



Kochi Municipal Corporation

CITY BIODIVERSITY INDEX – KOCHI

Supported by



based on a decision of the German Bundestag

Supported in India by



Ministry of Environment, Forest and Climate Change
Government of India



Prepared under



INTERACT-Bio
Integrated action on biodiversity

Project Implemented in Kochi by





Prepared under the BMU supported INTERACT-Bio Project. INTERACT-Bio is implemented by ICLEI – Local Governments for Sustainability and supported by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) through the International Climate Initiative (IKI).

Project implemented in India by: ICLEI-Local Governments for Sustainability, South Asia

Year of Publishing: 2020

Copyright © ICLEI South Asia (2020)

No part of this booklet may be disseminated or reproduced in any form (electronic or mechanical) without prior permission from or intimation to ICLEI South Asia. Permission and information may be sought at (iclei-southasia@iclei.org).

Contact

ICLEI-Local Governments for Sustainability, South Asia
C-3 Lower Ground Floor, Green Park Extension, New Delhi-110016
Tel: +91-11-4974 7200; Email: iclei-southasia@iclei.org

Contents

Acronyms -----	4
Background -----	5
Summary of the Scores -----	6
Geophysical Characteristics -----	7
PART 1 – Kochi City Profile -----	7
Demography -----	8
Economy -----	8
Biodiversity -----	9
Administration of Biodiversity -----	13
Native Biodiversity -----	15
Indicator 1: Proportion of Natural Areas in the City -----	15
PART II: Indicators of the Index on Cities’ Biodiversity -----	15
Indicator 2: Connectivity Measures or Ecological Networks to Counter Fragmentation -----	17
Indicator 3: Native Biodiversity in Built Up Areas (Bird Species) -----	20
Indicator 4 - 8: Change in Number of Native Species -----	21
Indicator 9: Proportion of Protected Natural Areas -----	24
Indicator 10: Proportion of Invasive Alien Species -----	25
Indicator 11: Regulation of Quantity of Water -----	27
Indicator 12: Climate Regulation: Carbon Storage and Cooling Effect of Vegetation -----	29
Indicator 13: Recreational Services -----	31
Indicator 14: Educational Services -----	34
Indicator 15: Budget Allocated to Biodiversity -----	35
Indicator 16: Number of Biodiversity Projects Implemented by the City Annually -----	37
Indicator 17: Policies, Rules and Regulations – Existence of Local Biodiversity Strategy and Action Plan -----	39
Indicator 18 : Institutional Capacity - Essential Biodiversity Related Functions -----	40
Indicator 19 : Institutional Capacity - Inter-Agency Co-Operation -----	41
Indicators 20 : Participation and Partnership - Formal or Informal Public Consultation -----	42
Indicators 20 : Participation and Partnership - Institutional Partnership -----	43
Indicators 22: Education and Awareness - Is Biodiversity or Nature Awareness included in the School Curriculum -----	44
Indicators 23: Education and Awareness - Number of Outreach or Public Awareness Events -----	45
Annexure 1 - References -----	47
Annexure 2 - Species Lists -----	49

Acronyms

ABD	Area Based Development
ABS	Access and Benefit Sharing
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
BMU	Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety
CBI	City Biodiversity Index
CBSE	Central Board of Secondary Education
CDP	City Development Plan
c-hed	Centre for Heritage, Environment and Development
CMFRI	Central Marine Fisheries Research Institute
CNHS	Cochin Natural History Society
CoP	Conference of Parties
CSML	Cochin Smart Mission Limited
CSO	Civil Society Organisation
CUSAT	Cochin University of Science and Technology
EIA	Environmental Impact Assessment
EPIP	Export Promotion Industrial Park
ICLEI South Asia	ICLEI - Local Governments for Sustainability, South Asia
ICSE	Indian Certificate of Secondary Education
IKI	International Klimate Initiative
INTERACT-Bio	Integrated subnational action for biodiversity: Supporting implementation of National Biodiversity Strategy and Action Plans through the mainstreaming of biodiversity objectives across city-regions
IT	Information Technology
ITeS	Information Technology enabled Services
IUCN	International Union for Conservation of Nature
KINFRA	Kerala Industrial Infrastructure Development Corporation
KMC	Kochi Municipal Corporation
KSSP	Kerala Shastra Sahitya Parishad
MULT	Multi-user Liquid Terminal
NbS	Nature based Solutions
NBSAP	National Biodiversity Strategy and Action Plan
NGO	Non Governmental Organisation
PBR	People's Biodiversity Register
PCCF	Principal Chief Conservator of Forests
SBB	State Biodiversity Board
SCBD	Secretariat for the Convention on Biological Diversity
SPV	Special Purpose Vehicle
ULB	Urban Local Body

Background

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)¹, 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 Climate 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.

1. Secretariat of the Convention on Biological Diversity (2014). City Biodiversity Index user's manual on the Singapore Index on Cities' Biodiversity (also known as the City Biodiversity Index). Available from <https://www.cbd.int/subnational/partners-and-initiatives/city-biodiversity-index>. Accessed online on 20 April 2020

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.

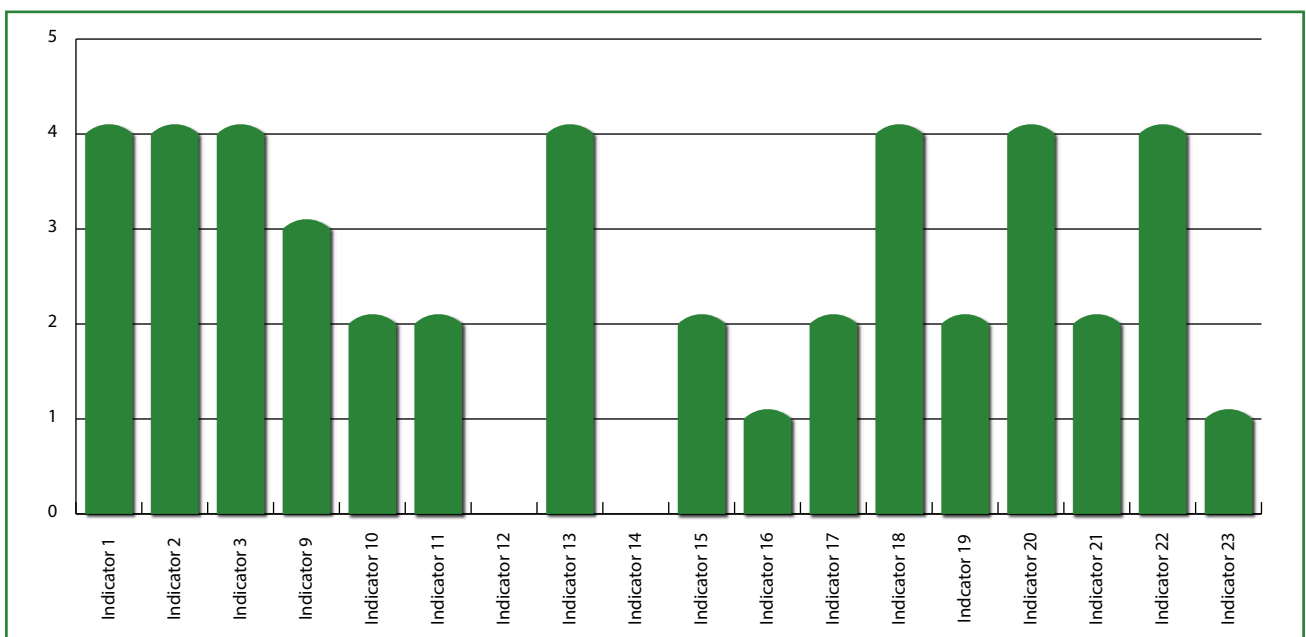


Figure 1: Kochi Municipal Corporation City Biodiversity Index 2020 at a Glance

PART 1 – Kochi City Profile

The city of Kochi ($76^{\circ}14'E$ and $76^{\circ}21'E$ and $9^{\circ}52'N$ and $10^{\circ}1'N$) 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.).

