 to 700 mm during the north-east monsoon. The maximum annual rainfall in the region is around 3,000 mm. The humidity is high all-round the year because of the nearness to the sea and due to the large area of backwaters in the region (ICLEI South Asia, n.d.).

Figure 2: Location Map of Kochi showing the municipal boundaries and the wards of the city

Geophysical Characteristics
Kochi’s location makes it a natural harbour with the city spanning the backwaters, covering the northern end of a peninsula, several islands and a portion of the mainland. Kochi’s west is bordered by the Arabian Sea. Elevation of land area varies between -1 to 27 m and most of the city is at an elevation less than 12m. The city has a coastline of 48 km.

The current metropolitan limits of Kochi include the mainland Ernakulam, Fort Kochi, the suburbs of Edapally, Kalamassery and Kakkanad to the northeast, Tripunithura to the southeast, and a group of islands closely scattered in the Vembanad Lake.
An ecologically sensitive area, the Mangalavanam Bird Sanctuary is located in the heart of the city. It has a wide range of mangrove species and is a nesting area for several migratory birds and a roosting spot for large colonies of the Indian Flying Fox. Kochi's water needs are entirely dependent on ground water and the two rivers flowing through the district viz., Periyar and Muvattupuzha. Periyar serves the entire northern part of the city whereas Muvattupuzha River covers the western part.

Demography
With a population of 601,574 as recorded in 2011, the city of Kochi has Kerala's highest population density with 5,620 people per sq. km (Census, 2011). In the decade of 2001-11, the city recorded a growth rate of 0.11 percent. According to the Development Plan (Department of Town and Country Planning, 2010), the projected population growth within the planning area is expected to be 1.37 million in 2021 and 1.43 million in 2026. The city being an industrial nucleus sees a daily influx of workers (0.25 million) who commute within a radius of about 100 km. Taking this into account, the total population is estimated to be 2.17 million in 2021 and 2.53 million in 2026 in the City Development Plan (CDP) area.

Kochi has significant Hindu, Christian, and Muslim population. A sizable number of Tamil workers fill low-wage economic niches. The city’s long history of international trade makes it unusually cosmopolitan, with many linkages to the Gulf States, Europe, and North America (MoUD and World Bank, 2010).

Kochi scores high on human resource indicators such as education levels and literacy. The city has a literacy rate of 97.36 percent, which is one of the highest in the country (Census, 2011). The city area has 70 schools, five colleges, a regional study centre of the Mahatma Gandhi University, the Law College and the Marine Campus of the Cochin University of Science and Technology (CUSAT).

Economy
Kochi, also known as the Queen of the Arabian Sea for its scenic beauty, is a trading port and was the spice trading centre of the world in the 14th century (Government of Kerala, 2006). To this day, the city is an important tourist site which attracts the maximum number of domestic and international tourists in Kerala, while also being a significant economic and trading hub within the state (ICLEI SA, n.d.). The city is home to the only stock exchange in Kerala, and has also witnessed considerable investment for industrial growth. Its port provides round the year anchorage, operates as an international container trans-shipment terminal, houses oil refineries, and supports commercial maritime businesses. The Southern Naval Command of the Indian Navy is also based here. Other economically important nodes found here include the Cochin Special Economic Zone (SEZ) and Kerala Industrial Infrastructure Development Corporation (KINFRA)-Export Promotion Industrial Park (EPIP).

Kochi city contributes 14.47 percent to the state’s GDP, out of which construction and manufacturing together contribute 37.01 percent and trade, tourism and hospitality together provide another 20.03 percent. Kochi is recognized as one of the seventeen major industrial cities of India as per the World Bank (2009).

Kochi’s growth and development priorities according to its CDP (Government of Kerala, 2006) are to enhance its citizen’s quality of life. To do this the Corporation has emphasized on the need to develop dependable urban services. Within the CDP itself, proposals mainly target the urban basic services sector, which includes Water Supply, Sewerage, Drainage, Solid waste disposal system, Traffic and Transportation with special emphasis to the urban poor. The overall vision, considering the city’s natural assets, human resources, medical facilities available and cultural heritage, is to develop Kochi as a world health care centre, tourism destination and an IT and ITeS centre.
Within the City’s Local Biodiversity Strategy and Action Plan, which has been developed by ICLEI South Asia, the city has envisioned sustainable development. “Kochi city will conserve its biodiversity, maintain the uninterrupted flow of ecosystem services, and ensure sustainable, safe and climate resilient development by managing its mosaic of ecosystems through a participatory planning approach”.

The major drivers of change in terms of biodiversity within the city are the following
1. Rapid urbanisation
2. Solid waste and effluent discharge
3. Increase in invasive species
4. Land use change (including land conversion, reclamation, encroachment)
5. Lack of strict enforcement of laws

**Biodiversity**
The coastal region, Vembanad backwaters, estuary, mangroves, wetlands, fresh water ponds, Pokkali paddy fields, other mixed cultivation, home gardens and public open spaces are the major biodiversity habitats of Kochi city (Figure 2).

Kochi lacks a comprehensive biodiversity profile although a People’s Biodiversity Register (2019) (PBR) has recently been developed for the Corporation area.

The register identified the following wild faunal species
- Crustaceans – 6 species
- Birds - 10 species
- Reptiles – 7 species including 3 snakes
- Amphibians – 1 species
- Molluscs – 3 species
- Mammals – 9 (wild species - 3)
- Aquatic wild fauna – 14 species
  - Non fish – 9 species
  - Fish – 26 species

It also identified the following numbers of wild floral species
- Climbers - 7 species
- Tubers – 8 species
- Shrubs – 10 species
- Trees – 20 species

In terms of agrodiversity, 5 tubers, 3 spices, 1 cereal, 4 vegetables, 1 oilseed, 6 fruit species are cultivated. 45 medicinal plants, 12 ornamental and 13 timber species were documented.

The scientifically available data is limited to several study reports on Mangalavanam bird sanctuary, known as the lungs of Kochi city, which is situated in the centre of the Kochi Corporation area (Jayson and Easa, 1999; Azeez and Bhupathy, 2006; Madhusudhanan and Jayesh, 2011). The other available references
are the faunal diversity of the South Kochi (Thevara) by Abin and Samson (2014) and the Environmental Impact Assessment (EIA) report of the Multi-user Liquid Terminal (MULT) project of Cochin Port (WAPCOS, 2015). Some of the information presented in the following section has been extrapolated from the district data.

**Flora:** An inventory of the flora of the Ernakulam district was prepared by Sunil et al. (2015). A total of 1,706 species belonging to 158 families and 866 genera have been documented during the study period 2012–2015. Poaceae is the largest family comprising 161 species followed by Papilionaceae (94 species), Euphorbiaceae (88 species), Cyperaceae (79 species), Rubiaceae (77 species), Acanthaceae (65 species), Asteraceae (54 species), Orchidaceae (47 species), Scrophulariaceae (41 species) and Convolvulaceae (34 species). Out of these 306 species are endemic to either the Western Ghats or Peninsular India and 108 species find a place in the IUCN Red List. 35 species of wild relatives of cultivated crops like piper, rice, ginger, nutmeg have been documented. A total of 56 invasive alien species belonging to 27 families and 48 genera have been documented. Ernakulam district is also rich in wetland plant species including mangroves and coastal species. Out of the 16 true mangroves of Kerala, 14 are found in the district.

In Mangalavanam, the total number of plant species reported was 25 including four species of true mangroves. The vegetation of the Mangalavanam is dominated by *Avicennia officinalis*, *Rhizophora mucronata* and *Acanthus ilicifolius*. True mangrove and mangrove associate species such as *Derris trifoliata* and *Acrostichus aureum* are also present here (Jayson and Easa, 1999; Azeez and Bhupathy, 2006; Madhusudhanan and Jayesh, 2011).

A study of tree species in Subhash Bose Park, Kochi in 2017 (ICLEI South Asia, 2018) identified 66 species of trees in the park. Another study of avenue trees of Fort Kochi and Mattancherry which is under preparation by ICLEI South Asia has documented 82 species in the area (ICLEI South Asia, unpubl.) From the EIA of the MULT project of Cochin port (2015) which surveyed a major part of the Kochi Municipal Corporation (KMC), 91 tree species were reported.

**Fauna:** An invertebrate survey conducted in South Kochi (Thevara) reported 44 species of butterflies belonging to 36 genera and five families (Abin and Samson, 2015). Of these, 45 percent belong to Nymphalidae family followed by Papilionidae (20 percent), Pieridae and Hesperiidae (14 percent), and Lycanidae (7 percent). The study also reported 10 dragonfly species belonging to nine genera and two families as well as five damselflies belonging to three genera of the Coenagrionidae family. A spider survey reported 49 species of spiders belonging to 39 genera and 13 families (ibid). The vertebrate survey conducted in Thevara, south Kochi reported 44 species of fishes belonging to 40 genera of 35 families, four species of amphibians belonging to four genera of three families, 14 species of reptiles belonging to 13 genera of 10 families, 57 species of birds belonging to 46 genera of 29 families and 10 species of mammals belonging to 10 genera of seven families (ibid).