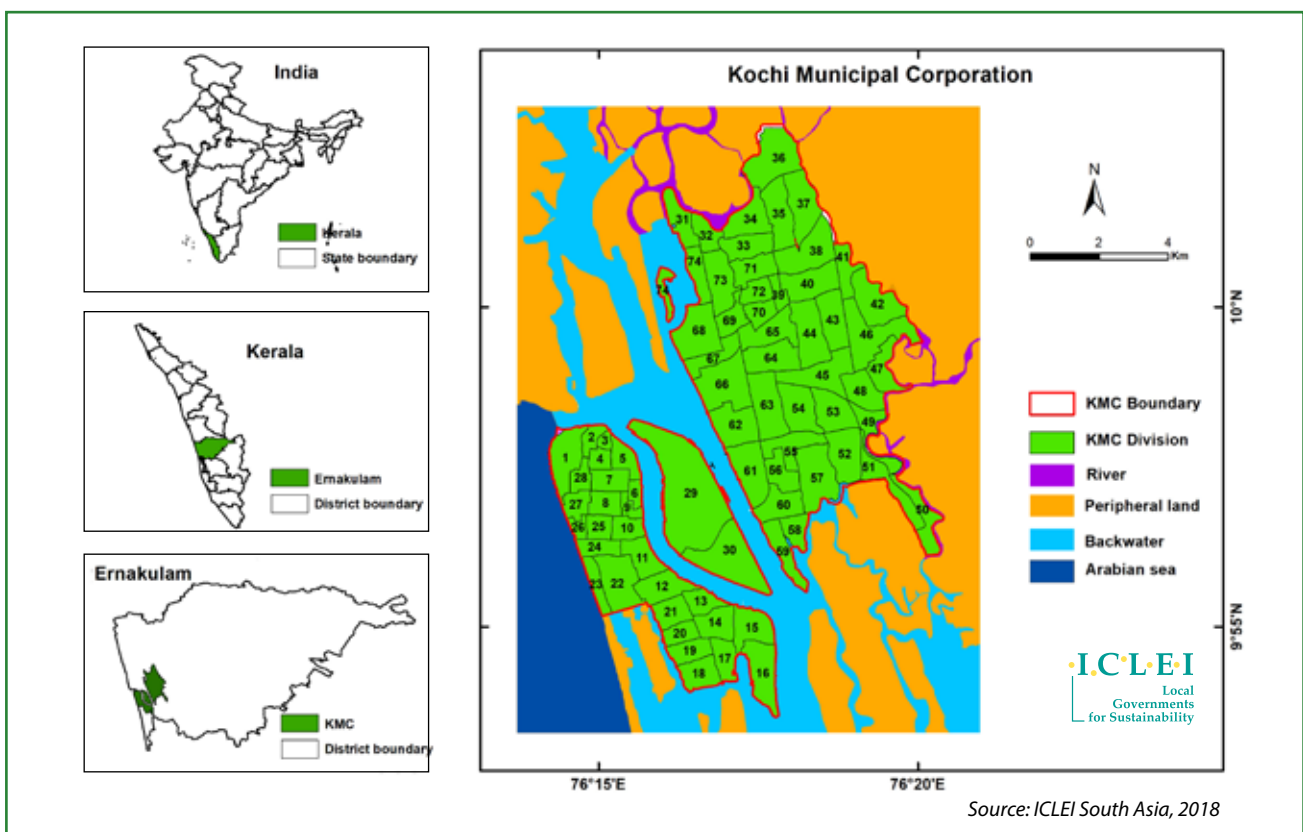


Figure 2: Location Map of Kochi showing the municipal boundaries and the wards of the city

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 Lycaenidae (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 cichlids, 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.



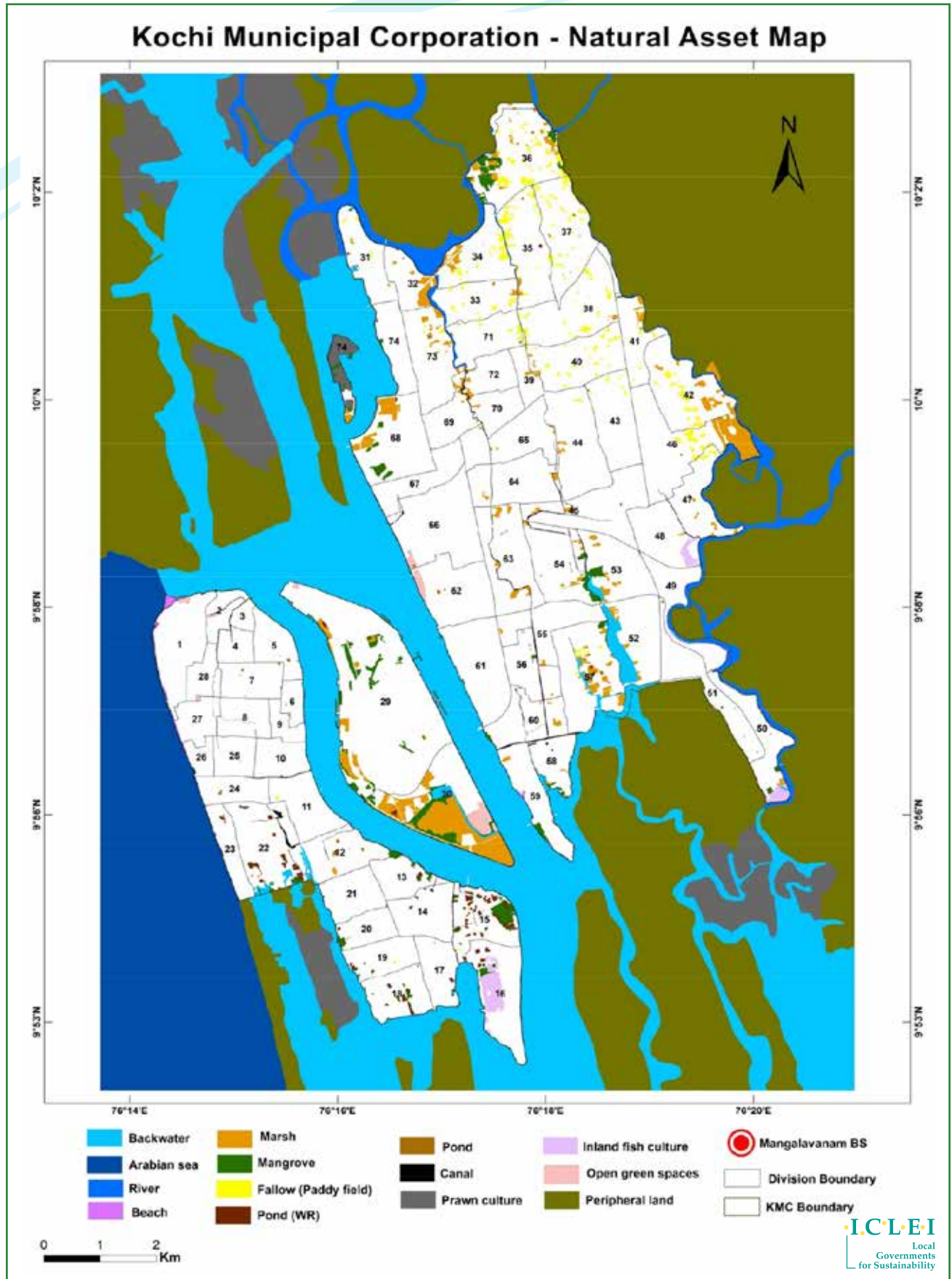


Figure 3: Natural Asset Map showing the main ecosystems of Kochi

Table 1: Area wise distribution of natural assets (inside KMC boundary)

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

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, Vyttila 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>

Table 2: BMC members of Kochi Municipal Corporation

Sl. No	Name	Designation
1	Soumini Jain	Chairperson
2	C. K. Peter	Member
3	K. J. Sohan	Member
4	C. Rajan	Member
5	Jalaja Mani	Member
6	Seena Gokulan	Member
7	V. P. Chandran	Member
8	R. Rahesh Kumar	Secretary

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/>

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/>

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://keralaagriculture.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

$(\text{Total area of natural, restored and naturalised areas}) \div (\text{Total area of city}) \times 100\%$

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

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

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 16.57sq.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,

$$(\text{Total area of natural, restored and naturalised areas}) \div (\text{Total area of city}) \times 100\%$$

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

$$\frac{1}{A_{\text{total}}} * (A_1^2 + A_2^2 + A_3^2 + \dots + A_n^2)$$

Where:

- A_{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

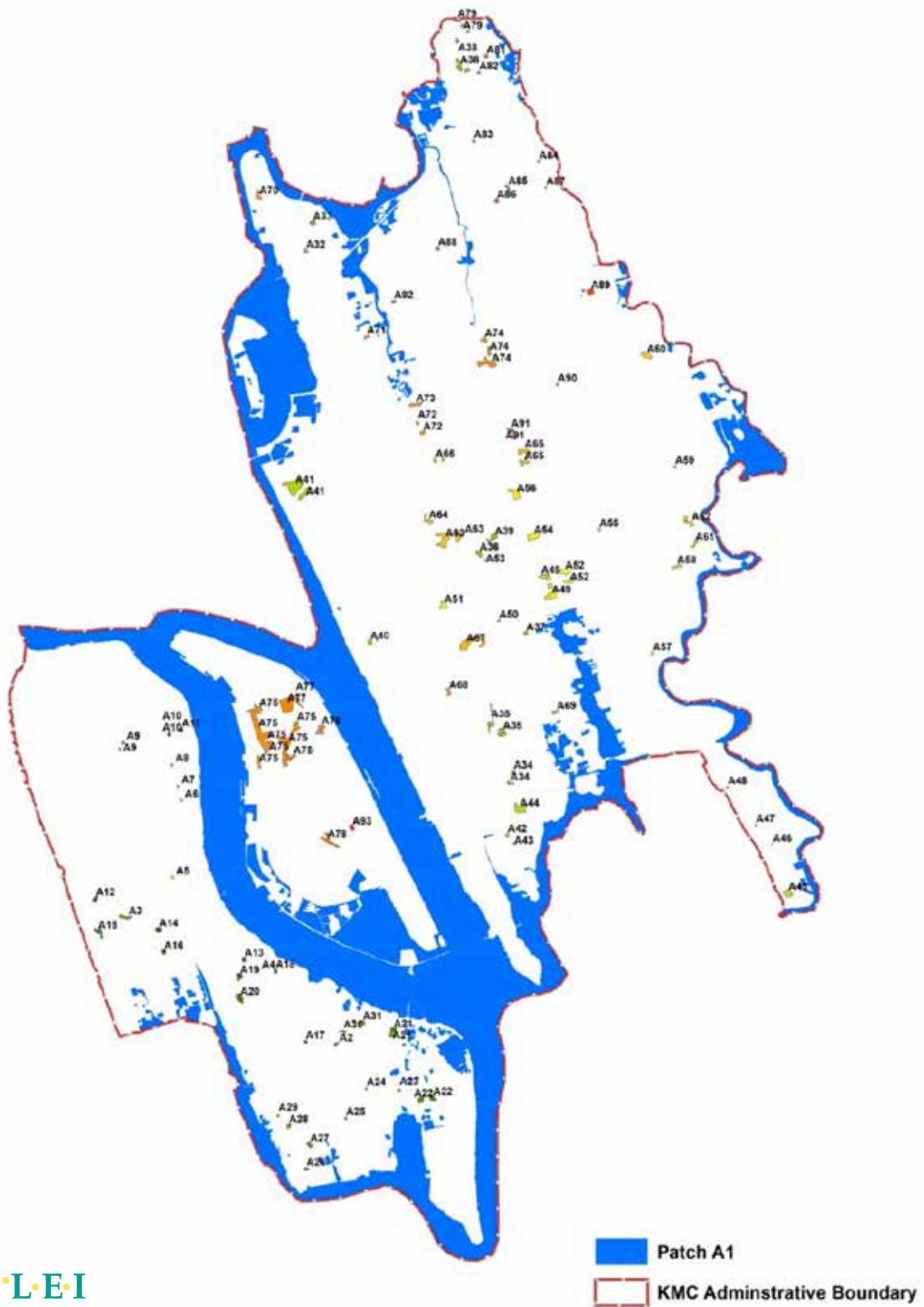
$$\text{Indicator 2} = 1/2216 \text{ ha} \times (4614134.664 \text{ ha}^2) = 2082.003 \text{ ha}$$

RESULT: 2082.003 ha

SCORE: 4



KOCHI CBI : CONNECTIVITY MEASURES

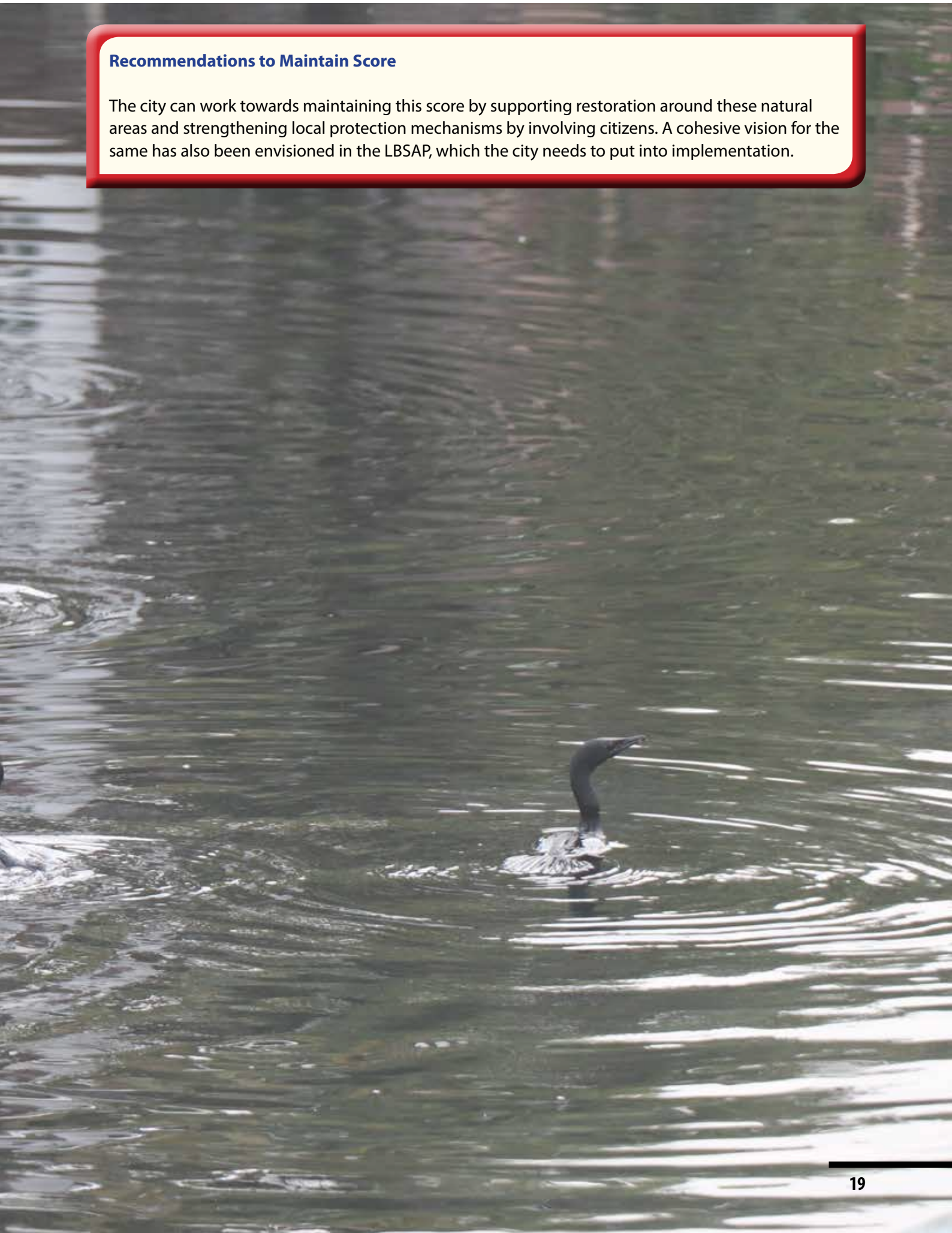


Source: ICLEI South Asia, 2019

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.