Azeez and Bhupathy (2006) documented 17 species of butterflies from Mangalavanam, of which 10 species belong to the Nymphalidae family, four species to the Papilionidae family and three species to the Pieridae family. A spider survey conducted in Mangalavanam during 2005 reported 16 families, 40 genera and 51 species from there. Araneidae is the dominant family constituting 12 species from eight genera. Salticidae was represented by 11 species from 10 genera. At the species level, Pisaura gitae was the dominant species (Sebastian et al., 2005). During the field survey in Mangalavanam by SACON (2004), a total of 74 species of vertebrates were recorded. It included two species of amphibians (*Limnonectes limnocharis* and *Bufo melanostictus*), five species of reptiles (*Calotes versicolor*, *Hemidactylus frenatus*, *Mabuya carinata*, *Sphenomorphous sp.*, and *Xenochropis piscator*), and five of mammals (*Pteropus giganteus*, *Kerivoula picta*, *Lutra sp.*, *Bandicota indica* and *Funambulus sublineatus*). The dominant vertebrate fauna
observed was birds. A total of 398 birds belonging to 62 species were observed during the survey. Aquatic forms numbering 20 species contributed to a majority of the bird population. In earlier records of Mangalavanam (Jayson and Easa, 1999), the total number of bird species visiting the area was 72.

Vembanad Lake and its wetlands is the largest Ramsar site on the south west coast of India, and forms shallow estuarine network running parallel to the coastline of Kerala opening into the Arabian Sea, at Kochi and at Azhikode. Several economically important fish species are found in the lake such as cichilids, cyprinids, mullets, cat fish, crustaceans such as penaeids and crabs. 80 species of fin fishes, five species of penaeid shrimps, three species of palaemonid prawns and two species of crabs were reported (Asha et al., 2014) from this ecosystem.

The Pokkali system of rice cultivation (paddy and prawn culture) was carried out in the city region but now the majority of these wetlands have been converted to other urban land-use, or some part is permanently used for prawn culture. Coconut is the commonly cultivated tree in the city region. Home gardens in the area also act as a good reservoir of biodiversity. One study in the nearby panchayats recorded 56 species of plants in 168 surveyed home gardens (Sankar et al., 2000).

Perhaps in terms of area, the largest study conducted was the Environmental Impact Assessment Study for Multi-User Liquid Terminal Project (MULT) at Puthuvypeen, Cochin Port in 2015. The assessment identified about 50 species of marine/estuary fish species, eight species of prawn, four species of crab and two species of clams (EIA – MULT, 2015). It also identified 91 flora, two species of amphibians, nine species of reptiles, 43 bird species and nine mammalian species.

Another citizen science platform, iNaturalist (inaturalist.org), which is a joint initiative of the California Academy of Sciences and the National Geographic Society, was also referred to.
Figure 3: Natural Asset Map showing the main ecosystems of Kochi
Table 1: Area wise distribution of natural assets (inside KMC boundary)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Land Class</th>
<th>Area in ha</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Backwater (inland)</td>
<td>82</td>
</tr>
<tr>
<td>2</td>
<td>Beach</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>Canal</td>
<td>34</td>
</tr>
<tr>
<td>4</td>
<td>Coconut cultivation</td>
<td>38</td>
</tr>
<tr>
<td>5</td>
<td>Fallow (Paddy field)</td>
<td>85</td>
</tr>
<tr>
<td>6</td>
<td>Inland fish culture</td>
<td>45</td>
</tr>
<tr>
<td>7</td>
<td>Mangrove</td>
<td>119</td>
</tr>
<tr>
<td>8</td>
<td>Marsh</td>
<td>289</td>
</tr>
<tr>
<td>9</td>
<td>Mixed cultivation</td>
<td>234</td>
</tr>
<tr>
<td>10</td>
<td>Open Green Spaces</td>
<td>34</td>
</tr>
<tr>
<td>11</td>
<td>Parking ground</td>
<td>11</td>
</tr>
<tr>
<td>12</td>
<td>Playground</td>
<td>79</td>
</tr>
<tr>
<td>13</td>
<td>Pond</td>
<td>6</td>
</tr>
<tr>
<td>14</td>
<td>Pond (Wetland Remnant)</td>
<td>32</td>
</tr>
<tr>
<td>15</td>
<td>Prawn culture</td>
<td>27</td>
</tr>
<tr>
<td>16</td>
<td>River</td>
<td>122</td>
</tr>
<tr>
<td>17</td>
<td>Sparse vegetation</td>
<td>106</td>
</tr>
<tr>
<td>18</td>
<td>Tree patch</td>
<td>199</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>1,555</strong></td>
</tr>
</tbody>
</table>

Administration of Biodiversity

Krishnan et al. (2012) detail out five types of biodiversity governance models that aid in conservation, sustainable use, and fair and equitable sharing of biological resources across different landscapes in India. Of the five models, two – territorial forests and protected areas, fall under the protected area type of biodiversity governance models. The other three – autonomous community efforts, co-management of forests and decentralized governance of biodiversity, are considered more closely under community based conservation.

In Kochi the following institutions at the state and the city level, are responsible for biodiversity related activities.

**Kerala Forest Department:** This department is headed by the Principal Chief Conservator of Forests (PCCF), who is assisted by other PCCFs, Additional PCCFs and Chief Conservator of Forests. The department is concerned with responsibilities like production, conservation, protection, development, working plans, research, budget, planning, policy, eco-development and tribal welfare, social forestry and community forestry, forest management information systems, human resource management, vigilance and administration. The Forest Department maintains Mangalavanam bird sanctuary and Vembanad Lake.

**Kochi Municipal Corporation (KMC):** KMC was notified in 1967, formed by the amalgamation of the three ancient Municipalities of the state, viz. Ernakulam, Mattancherry and Fort Kochi, the Willingdon Island and four panchayats viz. Palluruthy, Vennala, Vytila and Edappally and the small islands of Gundudeepu and Ramanthuruth. The city is divided into 74 administrative wards, from which members of the Corporation Council are elected for a period of five years. The functions of KMC includes major civic services including roads, street lighting, SWM, slum improvement. For more information please see https://cochinmunicipalcorporation.kerala.gov.in/
**Biodiversity Management Committee (BMC):** Under the Biological Diversity Act, 2002, every local body has to constitute a BMC for the purpose of promoting conservation, sustainable use and documentation of biological diversity. An important function of the BMC is the preparation of a PBR that contains comprehensive information on availability and use of local biological resources, and any other traditional knowledge associated with them. The BMC, is supposed to serve as the guardian of all biological resources and traditional knowledge. Kochi’s BMC was formed in 2018 and has developed the PBR of Kochi. For more information please see [https://keralabiodiversity.org/index.php/activities/biodiversity-management-committees-bmcs](https://keralabiodiversity.org/index.php/activities/biodiversity-management-committees-bmcs)

**Table 2: BMC members of Kochi Municipal Corporation**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Name</th>
<th>Designation</th>
</tr>
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<tr>
<td>1</td>
<td>Soumini Jain</td>
<td>Chairperson</td>
</tr>
<tr>
<td>2</td>
<td>C. K. Peter</td>
<td>Member</td>
</tr>
<tr>
<td>3</td>
<td>K. J. Sohan</td>
<td>Member</td>
</tr>
<tr>
<td>4</td>
<td>C. Rajan</td>
<td>Member</td>
</tr>
<tr>
<td>5</td>
<td>Jalaja Mani</td>
<td>Member</td>
</tr>
<tr>
<td>6</td>
<td>Seena Gokulan</td>
<td>Member</td>
</tr>
<tr>
<td>7</td>
<td>V. P. Chandran</td>
<td>Member</td>
</tr>
<tr>
<td>8</td>
<td>R. Rahesh Kumar</td>
<td>Secretary</td>
</tr>
</tbody>
</table>

**Centre for Heritage, Environment and Development (c-hed):** c-hed is an autonomous institution, functioning as the research and development wing of the Kochi Municipal Corporation, in the fields of Urban Development and Governance, Environment, Tourism, Culture and Heritage. Sanctioned by the Government of Kerala and established in the year 2002 by the city administration, c-hed has been an integral part of the planning efforts and development aspirations of the Kochi Municipal Corporation. c-hed, has been playing the role of a knowledge partner and resource centre for the city. It has been imparting academic support for the budget preparation and economic planning of the city. In terms of the environment it envisages and implements various schemes focusing conservation activities ensuring that the developmental activities do not impact the environment of the city. c-hed also manages three parks of Kochi i.e. Subhash Bose Park (Ernakulam), Nehru Park (Fort Kochi) and Koithara Children’s park (Panambilly nagar), on behalf of KMC. For more information please visit: [http://www.c-hed.org/](http://www.c-hed.org/)

**Cochin Smart Mission Limited (CSML):** CSML is a Special Purpose Vehicle (SPV) formed for the sole purpose of implementation of the smart city mission at the city level in Kochi. The SPV plans, appraises, approves, releases funds, implements, manages, operates, monitors and evaluates the Smart City development projects. Some biodiversity related projects that the CSML is involved in are development of parks and open areas under the Area Based Development (ABD), restoration of various canals in the city and improvement of sanitation within the city. For more information please visit: [http://csml.co.in/](http://csml.co.in/)

**Department of Agriculture Development and Farmers’ Welfare, Kerala:** This state department is responsible for agriculture development through promotion of scientific methods of cultivation and welfare of farmers of the State through various policies and programmes. The department includes a wide network of offices from the state level to Panchayat level, Departmental Farms and various other institutions. Kochi Corporation Krishi Bhavan looks after matters related to agriculture and horticulture in partnership with the Municipal Corporation. For more information please visit: [https://keralagriculture.gov.in/](https://keralagriculture.gov.in/)
PART II: Indicators of the Index on Cities’ Biodiversity

Native Biodiversity

Indicator 1: Proportion of Natural Areas in the City

The natural areas defined by the Singapore Index Manual are “Natural areas comprise predominantly native species and natural ecosystems, which are not, or no longer, or only slightly influenced by human actions, except where such actions are intended to conserve, enhance or restore native biodiversity.” This definition of natural areas has been followed as closely as possible when it comes to selection of natural areas. However, it was not possible to only consider areas which are free from most human activities. Income inequality, a high population density, and limited infrastructural outreach means that while there are native and natural ecosystems occurring within a city, public access to these areas cannot be completely restricted.

Methodology

As per the CBI user manual

Principle for calculation of the indicator

\[
\left( \frac{\text{Total area of natural, restored and naturalised areas}}{\text{Total area of city}} \right) \times 100\%
\]

Scoring Range: (based on the CBI user manual)

- 0 point: <1.0%
- 1 point: 1.0% - 6.9%
- 2 points: 7.0% - 13.9%
- 3 points: 14.0% - 20.0%
- 4 points: > 20.0%

City Data

To calculate the proportion of natural areas in the city, a natural asset map (Figure 3) which was developed under the INTERACT-Bio project was referred to. Table 1 below shows the various classes of natural assets identified within the natural asset map of Kochi. Several of these categories do not fit into the definition of natural areas laid out in the Singapore Index such as beach, coconut cultivation, paddy fields, inland fish and prawn culture, mixed cultivation, open green spaces, parking lots, playground. Beach area was excluded since there is significant construction and tourism activities that take place here.

The main areas that fall under natural areas are- Mangrove patches, including Mangalavanam Bird Sanctuary, Backwaters which are declared under the Ramsar Convention, Ponds and Wetland Remnant Ponds, Marshes and the River.
Table 3: Natural assets (inside KMC boundary) used in the calculation of Indicator 1

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Land Class</th>
<th>Area in ha</th>
<th>Area in Sq. Km.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Backwaters (inland)</td>
<td>82</td>
<td>0.82</td>
</tr>
<tr>
<td>2</td>
<td>Mangrove</td>
<td>119</td>
<td>1.19</td>
</tr>
<tr>
<td>3</td>
<td>Marsh</td>
<td>289</td>
<td>2.89</td>
</tr>
<tr>
<td>4</td>
<td>Pond</td>
<td>6</td>
<td>0.06</td>
</tr>
<tr>
<td>5</td>
<td>Pond (WR)</td>
<td>32</td>
<td>0.32</td>
</tr>
<tr>
<td>6</td>
<td>River</td>
<td>122</td>
<td>1.22</td>
</tr>
<tr>
<td>7</td>
<td>Sparse vegetation</td>
<td>106</td>
<td>1.06</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>756</strong></td>
<td><strong>7.56</strong></td>
</tr>
</tbody>
</table>

The natural asset map only considers the inland area of the backwaters rather than the total area of backwaters under the jurisdiction of the city. The total area of backwaters under the jurisdiction of Kochi city as per the Land Use Board of Kerala is 16.57 sq.km. Therefore in the calculation of this indicator the area of all the land classes in Table 3 are considered except S No 1 or backwaters (inland). The total backwater area has also been added to the calculation as below,

\[
\frac{\text{Total area of natural, restored and naturalised areas}}{\text{Total area of city}} \times 100\%
\]

Total area of natural, restored and naturalised areas as calculated from the Natural asset map and total backwater area is 6.74 + 16.57 sq. km. = 23.31 sq. km.

Total area of the city = 94.88 sq. km.

**RESULT: 24.57%**

**SCORE: 4**

** Recommendations to Maintain Score**

As previously stated, the high score for this indicator is because of the presence of the backwaters, the Vembanad Lake, which is a RAMSAR site. That being said, despite being declared as a RAMSAR site, the backwaters suffer from threats such as pollution and land reclamation (Thomson et al., 2001) across the city.

The city needs to take greater ownership for the protection of this ecosystem (backwaters) which can come through strategies and actions that have been formulated in the LBSAP. Strict environmental regulation especially over industries and construction activities, needs to be exercised.
Indicator 2: Connectivity Measures or Ecological Networks to Counter Fragmentation

Methodology

As per the CBI user manual

Principle for calculation of the indicator

\[
\frac{1}{A_{\text{total}}} \times (A_1^2 + A_2^2 + A_3^2 + \ldots + A_n^2)
\]

Where:
- \( A_{\text{total}} \) is the total area of all natural areas
- \( A_1 \) to \( A_n \) are areas that are distinct from each other (i.e. more than or equal to 100m apart)
- \( n \) is the total number of connected natural areas

This measures effective mesh size of the natural areas in the city. \( A_1 \) to \( A_n \) may consist of areas that are the sum of two or more smaller patches which are connected. In general, patches are considered as connected if they are less than 100 m apart.

Scoring Range: (based on the CBI user manual)
- 0 point: < 200 ha
- 1 point: 201 - 500 ha
- 2 points: 501 - 1000 ha
- 3 points: 1001 - 1500 ha
- 4 points: > 1500 ha

City Data

There are 303 polygons (patches) which can be merged with the backwaters (Figure 4) and river and can be considered a single unit as per the 100m proximity rule. The total area of this big patch (\( A_1 \)) is 2148.03 ha.

There are 147 patches which are outside the 100m buffer of this big patch. As per the 100 m proximity tool these 147 patches merge into 92 patches (\( A_2 - A_{93} \))

\[ A_{\text{total}} = 2216.20 \text{ ha} \]

The values of \( A_1 \) to \( A_{93} \) are given in the excel file

As per the final calculation

\[ \text{Indicator 2} = \frac{1}{2216 \text{ ha}} \times (4614134.664 \text{ ha}^2) = 2082.003 \text{ ha} \]

RESULT: 2082.003 ha

SCORE: 4
Figure 4: Patches of natural areas which can act as ecological corridors within the boundary of KMC.
**Recommendations to Maintain Score**

The city can work towards maintaining this score by supporting restoration around these natural areas and strengthening local protection mechanisms by involving citizens. A cohesive vision for the same has also been envisioned in the LBSAP, which the city needs to put into implementation.
Indicator 3: Native Biodiversity in Built Up Areas (Bird Species)

Methodology

How to calculate indicator
Number of native bird species in built up areas where built up areas include impermeable surfaces like buildings, roads, drainage channels, etc., and anthropogenic green spaces like roof gardens, roadside planting, golf courses, private gardens, cemeteries, lawns, urban parks, etc. Areas that are counted as natural areas in indicator 1 should not be included in this indicator.

Scoring Range: (based on the CBI user manual)
0 point: < 19 bird species
1 point: 19 - 27 bird species
2 points: 28 - 46 bird species
3 points: 47 - 68 bird species
4 points: > 68 bird species

City Data
A detailed and comprehensive inventory of bird diversity in Kochi is absent although, pockets of the city have been surveyed as indicated in Part 1. For the purpose of calculating indicator 3, the citizen science platform developed by Cornell Lab of Ornithology, eBird (2019) was referred to. Birds sighted within the municipal corporation limits were considered. Sightings from Mangalavanam Bird Sanctuary and the backwaters were excluded, as per the guidelines of the CBI manual. This type of exclusion of sightings is possible using e-bird’s mapping tools. Furthermore, the list generated was also checked for common urban birds by birding experts of the city.