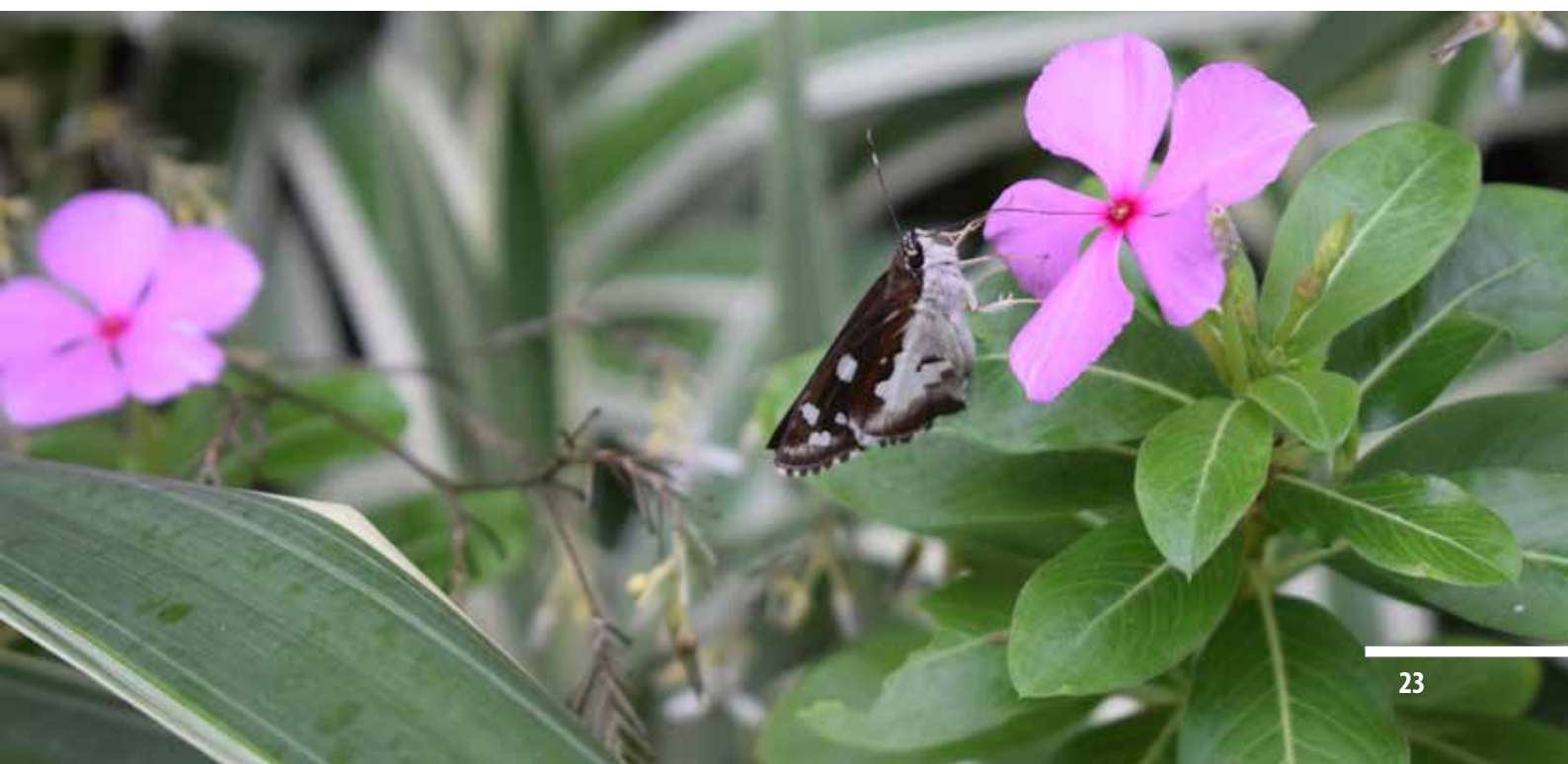
Since this is the baseline year for the species count, the city will not receive a score on the indicators 4-8 and it will be excluded from the overall calculation.

Table 4: Studies on biodiversity for various ecosystems of Kochi

Ecosystem Assessed	Study	Taxa Assessed	Results (species no.)
Mangalavanam	Jayson and Easa, 1999	Flora (Mangroves and Trees), Birds, Fish, Reptiles, Mammals.	Flora: 25 Fish: 7 Reptiles: 4 Birds: 42 Mammals: 5
	SACON, 2004	Flora, Butterflies, Birds, Reptiles, Amphibians, Mammals	Flora: 25 Butterflies: 17 Amphibians: 2 Reptiles: 5 Birds: 62 Mammals: 5
	Sebastian <i>et al.</i> , 2005	Spiders	51
	Azeez and Bhupathy, 2006	Birds	32
	Madhusudhanan and Jayesh, 2011	Flora	23
Thevara	Abin and Samson, 2015	Butterflies, Spiders, Dragonflies and Damselflies, Fish, Amphibians, Birds, Reptiles, Mammals	Butterflies: 44 Spiders: 49 Dragonflies: 10 Damselflies: 5 Fish: 44 Amphibians: 4 Reptiles: 14 Birds: 57 Mammals: 10
	Abin and Samson, 2017	Birds	73
Kochi City Region	Environmental Impact Assessment (EIA) report, 2015 of the Multi-user Liquid Terminal (MULT) project of Cochin Port	Flora, Crustaceans, Molluscs, Fish, Amphibians, Reptiles, Birds, Mammals	Flora: 91 Crustaceans: 12 Molluscs: 2 Fish: 50 Amphibians: 2 Reptiles: 9 Birds: 43 Mammals: 9
Vembanad Lake (entire lake including both North and South Zones)	Asha <i>et al.</i> , 2014	Fin Fish, Crustaceans	Fin Fish: 80 Crustaceans: 10
Subhash Park	ICLEI South Asia, 2019	Trees	66
Fort Kochi and Mattancherry	ICLEI South Asia, unpubl.	Trees	82
Entire Kochi	eBird	Birds	167 (resident and migratory)

Ecosystem Assessed	Study	Taxa Assessed	Results (species no.)
Entire Kochi	BMC, personal communication, 2019	Wild and Domesticated Biodiversity	Crustaceans: 6 Birds: 10 Reptiles: 7 Amphibians: 1 Mollusc: 3 Mammals: 9 Non fish aquatic sp.: 9 Fish: 26 Wild Flora: 45 Crops: 5 tubers, 3 spices, 1 cereal, 4 vegetables, 1 oilseed, 6 fruit species are cultivated. Medicinal Plants: 45 Ornamental Plants: 12 Timber Plants: 13
Entire Kochi region	iNaturalist	Several Taxa	Plants: 345 Fungi: 20 Molluscs: 14 Spiders: 79 Insects: 522 Fish: 9 Reptiles: 17 Birds: 164 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

(Area of protected or secured natural areas) ÷ (Total area of the city) × 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 Vembanad 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 16.57sq.km

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

(Area of protected or secured natural areas) ÷ (Total area of the city) × 100%

Indicator 9= (16.597) ÷ (94.88) × 100% = 17.49% which corresponds to 3 points.

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

Items	Tree	Shrub	Herb	Climber	Total
Species	157	119	149	58	483
Exotic	71	78	73	26	248
Native	86	41	76	32	235
Invasive species	2	7	10	10	29

Thus to calculate Indicator 10, we have,

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

Number of invasive alien species = 29

Number of native species = 235

$$\text{Indicator 10} = (29/235) \times 100 = 12.34\%$$

RESULT: 12.34%

SCORE: 2

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

(Total permeable area) ÷ (Total terrestrial area of the city) × 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 9° 49'N to 10°14'N and 76° 10'E to 76°31'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

Sl. No.	Land Class	Area in ha	Area in sq. km.
1	Beach	13	0.13
2	Canal	34	0.34
3	Coconut cultivation	38	0.38
4	Fallow (Paddy field)	85	0.85
5	Inland fish culture	45	0.45
6	Mangrove	119	1.19
7	Marsh	289	2.89
8	Mixed cultivation	234	2.34
9	Open Green Spaces	34	0.34
10	Open ground	11	0.11
11	Playground	79	0.79
12	Pond	6	0.06
13	Pond (WR)	32	0.32
14	Prawn culture	27	0.27

Sl. No.	Land Class	Area in ha	Area in sq. km.
15	River	122	1.22
16	Sparse vegetation	106	1.06
17	Tree patch	199	1.99
	Total	1,473	14.73

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.