The total number of bird species identified through this method was 94 of which 81 were resident which corresponds to a score of 4.

A list of the birds considered is given in Annexure 2, Table 8.

RESULT: 81  SCORE: 4

Recommendations to Maintain Score
In order to sustain this score, the city needs to ensure the maintenance of its natural and naturalized spaces which provide a mosaic of habitats and resources for birds of the city. This has also been emphasised in the LBSAP through policy recommendations.
Indicator 4 - 8: Change in Number of Native Species

**Methodology**

**How to calculate indicator**
The change in number of native species is used for indicators 4 to 8. The three core groups are:
- Indicator 4: Vascular plants
- Indicator 5: Birds
- Indicator 6: Butterflies

These groups have been selected as data are most easily available and to enable some common comparison.

Cities can select any two other taxonomic groups for indicators 7 and 8 (e.g., bryophytes, fungi, amphibians, reptiles, freshwater fish, molluscs, dragonflies, beetles, spiders, hard corals, marine fish, seagrasses, sponges, etc.)

The above data from the first application of the Singapore Index would be recorded in Part I: Profile of the City as the baseline.

Net change in species from the previous survey to the most recent survey is calculated as:

Total increase in number of species (as a result of re-introduction, rediscovery, new species found, etc.) minus number of species that have gone extinct.

**Scoring Range:** (based on the CBI user manual)
- 0 point: Maintaining or a decrease in the number of species
- 1 point: 1 species increase
- 2 points: 2 species increase
- 3 points: 3 species increase
- 4 points: 4 species or more increase

**City Data**
Apart from isolated studies compiled by organisations and academicians (please refer Part 1 and details in Table 4) and citizen science platforms (eBird and iNaturalist), there has not been a comprehensive compilation of the biodiversity of Kochi. Species lists which were compiled for the purpose of the CBI are provided in Annexure 2.

Indicators 4, 5, and 6 as directed by the CBI correspond to the taxonomic groups Vascular Plants, Birds and Butterflies. Taxonomic groups considered for Indicators 7 and 8 are Mammals and Spiders.

Since this is the baseline year for the species count, the city will not receive a score on the indicators 4-8 and it will be excluded from the overall calculation.
<table>
<thead>
<tr>
<th>Ecosystem Assessed</th>
<th>Study</th>
<th>Taxa Assessed</th>
<th>Results (species no.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mangalavanam</td>
<td>Jayson and Easa, 1999</td>
<td>Flora (Mangroves and Trees), Birds, Fish, Reptiles, Mammals</td>
<td>Flora: 25, Fish: 7, Reptiles: 4, Birds: 42, Mammals: 5</td>
</tr>
<tr>
<td></td>
<td>Sebastian et al., 2005</td>
<td>Spiders</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Azeez and Bhupathy, 2006</td>
<td>Birds</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Madhusudhanan and Jayesh, 2011</td>
<td>Flora</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Abin and Samson, 2017</td>
<td>Birds</td>
<td>73</td>
</tr>
<tr>
<td>Kochi City Region</td>
<td>Environmental Impact Assessment (EIA) report, 2015 of the Multi-user Liquid Terminal (MULT) project of Cochin Port</td>
<td>Flora, Crustaceans, Molluscs, Fish, Amphibians, Reptiles, Birds, Mammals</td>
<td>Flora: 91, Crustaceans: 12, Molluscs: 2, Fish: 50, Amphibians: 2, Reptiles: 9, Birds: 43, Mammals: 9</td>
</tr>
<tr>
<td>Vembanad Lake (entire lake including both North and South Zones)</td>
<td>Asha et al., 2014</td>
<td>Fin Fish, Crustaceans</td>
<td>Fin Fish: 80, Crustaceans: 10</td>
</tr>
<tr>
<td>Subhash Park</td>
<td>ICLEI South Asia, 2019</td>
<td>Trees</td>
<td>66</td>
</tr>
<tr>
<td>Fort Kochi and Mattancherry</td>
<td>ICLEI South Asia, unpubl.</td>
<td>Trees</td>
<td>82</td>
</tr>
<tr>
<td>Entire Kochi</td>
<td>eBird</td>
<td>Birds</td>
<td>167 (resident and migratory)</td>
</tr>
</tbody>
</table>
### Ecosystem Assessed | Study | Taxa Assessed | Results (species no.)
--- | --- | --- | ---
Entire Kochi | BMC, personal communication, 2019 | Wild and Domesticated Biodiversity | Crustaceans: 6<br>Birds: 10<br>Reptiles: 7<br>Amphibians: 1<br>Mollusc: 3<br>Mammals: 9<br>Non fish aquatic sp.: 9<br>Fish: 26<br>Wild Flora: 45<br>Crops: 5 tubers, 3 spices, 1 cereal, 4 vegetables, 1 oilseed, 6 fruit species are cultivated.<br>Medicinal Plants: 45<br>Ornamental Plants: 12<br>Timber Plants: 13

Entire Kochi region | iNaturalist | Several Taxa | Plants: 345<br>Fungi: 20<br>Molluscs: 14<br>Spiders: 79<br>Insects: 522<br>Fish: 9<br>Reptiles: 17<br>Birds: 164<br>Mammals: 11

**RESULT:** Since this is the baseline year for the species count, the city will not receive a score on the indicators 4-8 and it will be excluded from the overall calculation.
### Indicator 9: Proportion of Protected Natural Areas

**Methodology**

**How to calculate indicator**

\[
\text{Indicator 9} = \frac{\text{Area of protected or secured natural areas}}{\text{Total area of the city}} \times 100\%
\]

**Scoring Range:** (based on the CBI user manual)

- 0 point: < 1.4%
- 1 point: 1.4% - 7.3%
- 2 points: 7.4% - 11.1%
- 3 points: 11.2% - 19.4%
- 4 points: > 19.4%

**City Data**

As detailed in Part 1 of the index, the governance models for biodiversity in India are of five types which fall under two main streams: State driven conservation and Community based conservation. Therefore, the natural areas that receive protection in the city are Mangalavanam which is a Bird Sanctuary. The backwaters of the Vembanand Lake which is a Ramsar site was also considered as a protected area since it requires the cooperation of various levels of government to ensure its protection.

The total area of Mangalavanam is 0.027 sq.km.

The total area of the Vembanad Lake or backwaters which falls under the jurisdiction of KMC is 16.57 sq.km.

Therefore the total area which is protected in the city corporation jurisdiction is 16.597 sq.km.

\[
\text{Indicator 9} = \frac{16.597}{94.88} \times 100\% = 17.49\%
\]

**RESULT: 17.49%**

**SCORE: 3**

**Recommendations to Improve Score**

The city can improve its score for this indicator by increasing local protection to its natural areas. The score for this indicator is based primarily on state driven conservation efforts. The city can encourage more community based conservation through the Biodiversity Management Committee and can designate Biodiversity Heritage Sites under the Biological Diversity Act, 2002.
Indicator 10: Proportion of Invasive Alien Species

**Methodology**

**How to calculate indicator**

\[
\text{(Number of invasive alien species)} \div \text{(Number of native species)} \times 100\%
\]

**Scoring Range:** (based on the CBI user manual)

- 0 point: > 30.0%
- 1 point: 20.1% - 30.0%
- 2 points: 11.1% - 20.0%
- 3 points: 1.0% - 11.0%
- 4 points: < 1.0%

**City Data**

In India, the most well documented taxa in terms of alien species are flowering plants. This taxa was thus selected for the purpose of calculation of indicator 10. Due to lack of data on species lists of most taxa at the city level for Kochi, it was decided to refer to district lists. The inventory of the flora of the Ernakulam district which was prepared by Sunil et al. (2015) was referred to. A total of 1,706 species belonging to 158 families and 866 genera were documented during the study period 2012–2015. The study also reported a total of 56 invasive alien species belonging to 27 families and 48 genera from the district.

Unfortunately, a detailed floristic study within KMC jurisdiction has not been conducted and hence, the city lacks a comprehensive floral profile. In order to overcome this difficulty, the inventory of flora of the Ernakulam district was reviewed by Dr. C. Jose, a subject matter specialist, who identified the species that could occur within the municipal jurisdiction based on his knowledge and field surveys (Annexure 2, Table 9). A total of 490 species of flowering plants occur in KMC of which 253 species are non-indigenous including introduced plants, naturalized plants, alien/ invasive plants, transformers and weeds. Native species numbered 237 of the total species.

Sankaran et al. (2013) reported 82 invasive plant species in the State of Kerala and conducted a risk assessment by grouping these invasive species into high, medium, low and insignificant risk. This resource was referred to in the preparation of an invasive species list for Kochi city, by comparing species reported in Sankaran et al. (2013) with a local list developed. The list was vetted by local experts. 39 invasive species were identified in the KMC area of which 14 are of high risk, 8 are of medium risk, 7 pose a low risk and the rest 10 are insignificant (Annexure 2, Table 13). Invasive species which fell under the category of insignificant impact were not considered for the purpose of this indicator calculation.

**Table 5: Habit wise distribution of flowering plants of KMC**

<table>
<thead>
<tr>
<th>Items</th>
<th>Tree</th>
<th>Shrub</th>
<th>Herb</th>
<th>Climber</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species</td>
<td>157</td>
<td>119</td>
<td>149</td>
<td>58</td>
<td>483</td>
</tr>
<tr>
<td>Exotic</td>
<td>71</td>
<td>78</td>
<td>73</td>
<td>26</td>
<td>248</td>
</tr>
<tr>
<td>Native</td>
<td>86</td>
<td>41</td>
<td>76</td>
<td>32</td>
<td>235</td>
</tr>
<tr>
<td>Invasive species</td>
<td>2</td>
<td>7</td>
<td>10</td>
<td>10</td>
<td>29</td>
</tr>
</tbody>
</table>
Thus to calculate Indicator 10, we have,

**Indicator 10 = \( \frac{\text{Number of invasive alien species}}{\text{Number of native species}} \times 100\% \)**

Number of invasive alien species = 29

Number of native species = 235

Indicator 10 = \( \frac{29}{235} \times 100 = 12.34\% \)

**Recommendations to Improve Score**

As per the risk assessment (Annexure 2, Table 13), the city government along with the BMC, should focus on developing strategies and action plans to address the high and medium risk species. Distribution maps of invasive species should also be prepared. Partnerships with academic institutions, NGOs and CSOs will be of great benefit to the city in tackling the issue.
**Indicator 11: Regulation of Quantity of Water**

**Methodology**

**How to calculate indicator**

\[
\text{(Total permeable area)} \div \text{(Total terrestrial area of the city)} \times 100\%
\]

**Scoring Range:** (based on the CBI user manual)

- 0 point: < 33.1%
- 1 point: 33.1% - 39.7%
- 2 points: 39.8% - 64.2%
- 3 points: 64.3% - 75.0%
- 4 points: > 75.0%

**City Data**

Chithra (2016), measured the total impervious area of the Greater Cochin Area. This area includes Kochi City and the surrounding urbanizing area, which comprises 330 sq. km extending from 9º 49’N to 10º14’N and 76º 10’E to 76º31’E.

The analysis showed that the impervious coverage of 53.74 km² in 1990 increased to 154.63 km² by 2014, while there was a corresponding decrease of pervious areas from 183.70 km² to 87.25 km² during the same period. It was also found that this change is not only contributed by conversion of pervious lands into built up area, but also by reclamation of the backwaters.

The area under the jurisdiction of KMC is only 94.88 sq km. Therefore, an accurate calculation from the aforementioned source is not possible. However, if the application of the overall percent can be assumed to the jurisdiction, then the percent of permeable area is 26% which would arrive at a score of 0.

Alternatively, using the Natural Asset Map (Figure 3) to calculate the total permeable area, we have the following land classes which can be considered (Table 6).

**Table 6: Land classes used in the calculation indicator 11**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Land Class</th>
<th>Area in ha</th>
<th>Area in sq. km.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Beach</td>
<td>13</td>
<td>0.13</td>
</tr>
<tr>
<td>2</td>
<td>Canal</td>
<td>34</td>
<td>0.34</td>
</tr>
<tr>
<td>3</td>
<td>Coconut cultivation</td>
<td>38</td>
<td>0.38</td>
</tr>
<tr>
<td>4</td>
<td>Fallow (Paddy field)</td>
<td>85</td>
<td>0.85</td>
</tr>
<tr>
<td>5</td>
<td>Inland fish culture</td>
<td>45</td>
<td>0.45</td>
</tr>
<tr>
<td>6</td>
<td>Mangrove</td>
<td>119</td>
<td>1.19</td>
</tr>
<tr>
<td>7</td>
<td>Marsh</td>
<td>289</td>
<td>2.89</td>
</tr>
<tr>
<td>8</td>
<td>Mixed cultivation</td>
<td>234</td>
<td>2.34</td>
</tr>
<tr>
<td>9</td>
<td>Open Green Spaces</td>
<td>34</td>
<td>0.34</td>
</tr>
<tr>
<td>10</td>
<td>Open ground</td>
<td>11</td>
<td>0.11</td>
</tr>
<tr>
<td>11</td>
<td>Playground</td>
<td>79</td>
<td>0.79</td>
</tr>
<tr>
<td>12</td>
<td>Pond</td>
<td>6</td>
<td>0.06</td>
</tr>
<tr>
<td>13</td>
<td>Pond (WR)</td>
<td>32</td>
<td>0.32</td>
</tr>
<tr>
<td>14</td>
<td>Prawn culture</td>
<td>27</td>
<td>0.27</td>
</tr>
</tbody>
</table>
We also consider the area of the backwaters found in the city's jurisdiction which is 16.57 sq.km.

Total permeable area = area of Backwaters (16.57 sq.km.) + Beach + Canal + Coconut cultivation + Fallow (Paddy field) + Inland fish culture + Mangrove + Marsh + Mixed cultivation + Open Green Spaces + Open ground + Playground + Pond + Pond (WR) + Prawn culture + River + Sparse vegetation + Tree patch = 31.3 sq km.

Total terrestrial area = 78.31 sq. km

Proportion of permeable area = 39.97% which scores 2 points.

# Recommendations to Improve Score

The city should look into Nature based Solutions (NbS) or a mix of grey and green infrastructure that can improve the percolation of rainwater into the ground within feasible built-up areas. Strict enforcement of installation of rainwater harvesting structures as per the Water Policy of Kochi (2015) can also improve the capture of rainwater and reduce run-off. Increasing the proportion of vegetated (trees, shrubs and herbs) surface areas in the city through targeted greening activities will also support the regulation of water especially along the natural drainage.

Policy and legal instruments are effective tools that can also be used to restrict construction in eco-sensitive zones of the city, especially within or near the natural drainage areas.
**Indicator 12: Climate Regulation: Carbon Storage and Cooling Effect of Vegetation**

**Methodology**

**How to calculate indicator**

\[
\text{Tree canopy cover} \div \text{(Total terrestrial area of the city)} \times 100\%
\]

**Scoring Range:** (based on the CBI user manual)

<table>
<thead>
<tr>
<th>Score Points</th>
<th>Scoring Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 point:</td>
<td>&lt; 10.5%</td>
</tr>
<tr>
<td>1 point:</td>
<td>10.5% - 19.1%</td>
</tr>
<tr>
<td>2 points:</td>
<td>19.2% - 29.0%</td>
</tr>
<tr>
<td>3 points:</td>
<td>29.1% - 59.7%</td>
</tr>
<tr>
<td>4 points:</td>
<td>&gt; 59.7%</td>
</tr>
</tbody>
</table>

**City Data**

This indicator has been calculated from the Natural Asset Map (Figure 3), taking into account the following land uses - Coconut Cultivation, Mangroves, Mixed Cultivation, Open Green Spaces, Parking Ground, Sparse Vegetation, Tree Patches (Table 1).

As per a field exercise during the development of the Natural Asset Map, it was found that approximately half the areas of Open Green Spaces, Open Ground and Sparse Vegetation land classes have trees, and therefore only 50% of their areas have been considered.

**Table 7: Land use classes which comprise various types of vegetation which have a role in carbon storage and cooling**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Land Class</th>
<th>Area in ha</th>
<th>Tree Cover in ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Coconut cultivation</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>2</td>
<td>Mangrove</td>
<td>119</td>
<td>119</td>
</tr>
<tr>
<td>3</td>
<td>Mixed cultivation</td>
<td>234</td>
<td>234</td>
</tr>
<tr>
<td>4</td>
<td>50% Open green spaces</td>
<td>34</td>
<td>17</td>
</tr>
<tr>
<td>5</td>
<td>50% Open ground</td>
<td>11</td>
<td>5.5</td>
</tr>
<tr>
<td>6</td>
<td>50% Sparse vegetation</td>
<td>106</td>
<td>53</td>
</tr>
<tr>
<td>7</td>
<td>Tree patch</td>
<td>199</td>
<td>199</td>
</tr>
</tbody>
</table>

Therefore the total tree cover in the city of Kochi is 665.5 ha or 6.655 sq. km.