RESULT: 39.97%

SCORE: 2

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)

0 point:	< 10.5%
1 point:	10.5% - 19.1%
2 points:	19.2% - 29.0%
3 points:	29.1% - 59.7%
4 points:	> 59.7%

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

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

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.

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

$(6.655) \div (78.31) \times 100\% = 8.498\%$ which is less than <10% 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

Sl. No.	Name	Ward No
1	Nehru Park	1
2	Mahaboob Park	2
3	Mattanchery Children's Park	5
4	YMCA Children's Park	8
5	P R Mathew Park	21
6	Santham Colony Park	22
7	Nazareth Triangle Park	25
8	Thamarakkulam Park	28
9	Pallath Raman Park	28
10	Priyadarshini Park	29
11	Vathuruthy Park	30
12	Navy Environmental Park	30
13	Edappilly Ragavan Memorial Park	37
14	Changambuzha Park	37
15	Senior Citizen Park	41
16	Kunnara Park	49
17	Kumaranasan Nagar North Park	54
18	Jawahar Nagar North Park	54
19	Girinagar Park	55
20	Panampilli Nagar Park	56
21	LIG Park	56

Sl. No.	Name	Ward No
22	Silver Park	56
23	GCDA Children's Park	56
24	Koithara Children's Park	60
25	Kasthurbha Nagar Park	60
26	Subhash Chandra Bose Park	62
27	Childrens Walkway Park	63
28	Residential Park	63
29	KMC Park	63
30	Girinagar North Park	63
31	Vyloppilli Smaraka Park	65
32	Kochi Refineries Park	66
33	Indira Priyadharshini Children's Park	66
34	Shevan Kartha Park	66

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 9: Land classes used in the calculation of Indicator 13

Land class	Area in ha
Parks/ Open Green Spaces	34
Mangalavanam Bird Sanctuary	2.74
Beach	13
Backwaters	1,657
Total	1,706.74

$(\text{Area of parks with natural areas and protected or secured natural areas})/1000 \text{ persons} = 1706.74/1000$

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.

RESULT: 1.7 ha

SCORE: 4

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%

RESULT: 1.8%

SCORE: 2

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)

- | | |
|-----------|-----------------------------|
| 0 point: | < 12 programmes/projects |
| 1 point: | 12 - 21 programmes/projects |
| 2 points: | 22 - 39 programmes/projects |
| 3 points: | 40 - 71 programmes/projects |
| 4 points: | > 71 programmes/projects |

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.

RESULT: > 12

SCORE: 1

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.



Indicator 17: Policies, Rules and Regulations – Existence of Local Biodiversity Strategy and Action Plan

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/>. 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>).

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 para-statal 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

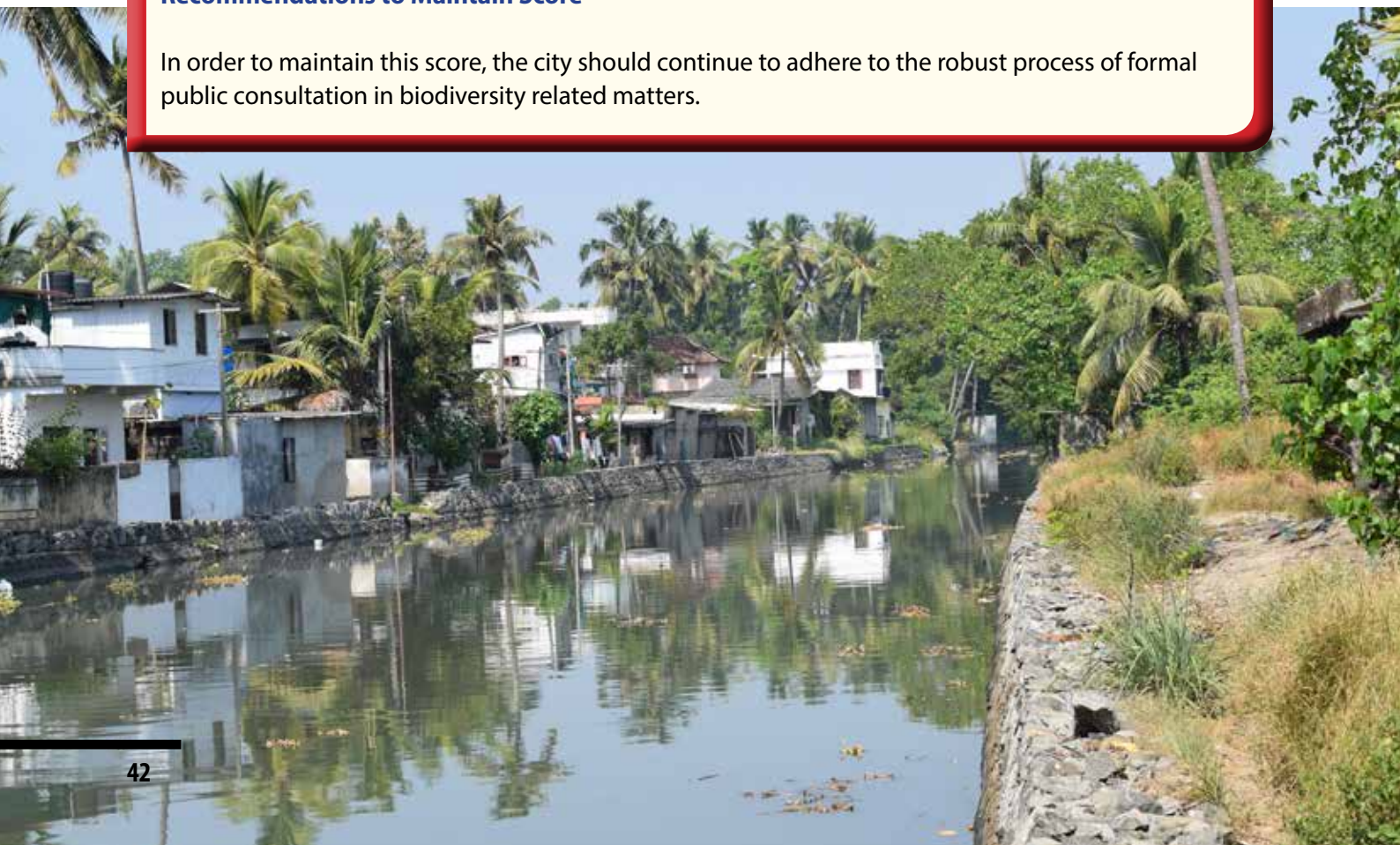
In the matter of public consultation, not just the city, but the entire state of Kerala follows a strict formal process. In fact Kerala was the first state in India to launch a pre-legislative public consultation in 2011. Therefore for this indicator, the highest score of 4 points applies i.e. formal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