The total terrestrial area of the city is 78.31 sq. km.

\[
\text{(Tree canopy cover)} \div \text{(Total terrestrial area of the city)} \times 100\% \]

\[
(6.655) \div (78.31) \times 100\% = 8.498\% \text{ which is less that } <10\% \text{ and therefore scores 0 points.}
\]

RESULT: 8.498%

SCORE: 0
Recommendations to Improve Score

The city can improve their score for this indicator through a mix of activities related to conservation and restoration of its green spaces. Plantation of native tree species should be actively taken up by KMC. Community participation is key in ensuring the success of programmes and strategies towards the same. The municipal corporation can also introduce policies that encourage the enhancement and maintenance of home gardens in the city. Active support from the NGOs working in the city can be taken up.
Indicator 13: Recreational Services

Methodology

How to calculate indicator
(Area of parks with natural areas and protected or secured natural areas)/1000 persons

Scoring Range: (based on the CBI user manual)
0 point: < 0.1 ha/1000 persons
1 point: 0.1 - 0.3 ha/1000 persons
2 points: 0.4 - 0.6 ha/1000 persons
3 points: 0.7 - 0.9 ha/1000 persons
4 points: > 0.9 ha/1000 persons

City Data

Indicator 13: This is calculated as area of parks with natural areas and protected or secured natural areas/1000 persons

The parks that are present in Kochi’s Corporation area are detailed in Table 8.

Table 8: Parks in KMC jurisdiction

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name</th>
<th>Ward No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nehru Park</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Mahabooob Park</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Mattanchery Children's Park</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>YMCA Children's Park</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>P R Mathew Park</td>
<td>21</td>
</tr>
<tr>
<td>6</td>
<td>Santham Colony Park</td>
<td>22</td>
</tr>
<tr>
<td>7</td>
<td>Nazareth Triangle Park</td>
<td>25</td>
</tr>
<tr>
<td>8</td>
<td>Thamarakkulam Park</td>
<td>28</td>
</tr>
<tr>
<td>9</td>
<td>Pallath Raman Park</td>
<td>28</td>
</tr>
<tr>
<td>10</td>
<td>Priyadarshini Park</td>
<td>29</td>
</tr>
<tr>
<td>11</td>
<td>Vathuruthy Park</td>
<td>30</td>
</tr>
<tr>
<td>12</td>
<td>Navy Environmental Park</td>
<td>30</td>
</tr>
<tr>
<td>13</td>
<td>Edappilly Ragavan Memorial Park</td>
<td>37</td>
</tr>
<tr>
<td>14</td>
<td>Changambuzha Park</td>
<td>37</td>
</tr>
<tr>
<td>15</td>
<td>Senior Citizen Park</td>
<td>41</td>
</tr>
<tr>
<td>16</td>
<td>Kunnara Park</td>
<td>49</td>
</tr>
<tr>
<td>17</td>
<td>Kumaranasan Nagar North Park</td>
<td>54</td>
</tr>
<tr>
<td>18</td>
<td>Jawahar Nagar North Park</td>
<td>54</td>
</tr>
<tr>
<td>19</td>
<td>Girinagar Park</td>
<td>55</td>
</tr>
<tr>
<td>20</td>
<td>Panampilli Nagar Park</td>
<td>56</td>
</tr>
<tr>
<td>21</td>
<td>LIG Park</td>
<td>56</td>
</tr>
</tbody>
</table>
The total area of parks, along with natural areas and protected or secured natural areas is 34 ha, excluding Mangalavanam Bird Sanctuary which is a protected area. Including the Sanctuary which is accessible to the public, the total area of parks comes to 36.74 ha. Fort Kochi which is ward 1 has a small beach area which has also been considered in the calculation.

Outside of these terrestrial recreational spaces, the backwaters of Kochi span an area of 1,657 ha, have a number of activities for tourists and the locals to avail, such as house boat renting, boat rides, tours, cruises and recreational fishing. This was also considered in the calculation of the indicator. Thus we have the following land classes which have been considered below:

<table>
<thead>
<tr>
<th>Land class</th>
<th>Area in ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parks/ Open Green Spaces</td>
<td>34</td>
</tr>
<tr>
<td>Mangalavanam Bird Sanctuary</td>
<td>2.74</td>
</tr>
<tr>
<td>Beach</td>
<td>13</td>
</tr>
<tr>
<td>Backwaters</td>
<td>1,657</td>
</tr>
<tr>
<td>Total</td>
<td>1,706.74</td>
</tr>
</tbody>
</table>

(Area of parks with natural areas and protected or secured natural areas)/1000 persons = 1706.74/1000

Using this calculation to score Indicator 13, we have 1.7 ha which results in a score of 4 points.

Again, it is important to note that the sheer area of the backwaters contributes to the high score for this indicator.
Recommendations to Maintain Score

The score for this indicator will always remain high due to the presence of the backwaters. However, the city can take steps to improve terrestrial natural recreational services, by setting aside more green space for public access and recreation. Community gardens can achieve this goal as well as improve the city's food security and link with the State's organic mission.
Indicator 14: Educational Services

Methodology

How to calculate indicator
Average number of formal educational visits per child below 16 years to parks with natural areas or protected or secured natural areas per year

Scoring Range: (based on the CBI user manual)
0 point: 0 formal educational visit/year
1 point: 1 formal educational visit/year
2 points: 2 formal educational visits/year
3 points: 3 formal educational visits/year
4 points: > 3 formal educational visits/year

City Data

Discussions with officials of KMC and other stakeholders yielded the information that park visits are not mandatory for schools, as per the set curriculum. However, schools do voluntarily organize these visits, in accordance with their schedule.

Therefore, for this indicator, it was identified that no formal educational visit to natural areas takes place in schools of Kochi.

RESULT: No formal educational visit

SCORE: 0

Recommendations to Improve Score

Although Kochi’s city administration does not have an influence on the curriculum of the various boards followed by schools in the city, it can give a directive to all schools to include such visits in their curriculum.

The various school boards responsible for curriculum development should consider including mandatory practical aspects and educational visits to support theoretical frameworks within themes of biodiversity education in curricula. The city can send such a request to the boards, through the state government.
Indicator 15: Budget Allocated to Biodiversity

Methodology

How to calculate indicator
(Amount spent on biodiversity related administration) ÷ (Total budget of city) × 100%

Scoring Range: (based on the CBI user manual)
0 point: < 0.4%
1 point: 0.4% - 2.2%
2 points: 2.3% - 2.7%
3 points: 2.8% - 3.7%
4 points: > 3.7%

City Data
The following are the various direct or indirect budget allocations (in INR) for biodiversity made by Kochi city in 2019-2020

Direct
- Open green space management – INR 80.76 million
- Kochi biodiversity park – INR 2 million
- New sacred groves in Azhakiya kavu temple ground – INR 1.5 million
- Kochi tree bank - INR 2 million
- Controlling invasive species (Giant African snail) - INR 1 million
- Urban farming - INR 10 million
- Animal husbandry – INR 35 million
- Fisheries – INR 40 million
- Environmental awareness programme (Our Kochi, Our Environment - Know your city) – INR 1 million

There are also some projects which indirectly fit into biodiversity administration and protection as listed below, but these have not been considered for the purpose of this indicator.

Indirect
- Canal rejuvenation and management – INR 1 billion
- Prevention of saltwater intrusion and rain water recharging - INR 2 million
- Plastic-free green Kochi (biobag / low strengthening / awareness) - INR 10 million
- Biogas plant - INR 2 million
- Bio-waste management - INR 1 million
- Sewage treatment projects – INR 800 million
- Biotoilets – INR 30 million
- Climate smart city project – INR 1 million

Amount spent on biodiversity related administration = INR 178,100,000

Total Budget = INR 9,875,694,858

Indicator 15= (Amount spent on biodiversity related administration) ÷ (Total budget of city) × 100%
**Recommendations to Improve Score**

The city’s annual budget invariably reflects some component towards biodiversity related activities which is commendable for an Indian city. To improve the score, the city can look into funding NbS that can support the delivery of infrastructure and services within the city. The city should also look into implementing the measures suggested in the LBSAP, through the municipal budget.
**Indicator 16: Number of Biodiversity Projects Implemented by the City Annually**

**Methodology**

**How to calculate indicator**
Number of programmes and projects that are being implemented by the city authorities, possibly in partnership with private sector, NGOs, etc. per year.

In addition to submitting the total number of projects and programmes carried out, cities are encouraged to provide a listing of the projects and to categorise the list into projects that are:

1. Biodiversity related
2. Ecosystem services related

**Scoring Range:** (based on the CBI user manual)

<table>
<thead>
<tr>
<th>Points</th>
<th>Number of projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>&lt; 12 programmes/projects</td>
</tr>
<tr>
<td>1</td>
<td>12 - 21 programmes/projects</td>
</tr>
<tr>
<td>2</td>
<td>22 - 39 programmes/projects</td>
</tr>
<tr>
<td>3</td>
<td>40 - 71 programmes/projects</td>
</tr>
<tr>
<td>4</td>
<td>&gt; 71 programmes/projects</td>
</tr>
</tbody>
</table>

**City Data**

The city is implementing the following projects for the year 2019-20:

1. INTERACT- Bio (ICLEI South Asia)
2. EcoLogistics (ICLEI South Asia)
3. Cities 4 Forests (WRI)
4. Plastic-free Green Kochi (KMC)
5. Solar city project (c-hed)
6. Zero carbon building (WRI)
7. Urban pathways (GIZ)
8. International Urban Corporation (EU)
9. Maintenance of Parks (Subash Bose park, Nehru park and Koithara park) (c-hed)
10. Climate smart cities (GIZ)
11. Sustainable urban transport (Smart SUT) – (GIZ)
12. Mobilize your city (EU)
13. E-mobility (Wuppertal Institute)
14. Reimagining Fort Kochi, TUMI Global Urban Mobility Challenge (GIZ and WRI)
15. One Planet One City Challenge (WWF)

In addition to these there are centrally and other agency funded projects linked to the Smart Cities Programme like open space management; projects with KMRL and avenue tree maintenance. In November 2016, the Kerala Government launched Haritha Kerala (Green Kerala) Mission which envisages pollution-free water sources, revival of water sources, water conservation, eco-friendly and sustainable waste management, and organic farming. In that vein, KMC started a programme (2016-2017) called ‘Jaiva gramam’ (organic village) promoting organic farming within neighbourhoods. The BMC with additional support from the Kerala SBB developed Kochi’s PBR in 2019 and has a continued partnership in the running of biodiversity clubs within government schools.

This brings the score for this indicator to 1 point as the number of projects/programmes is greater than 12 but less than 21.
Recommendations to Improve Score

With support from c-hed, the city can look into building partnerships with the smaller organisations working in the city on biodiversity related activities. This will help to improve the score, as well as ensure public participation in activities related to biodiversity conservation.

**Methodology**

**How to calculate indicator**
Status of LBSAP (or any equivalent plan); number of associated CBD initiatives.

**Scoring Range:** (based on the CBI user manual)
- 0 point: No LBSAP*
- 1 point: LBSAP not aligned with NBSAP
- 2 points: LBSAP incorporates elements of NBSAP, but does not include any CBD initiatives**
- 3 points: LBSAP incorporates elements of NBSAP, and includes one to three CBD initiatives
- 4 points: LBSAP incorporates elements of NBSAP, and includes four or more CBD initiatives

* LBSAP or equivalent.
** The thematic programmes of work and cross-cutting issues of the CBD are listed in [http://www.cbd.int/programmes/](http://www.cbd.int/programmes/). The Strategic Plan for Biodiversity (2011-2020), including the Aichi Biodiversity Targets can also be used as a reference framework ([http://www.cbd.int/sp/default.shtml](http://www.cbd.int/sp/default.shtml)).

**City Data**
The LBSAP for Kochi city has been recently developed under the INTERACT-Bio Project in conjunction with ICLEI South Asia.

The LBSAP is in alignment with the NBSAP but does not formally include one to three CBD initiatives.

RESULT: LBSAP prepared  
SCORE: 2

**Recommendations to Improve Score**
The LBSAP reflects broad strategies and corresponding action plans that the city can take up to strengthen biodiversity governance. These strategies can easily be tailored to reflect several of the CBD initiatives such as Traditional Knowledge, Innovations and Practices, Health and Biodiversity, Biological and Cultural Diversity, Climate Change and Biodiversity. The city should prioritise implementation of the LBSAP initiatives through municipal and other funds.
Indicator 18: Institutional Capacity - Essential Biodiversity Related Functions

**Methodology**

**How to calculate indicator**
Number of essential biodiversity related functions* that the city uses.

* The functions could include the following: biodiversity centre, botanical garden, herbarium, zoological garden or museum, insectarium, etc.

**Scoring Range:** (based on the CBI user manual)

- 0 point: No functions
- 1 point: 1 function
- 2 points: 2 functions
- 3 points: 3 functions
- 4 points: > 3 functions

**City Data**

About 40 schools in KMC have biodiversity parks/ butterfly gardens/ medicinal plant gardens/vegetable gardens in their school. The State Government of Kerala runs a programme for setting up of these above-mentioned gardens in each school. Every college within the city also maintains herbaria for the purpose of education. Sacred Heart College has a Zoological Museum and CMFRI has a Marine Biodiversity Museum which are accessible to the public.

Considering the information above, Kochi will score the highest i.e. 4 points for this indicator

**RESULT: 40**

**SCORE: 4**

**Recommendations to Maintain Score**

Since a large number of essential biodiversity related functions are housed within academic institutions in Kochi, the Municipal Corporation should look into partnerships with these institutions which will help to maintain and upgrade these facilities.
Indicator 19: Institutional Capacity - Inter-Agency Co-Operation

Methodology

How to calculate indicator
Number of city or local government agencies involved in inter-agency co-operation pertaining to biodiversity matters.

Scoring Range: (based on the CBI user manual)
- 0 point: 1 or 2 agencies* cooperate on biodiversity matters
- 1 point: 3 agencies cooperate on biodiversity matters
- 2 points: 4 agencies cooperate on biodiversity matters
- 3 points: 5 agencies cooperate on biodiversity matters
- 4 points: > 5 agencies cooperate on biodiversity matters

* Agencies could include departments or authorities responsible for biodiversity, planning, water, transport, development, finance, infrastructure, etc.

City Data
There are four main local government agencies which are involved in matters pertaining to biodiversity. They are:
1. Kochi Municipal Corporation
2. Biodiversity Management Committee
3. c-hed
4. Cochin Smart Mission Limited

RESULT: 4  
SCORE: 2

Recommendations to Improve Score
The visionary leadership of the city is highlighted from the fact that an organisation like c-hed had been established by the city corporation. The city level agencies are collaborating well (through coordination by c-hed). However, biodiversity-related issues in the city are also handled by parastatal and state agencies and the city should collaborate with them as well. Though this will not increase the score of the city (as the index considers only local government agencies), it can help in strengthening mainstreaming biodiversity conservation.
Indicators 20: Participation and Partnership - Formal or Informal Public Consultation

Methodology

How to calculate indicator
Existence and state of formal or informal public consultation process pertaining to biodiversity related matters.

Scoring Range: (based on the CBI user manual)
0 point: No routine formal or informal process
1 point: Formal or informal process being considered as part of the routine process
2 points: Formal or informal process being planned as part of the routine process
3 points: Formal or informal process in the process of being implemented as part of the routine process
4 points: Formal or informal process exists as part of the routine process

City Data
In the matter of public consultation, not just the city, but the entire state of Kerala follows a strict formal process. In fact Kerala was the first state in India to launch a pre-legislative public consultation in 2011. Therefore for this indicator, the highest score of 4 points applies i.e. formal or informal process exists as part of the routine process.

RESULT: Formal or Informal Process Exist
SCORE: 4

Recommendations to Maintain Score
In order to maintain this score, the city should continue to adhere to the robust process of formal public consultation in biodiversity related matters.
Indicators 22: Participation and Partnership - Institutional Partnership

Methodology

How to calculate indicator
Number of agencies/private companies/NGOs/academic institutions/international organisations with which the city is partnering in biodiversity activities, projects and programmes.

Instances of inter-agency co-operation listed in Indicator 19 should not be listed here again.

Scoring Range: (based on the CBI user manual)
- 0 point: No formal or informal partnerships
- 1 point: City in partnership with 1-6 other national or subnational agencies/private companies/NGOs/academic institutions/international organisations
- 2 points: City in partnership with 7-12 other national or subnational agencies/private companies/NGOs/academic institutions/international organisations
- 3 points: City in partnership with 13-19 other national or subnational agencies/private companies/NGOs/academic institutions/international organisations
- 4 points: City in partnership with 20 or more other national or subnational agencies/private companies/NGOs/academic institutions/international organisations

City Data
The following are the agencies with whom the Municipal Corporation is partnering with in terms of biodiversity related activities, projects and programmes:
- ICLEI- Local Governments for Sustainability, South Asia implementing INTERACT-Bio Project
- World Resources Institute implementing Cities 4 forest, TUMI and Zero emission building projects
- GIZ implementing Urban pathways, TUMI, Climate Smart Cities projects
- European Union implementing International Urban Corporation and Mobilize your city projects
- Wuppertal Institute implementing E-mobility project
- Agriculture related programmes with sub-national authorities such as Krishi Bhavan, Kerala Agriculture Department
- Open Space Management using funds of the Smart City Mission funded by the National Government
- Kerala State Government’s Haritha Kerala Mission
- Kerala State Biodiversity Board in partnership with the BMC to develop Kochi’s PBR and run biodiversity clubs in government schools with the city’s support

RESULT: 9  
SCORE: 2

Recommendations to Improve Score
The city should look at increasing the number of partnerships to improve the score. Some organisations with whom the city can readily partner with include Cochin Natural History Society (CNHS), Kerala Shastra Sahitya Parishad (KSSP), as well as several academic and research institutions like the Central Marine Fisheries Research Institute (CMFRI) and CUSAT.
Indicators 22: Education and Awareness - Is Biodiversity or Nature Awareness included in the School Curriculum

Methodology

**How to calculate indicator**
Is biodiversity or nature awareness included in the school curriculum (e.g. biology, geography, etc.)?