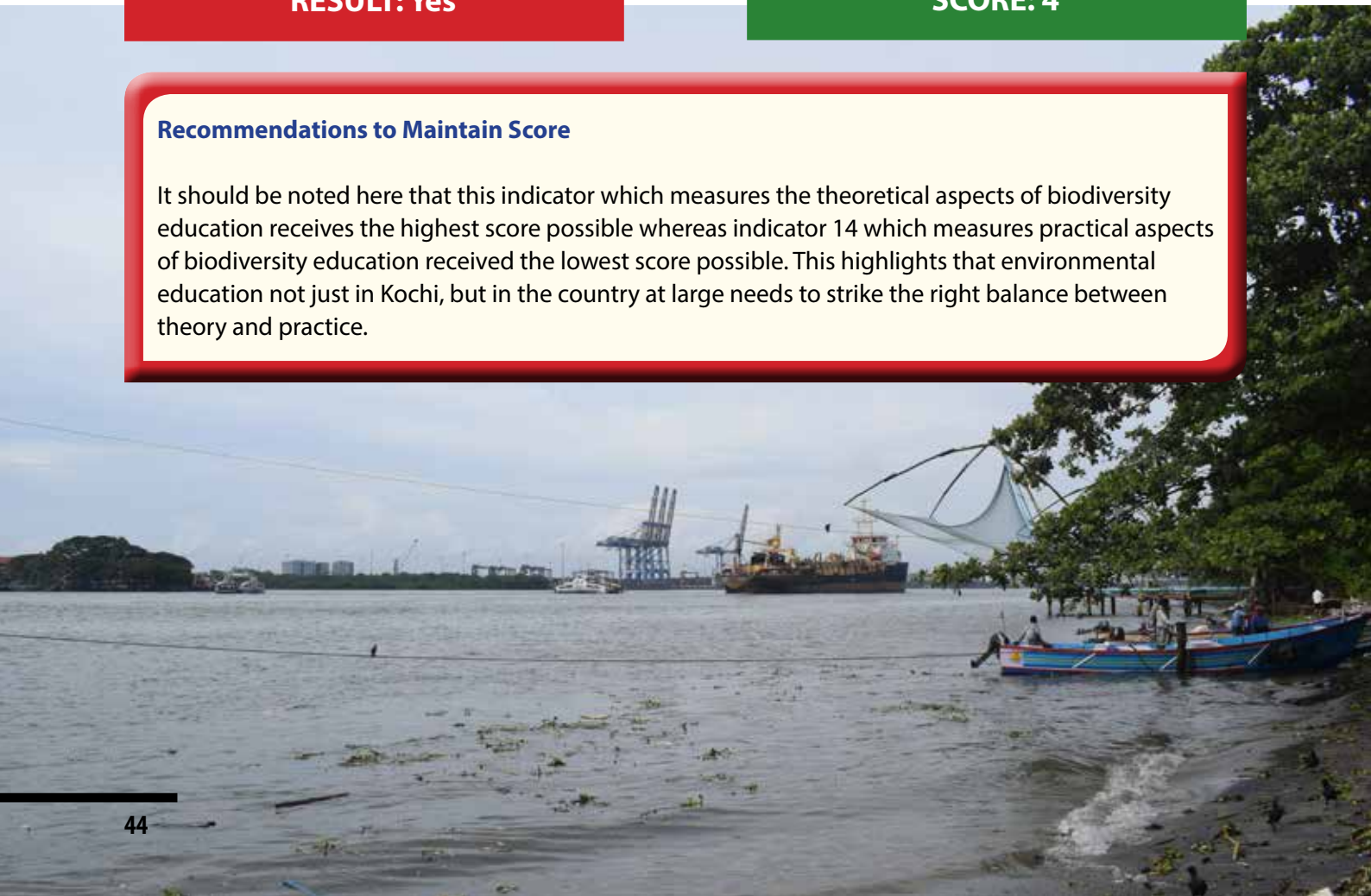
Hence, biodiversity or elements of it are included in the school curriculum bringing the score under this indicator to 4 points.

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 10: Kochi's score indicator-wise for the CBI

Components	Indicators	Maximum Score	Kochi City's score
Native Biodiversity in the City	1. Proportion of Natural Areas in the City	4 points	4 points
	2. Connectivity Measures	4 points	4 points
	3. Native Biodiversity in Built Up Areas (Bird Species)	4 points	4 points
	4. Change in Number of Vascular Plant Species	4 points	N/A as baseline year
	5. Change in Number of Bird Species	4 points	N/A as baseline year
	6. Change in Number of Mammal Species	4 points	N/A as baseline year
	7. Change in Number of Moth Species	4 points	N/A as baseline year
	8. Change in Number of Fish Species	4 points	N/A as baseline year
	9. Proportion of Protected Natural Areas	4 points	3 points
	10. Proportion of Invasive Alien Species	4 points	2 points
Ecosystem Services provided by Biodiversity	11. Regulation of Quantity of Water	4 points	2 points
	12. Climate Regulation: Carbon Storage and Cooling Effect of Vegetation	4 points	0 points
	13. Recreation and Education: Area of Parks with Natural Areas	4 points	4 points
	14. Recreation and Education: Number of Formal Education Visits per Child Below 16 Years to Parks with Natural Areas per Year	4 points	0 points
Governance and Management of Biodiversity	15. Budget Allocated to Biodiversity	4 points	2 points
	16. Number of Biodiversity Projects Implemented by the City Annually	4 points	1 point
	17. Existence of Local Biodiversity Strategy and Action Plan	4 points	2 points
	18. Institutional Capacity: Number of Biodiversity Related Function	4 points	4 points
	19. Institutional Capacity: Number of City or Local Government Agencies Involved in Inter-agency Cooperation Pertaining to Biodiversity Matters	4 points	2 points
	20. Participation and Partnership: Existence of Formal or Informal Public Consultation Process	4 points	4 points
	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	4 points	2 points
	22. Education and Awareness: Is Biodiversity or Nature Awareness Included in the School Curriculum	4 points	4 points
	23. Education and Awareness: Number of Outreach or Public Awareness Events Held in the City per Year	4 points	1 point
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

- Abin, J. and Samson, P. D. (2015). An Inventory of Urban Faunal Diversity–With Reference to Thevara, Kochi, Kerala. *Heartian Journal of Pure and Applied Sciences (HJPAS)*, 11.
- Abin, J. and Samson, P. D. (2017). Bird fauna as an indicator to urban biodiversity in Thevara, Kochi. *Mainstreaming Biodiversity for Sustainable Development*. Pp 281-289. Eds Cheruvat, D., Nilayangode, P., and Oommen, O.V. Kerala State Biodiversity Board Thiruvananthapuram.
- Asha, C.V., Suson, P.S., Cleetus, R., and Sivasankaran, B. N. (2014). Decline in Diversity and Production of Exploited Fishery Resources in Vembanad Wetland System: Strategies for Better Management and Conservation. *Open Journal of Marine Science*. 04. 344-357.
- Azeez, P. A., and Bhupathy, S. (2006). The Mangalavanam bird sanctuary / mangrove area, Ernakulam, Kerala. Report submitted Kerala Forest & Wildlife Department, Thiruvananthapuram.
- SCBD. (2014). User’s manual on the Singapore Index on Cities’ Biodiversity (also known as the city biodiversity index). Secretariat of the Convention on Biological Diversity. Available at: <http://www.cbd.int/en/subnational/partners-and-initiatives/city-biodiversity-index>
- Census of India. (2011). Kochi City Census 2011 data. Accessed online at <http://www.census2011.co.in/census/city/459-kochi.html>
- Chithra S. V. (2016). ‘The Spatio-Temporal Changes in Impervious Surface Coverage and Their Environmental Impacts due to Urbanization in Kochi - A Study Using Remote Sensing and GIS’ A thesis submitted to CUSAT. Kochi.
- Department of Town and Country Planning, (2010). “Development Plan for Kochi City Region 2031”. Government of Kerala.
- eBird. (2019). The Cornell Lab of Ornithology <https://ebird.org/region/IN-KL-ER/hotspots?yr=all&m=>
- iNaturalist. (2020). California Academy of Sciences and the National Geographic Society. Accessed from <https://www.inaturalist.org/> on 8 May 2020
- WAPCOS Limited. (2015). Environmental Impact Assessment Study for Multi – User Liquid Terminal Project (MULT) at Puthuvypeen, Cochin port, Vol :1. Cochin Port Trust.
- Jayson, E. A., and Easa, P. S. (1999). Documentation of vertebrate fauna in Mangalavanam mangrove area. KPRI Research Report 183: 42 pp.
- Government of Kerala. (2006). “City Development Plan Kochi”. Prepared under the Kerala Sustainable Urban Development Project by the Local Self Government Department, Government of Kerala. <http://www.ksudp.org/index.php/city-development-plan-kochi>
- ICLEI SA. (n.d.). City Resilience Strategy: Kochi. Prepared under the Asian Cities Climate Change Resilience Network Grant funded by the Rockefeller Foundation. Retrieved from http://southasia.iclei.org/fileadmin/user_upload/SouthAsia/documents/Kochi_4_pager.pdfICLEI

- ICLEI South Asia. (unpubl.). Trees of Fort Kochi and Mattancherry, Kochi, Kerala. Prepared under INTERACT-Bio, Implemented by ICLEI- South Asia and c-hed.
- ICLEI South Asia. (2018). Trees of Subash Chandra Bose Park, Kochi, Kerala. Prepared under INTERACT-Bio, Implemented by ICLEI South Asia and c-hed.
- Kochi Municipal Corporation. (2016). The Smart City Challenge Stage 2: Smart City Proposal Kochi. New Delhi, India: Ministry of Urban Development, Government of India.
- Krishnan, P., Ramakrishnan, R., Saigal, S., Nagar, S., Faizi, S., Panwar, H.S., Singh, S. and Ved, N. (2012). "Conservation Across Landscapes: India's Approaches to Biodiversity Governance". United Nations Development Programme, New Delhi, India.
- Madhusudhanan, K., and Jayesh, R. (2011). Physico-Chemical and Floristic Studies of Mangalavanam Mangrove Ecosystem in Ernakulam District, Kerala, South India. *Nature, Environment and Pollution Technology*, 10(1), 15-20.
- SACON (2004). Eco-development Plan for the Mangalavanam Mangrove Area, Ernakulam, Kerala.. Report submitted to the Kerala Forest Development.
- Sankar. S., Anil, P. C., Pradeep, K. M., and Mohammed, K. V. (2000). Carrying capacity based development planning for greater Kochi region, KFRI Project report.
- Sankaran, K. V., Suresh, T. A., & Sajeev, T. V. (2013). Handbook on invasive plants of Kerala. Kerala State Biodiversity Board.
- Sebastian, P. A., Murugesan, S., Mathew, M. J., Sudhikumar, A. V., and Sunish, E. (2005). Spiders in Mangalavanam, an ecosensitive mangrove forest in Cochin, Kerala, India (Araneae). *European Arachnology (Suppl. No. 1)*, 315-318.
- Sunil *et al.* (2015). Studies on Flowering Plant Diversity of Ernakulam District, Kerala (in press).
- The World Bank Group. (2009). Doing Business 2009. Comparing Regulation in 181 Economies. A publication of the World Bank and the International Finance Corporation. Washington DC.
- Thomson, K.T., Joy, D and Abraham, S. (2001). Economic and Social Issues of Biodiversity Loss In Cochin Backwaters. School of Industrial Fisheries, Cochin University of Science and Technology, Cochin. Kerala Research, Programme on Local Level Development, Centre for Development Studies, Trivandrum. 178pg.



Annexure 2 - Species Lists

Table 11: List of Birds used to calculate Indicator 3

Sl. No.	Species	Scientific Name	Resident / Migrant	Urban Species
1	Shikra	<i>Accipiter badius</i>	R	Yes
2	Jungle Myna	<i>Acridotheres fuscus</i>	R	No
3	Common Myna	<i>Acridotheres tristis</i>	R	Yes
4	Blyth's Reed Warbler	<i>Acrocephalus dumetorum</i>	M	Yes
5	Clamorous Reed Warbler	<i>Acrocephalus stentoreus</i>	M	Yes
6	Common Sandpiper	<i>Actitis hypoleucos</i>	M	Yes
7	Common Iora	<i>Aegithina tiphia</i>	R	Yes
8	Indian Swiftlet	<i>Aerodramus unicolor</i>	R	Yes
9	Common Kingfisher	<i>Alcedo atthis</i>	R	Yes
10	White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	R	Yes
11	Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>	R	No
12	Garganey	<i>Anas querquedula</i>	M	No
13	Asian Openbill	<i>Anastomus oscitans</i>	R	Yes
14	Oriental Darter	<i>Anhinga melanogaster</i>	R	No
15	Paddyfield Pipit	<i>Anthus rufulus</i>	R	Yes
16	Little Swift	<i>Apus affinis</i>	R	Yes
17	Great Egret	<i>Ardea alba</i>	R	No
18	Gray Heron	<i>Ardea cinerea</i>	R	No
19	Intermediate Egret	<i>Ardea intermedia</i>	R	No
20	Purple Heron	<i>Ardea purpurea</i>	R	No
21	Indian Pond-Heron	<i>Ardeola grayii</i>	R	Yes
22	Ruddy Turnstone	<i>Arenaria interpres</i>	M	No
23	Ashy Woodswallow	<i>Artamus fuscus</i>	R	No
24	Spotted Owlet	<i>Athene brama</i>	R	Yes
25	Cattle Egret	<i>Bubulcus ibis</i>	R	Yes
26	Striated Heron	<i>Butorides striata</i>	R	No
27	Gray-bellied Cuckoo	<i>Cacomantis passerinus</i>	M	Yes
28	Sanderling	<i>Calidris alba</i>	M	No
29	Curlew Sandpiper	<i>Calidris ferruginea</i>	M	No
30	Little Stint	<i>Calidris minuta</i>	M	No
31	Temminck's Stint	<i>Calidris temminckii</i>	M	No
32	Jerdon's Nightjar	<i>Caprimulgus atripennis</i>	R	No
33	Jungle Nightjar	<i>Caprimulgus indicus</i>	R	No
34	Red-rumped Swallow	<i>Cecropis daurica</i>	R	Yes
35	Greater Coucal	<i>Centropus sinensis</i>	R	Yes
36	Pied Kingfisher	<i>Ceryle rudis</i>	R	No
37	Little Ringed Plover	<i>Charadrius dubius</i>	R	No
38	Lesser Sand-Plover	<i>Charadrius mongolus</i>	M	No

Sl. No.	Species	Scientific Name	Resident / Migrant	Urban Species
39	Whiskered Tern	<i>Chlidonias hybrida</i>	M	No
40	Golden-fronted Leafbird	<i>Chloropsis aurifrons</i>	R	No
41	Brown-headed Gull	<i>Chroicocephalus brunnicephalus</i>	M	No
42	Black-headed Gull	<i>Chroicocephalus ridibundus</i>	M	No
43	Greater Flameback	<i>Chrysocolaptes guttacristatus</i>	R	Yes
44	Woolly-necked Stork	<i>Ciconia episcopus</i>	R	Yes
45	Purple Sunbird	<i>Cinnyris asiaticus</i>	R	Yes
46	Long-billed Sunbird	<i>Cinnyris lotenius</i>	R	Yes
47	Eurasian Marsh-Harrier	<i>Circus aeruginosus</i>	M	No
48	Pied Cuckoo	<i>Clamator jacobinus</i>	R	Yes
49	Greater Spotted Eagle	<i>Clanga clanga</i>	M	No
50	Rock Pigeon	<i>Columba livia</i>	R	Yes
51	Oriental Magpie-Robin	<i>Copsychus saularis</i>	R	Yes
52	Indian Roller	<i>Coracias benghalensis</i>	R	No
53	Large-billed Crow	<i>Corvus macrorhynchos</i>	R	Yes
54	House Crow	<i>Corvus splendens</i>	R	Yes
55	Common Cuckoo	<i>Cuculus canorus</i>	M	No
56	Indian Cuckoo	<i>Cuculus micropterus</i>	R	Yes
57	Tickell's Blue Flycatcher	<i>Cyornis tickelliae</i>	R	Yes
58	Asian Palm-Swift	<i>Cypsiurus balasiensis</i>	R	Yes
59	Rufous Treepie	<i>Dendrocitta vagabunda</i>	R	Yes
60	Lesser Whistling-Duck	<i>Dendrocygna javanica</i>	R	No
61	Forest Wagtail	<i>Dendronanthus indicus</i>	M	No
62	Pale-billed Flowerpecker	<i>Dicaeum erythrorhynchos</i>	R	Yes
63	Bronzed Drongo	<i>Dicrurus aeneus</i>	R	Yes
64	Ashy Drongo	<i>Dicrurus leucophaeus</i>	R	Yes
65	Black Drongo	<i>Dicrurus macrocercus</i>	R	Yes
66	Greater Racket-tailed Drongo	<i>Dicrurus paradiseus</i>	R	No
67	Black-rumped Flameback	<i>Dinopium benghalense</i>	R	Yes
68	Little Egret	<i>Egretta garzetta</i>	R	Yes
69	Western Reef-Heron	<i>Egretta gularis</i>	R	No
70	Black-winged Kite	<i>Elanus caeruleus</i>	R	Yes
71	Asian Koel	<i>Eudynamys scolopaceus</i>	R	Yes
72	Peregrine Falcon	<i>Falco peregrinus</i>	M	No
73	Eurasian Coot	<i>Fulica atra</i>	R	No
74	Malabar Lark	<i>Galerida malabarica</i>	R	No
75	Common Snipe	<i>Gallinago gallinago</i>	M	No
76	Pin-tailed Snipe	<i>Gallinago stenura</i>	M	No
77	Eurasian Moorhen	<i>Gallinula chloropus</i>	R	No
78	Gull-billed Tern	<i>Gelochelidon nilotica</i>	M	No
79	Orange-headed Thrush	<i>Geokichla citrina</i>	R	No
80	Small Pratincole	<i>Glareola lactea</i>	R	No
81	Jungle Owlet	<i>Glaucidium radiatum</i>	R	No