**Scoring Range:** (based on the CBI user manual)
- 0 point: Biodiversity or elements of it are not covered in the school curriculum
- 1 point: Biodiversity or elements of it are being considered for inclusion in the school curriculum
- 2 points: Biodiversity or elements of it are being planned for inclusion in the school curriculum
- 3 points: Biodiversity or elements of it are in the process of being implemented in the school curriculum
- 4 points: Biodiversity or elements of it are included in the school curriculum

**City Data**
The schools within the city follow the curriculum of various boards such as the Kerala State Education Board, CBSE and ICSE. All of these boards have included biodiversity and nature awareness in various subjects like Biology, Geography, Environmental Science.

Hence, biodiversity or elements of it are included in the school curriculum bringing the score under this indicator to 4 points.

**RESULT:** Yes  
**SCORE:** 4

**Recommendations to Maintain Score**
It should be noted here that this indicator which measures the theoretical aspects of biodiversity education receives the highest score possible whereas indicator 14 which measures practical aspects of biodiversity education received the lowest score possible. This highlights that environmental education not just in Kochi, but in the country at large needs to strike the right balance between theory and practice.
Indicators 23: Education and Awareness - Number of Outreach or Public Awareness Events

Methodology

How to calculate indicator
Number of outreach or public awareness events held in the city per year.

Scoring Range: (based on the CBI user manual)
- 0 point: 0 outreach events/year
- 1 point: 1 - 59 outreach events/year
- 2 points: 60 - 149 outreach events/year
- 3 points: 150 - 300 outreach events/year
- 4 points: > 300 outreach events/year

City Data
The ULB is involved in and organises a number of ward and city level programmes such as tree sapling distribution, World Environment Day celebration, Day for farmers, One Planet One City Challenge, One Tree - One Child programme, state level programmes like the Social forestry programme of Kerala Forest Department, Jaiva Karshaka Samithi Meet (Eco-friendly farmers/ Organic agriculture), Cochin Flower Shows, Swachh Bharat Mission awareness programmes and so on. The number of programmes and events organised per year fall within the range of 1-59, thus resulting in a score of 1 point for this indicator.

RESULT: 1 - 59
SCORE: 1

Recommendations to Improve Score
To improve the score under this indicator the city can partner with various organisations who work in related fields to celebrate important days such as World Wetlands Day- 2 February, National Science Day- 28 February, World Wildlife Day- 3 March International Day of Action for Rivers- 14 March, World Forestry Day- 21 March, World Heritage Day- 18 April, Earth Day- 22 April, World Biodiversity Day- 22 May, World Ocean Day- 8 June, International Mangrove Day- 26 July, Honey Bee day- 22 August, Zero Emission's Day- 21 September, World Environmental Health Day- 26 September, World Nature Day- 3 October, International Day of Climate Action- 24 October, World Birds’ Day- 12 November.
<table>
<thead>
<tr>
<th>Components</th>
<th>Indicators</th>
<th>Maximum Score</th>
<th>Kochi City's score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native Biodiversity in the City</td>
<td>1. Proportion of Natural Areas in the City</td>
<td>4 points</td>
<td>4 points</td>
</tr>
<tr>
<td></td>
<td>2. Connectivity Measures</td>
<td>4 points</td>
<td>4 points</td>
</tr>
<tr>
<td></td>
<td>3. Native Biodiversity in Built Up Areas (Bird Species)</td>
<td>4 points</td>
<td>4 points</td>
</tr>
<tr>
<td></td>
<td>4. Change in Number of Vascular Plant Species</td>
<td>4 points</td>
<td>N/A as baseline year</td>
</tr>
<tr>
<td></td>
<td>5. Change in Number of Bird Species</td>
<td>4 points</td>
<td>N/A as baseline year</td>
</tr>
<tr>
<td></td>
<td>6. Change in Number of Mammal Species</td>
<td>4 points</td>
<td>N/A as baseline year</td>
</tr>
<tr>
<td></td>
<td>7. Change in Number of Moth Species</td>
<td>4 points</td>
<td>N/A as baseline year</td>
</tr>
<tr>
<td></td>
<td>8. Change in Number of Fish Species</td>
<td>4 points</td>
<td>N/A as baseline year</td>
</tr>
<tr>
<td></td>
<td>9. Proportion of Protected Natural Areas</td>
<td>4 points</td>
<td>3 points</td>
</tr>
<tr>
<td></td>
<td>10. Proportion of Invasive Alien Species</td>
<td>4 points</td>
<td>2 points</td>
</tr>
<tr>
<td>Ecosystem Services provided by Biodiversity</td>
<td>11. Regulation of Quantity of Water</td>
<td>4 points</td>
<td>2 points</td>
</tr>
<tr>
<td></td>
<td>12. Climate Regulation: Carbon Storage and Cooling Effect of Vegetation</td>
<td>4 points</td>
<td>0 points</td>
</tr>
<tr>
<td></td>
<td>13. Recreation and Education: Area of Parks with Natural Areas</td>
<td>4 points</td>
<td>4 points</td>
</tr>
<tr>
<td></td>
<td>14. Recreation and Education: Number of Formal Education Visits per Child Below 16 Years to Parks with Natural Areas per Year</td>
<td>4 points</td>
<td>0 points</td>
</tr>
<tr>
<td>Governance and Management of Biodiversity</td>
<td>15. Budget Allocated to Biodiversity</td>
<td>4 points</td>
<td>2 points</td>
</tr>
<tr>
<td></td>
<td>16. Number of Biodiversity Projects Implemented by the City Annually</td>
<td>4 points</td>
<td>1 point</td>
</tr>
<tr>
<td></td>
<td>17. Existence of Local Biodiversity Strategy and Action Plan</td>
<td>4 points</td>
<td>2 points</td>
</tr>
<tr>
<td></td>
<td>18. Institutional Capacity: Number of Biodiversity Related Function</td>
<td>4 points</td>
<td>4 points</td>
</tr>
<tr>
<td></td>
<td>19. Institutional Capacity: Number of City or Local Government Agencies Involved in Inter-agency Cooperation Pertaining to Biodiversity Matters</td>
<td>4 points</td>
<td>2 points</td>
</tr>
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<td>20. Participation and Partnership: Existence of Formal or Informal Public Consultation Process</td>
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<td>21. 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</td>
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<td>22. Education and Awareness: Is Biodiversity or Nature Awareness Included in the School Curriculum</td>
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<td>23. Education and Awareness: Number of Outreach or Public Awareness Events Held in the City per Year</td>
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Native Biodiversity in the City (Sub-total for indicators 1-10) 17/20*
Ecosystem Services provided by Biodiversity (Sub-total for indicators 11-14) 6/16
Governance and Management of Biodiversity (Sub-total for indicators 15-23) 22/36
Total 45/72*

*as this is the baseline year, the score will only be applicable for five indicators out of ten
Annexure 1 - References


## Annexure 2 - Species Lists

### Table 11: List of Birds used to calculate Indicator 3

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Species</th>
<th>Scientific Name</th>
<th>Resident / Migrant</th>
<th>Urban Species</th>
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<td>1</td>
<td>Shikra</td>
<td>Accipiter badius</td>
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<td>2</td>
<td>Jungle Myna</td>
<td>Acridotheres fuscus</td>
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<td>Blyth’s Reed Warbler</td>
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<td>5</td>
<td>Clamorous Reed Warbler</td>
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<td>Common Sandpiper</td>
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<td>Amaurornis phoenicurus</td>
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<td>Garganey</td>
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<td>Artamus fuscus</td>
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<td>Bubulcus ibis</td>
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### Table 12: Flora of Kochi (extracted from Sunil et al. (2015))

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### Table 14: List of Butterfly Species for Indicator 6

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