Sl. No.	Species	Scientific Name	Resident / Migrant	Urban Species
82	White-throated Kingfisher	<i>Halcyon smyrnensis</i>	R	Yes
83	White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	R	Yes
84	Brahminy Kite	<i>Haliastur indus</i>	R	Yes
85	Booted Eagle	<i>Hieraetus pennatus</i>	M	No
86	Common Hawk-Cuckoo	<i>Hierococyx varius</i>	R	Yes
87	Black-winged Stilt	<i>Himantopus himantopus</i>	R	No
88	Barn Swallow	<i>Hirundo rustica</i>	M	Yes
89	Wire-tailed Swallow	<i>Hirundo smithii</i>	R	Yes
90	Pallas's Gull	<i>Ichthyaeetus ichthyaeetus</i>	M	No
91	Black Bittern	<i>Ixobrychus flavicollis</i>	M	No
92	Yellow Bittern	<i>Ixobrychus sinensis</i>	R	No
93	Brown Shrike	<i>Lanius cristatus</i>	M	Yes
94	Long-tailed Shrike	<i>Lanius schach</i>	R	Yes
95	Lesser Black-backed Gull	<i>Larus fuscus</i>	M	No
96	Purple-rumped Sunbird	<i>Leptocoma zeylonica</i>	R	Yes
97	Tricolored Munia	<i>Lonchura malacca</i>	R	Yes
98	Scaly-breasted Munia	<i>Lonchura punctulata</i>	R	Yes
99	White-rumped Munia	<i>Lonchura striata</i>	R	Yes
100	Vernal Hanging-Parrot	<i>Loriculus vernalis</i>	R	No
101	Coppersmith Barbet	<i>Megalaima haemacephala</i>	R	Yes
102	White-cheeked Barbet	<i>Megalaima viridis</i>	R	Yes
103	Chestnut-headed Bee-eater	<i>Merops leschenaulti</i>	R	Yes
104	Green Bee-eater	<i>Merops orientalis</i>	R	Yes
105	Blue-tailed Bee-eater	<i>Merops philippinus</i>	R	No
106	Bronze-winged Jacana	<i>Metopidius indicus</i>	R	No
107	Little Cormorant	<i>Microcarbo niger</i>	R	Yes
108	Rufous Woodpecker	<i>Micropternus brachyurus</i>	R	No
109	Black Kite	<i>Milvus migrans</i>	R	Yes
110	Jerdon's bushlark	<i>Mirafra affinis</i>	R	Yes
111	White Wagtail	<i>Motacilla alba</i>	M	Yes
112	Gray Wagtail	<i>Motacilla cinerea</i>	M	Yes
113	Western Yellow Wagtail	<i>Motacilla flava</i>	M	Yes
114	White-browed Wagtail	<i>Motacilla maderaspatensis</i>	R	Yes
115	Asian Brown Flycatcher	<i>Muscicapa latirostris</i>	M	Yes
116	Painted Stork	<i>Mycteria leucocephala</i>	R	No
117	Cotton Pygmy-Goose	<i>Nettapus coromandelianus</i>	R	No
118	Whimbrel	<i>Numenius phaeopus</i>	M	No
119	Black-crowned Night-Heron	<i>Nycticorax nycticorax</i>	R	No
120	Wilson's Storm Petrel	<i>Oceanites oceanicus</i>	M	No
121	Bridled Tern	<i>Onychoprion anaethetus</i>	M	No
122	Indian Golden Oriole	<i>Oriolus kundoo</i>	R	Yes
123	Black-hooded Oriole	<i>Oriolus xanthornus</i>	R	No
124	Common Tailorbird	<i>Orthotomus sutorius</i>	R	Yes
125	Indian Scops-Owl	<i>Otus bakkamoena</i>	R	No
126	Osprey	<i>Pandion haliaetus</i>	M	No

Sl. No.	Species	Scientific Name	Resident / Migrant	Urban Species
127	Cinereous Tit	<i>Parus cinereus</i>		
128	House Sparrow	<i>Passer domesticus</i>	R	Yes
129	Rosy Starling	<i>Pastor roseus</i>	M	Yes
130	Indian Peafowl	<i>Pavo cristatus</i>	R	Yes
131	Stork-billed Kingfisher	<i>Pelargopsis capensis</i>	R	No
132	Spot-billed Pelican	<i>Pelecanus philippensis</i>	R	No
133	Small Minivet	<i>Pericrocotus cinnamomeus</i>	R	Yes
134	Chestnut-shouldered Petronia	<i>Petronia xanthocollis</i>	R	Yes
135	Great Cormorant	<i>Phalacrocorax carbo</i>	R	Yes
136	Indian Cormorant	<i>Phalacrocorax fuscicollis</i>	R	Yes
137	Greater Flamingo	<i>Phoenicopterus roseus</i>	M	No
138	Greenish Warbler	<i>Phylloscopus trochiloides</i>	M	Yes
139	Eurasian Spoonbill	<i>Platalea leucorodia</i>	R	No
140	Glossy Ibis	<i>Plegadis falcinellus</i>	R	No
141	Streaked Weaver	<i>Ploceus manyar</i>	R	Yes
142	Baya Weaver	<i>Ploceus philippinus</i>	R	Yes
143	Gray-headed Swamphen	<i>Porphyrio poliocephalus</i>	R	No
144	Ballion's Crake	<i>Porzana pusilla</i>	R	No
145	Gray-breasted Prinia	<i>Prinia hodgsonii</i>	R	No
146	Plain Prinia	<i>Prinia inornata</i>	R	No
147	Ashy Prinia	<i>Prinia socialis</i>	R	Yes
148	Rose-ringed Parakeet	<i>Psittacula krameri</i>	R	Yes
149	Flesh-footed Shearwater	<i>Puffinus carneipes</i>	M	No
150	Red-vented Bulbul	<i>Pycnonotus cafer</i>	R	Yes
151	Red-whiskered Bulbul	<i>Pycnonotus jocosus</i>	R	Yes
152	Pied Bushchat	<i>Saxicola caprata</i>	R	Yes
153	Indian Robin	<i>Saxicoloides fulicatus</i>	R	Yes
154	Spotted Dove	<i>Spilopelia chinensis</i>	R	Yes
155	Crested Serpent-Eagle	<i>Spilornis cheela</i>	R	Yes
156	Parasitic Jaeger	<i>Stercorarius parasiticus</i>	M	No
157	Pomarine Jaeger	<i>Stercorarius pomarinus</i>	M	No
158	River Tern	<i>Sterna aurantia</i>	R	No
159	Common Tern	<i>Sterna hirundo</i>	M	No
160	Little Tern	<i>Sternula albifrons</i>	R	No
161	Mottled Woodowl	<i>Strix ocellata</i>	R	Yes

Sl. No.	Species	Scientific Name	Resident / Migrant	Urban Species
162	Malabar Starling	<i>Sturnia blythii</i>	R	Yes
163	Chestnut-tailed Starling	<i>Sturnia malabarica</i>	R	Yes
164	Brahminy Starling	<i>Sturnia pagodarum</i>	R	Yes
165	Fork-tailed Drongo-Cuckoo	<i>Surniculus dicruroides</i>	M	No
166	Little Grebe	<i>Tachybaptus ruficollis</i>	R	No
167	Alpine Swift	<i>Tachymarptis melba</i>	R	Yes
168	Indian Paradise-Flycatcher	<i>Terpsiphone paradisi</i>	M	No
169	Lesser Crested Tern	<i>Thalasseus bengalensis</i>	M	No
170	Lesser-crested Tern	<i>Thalasseus bengalensis</i>	M	No
171	Great Crested Tern	<i>Thalasseus bergii</i>	M	No
172	Sandwich Tern	<i>Thalasseus sandvicensis</i>	M	No
173	Black-headed Ibis	<i>Threskiornis melanocephalus</i>	R	No
174	Wood Sandpiper	<i>Tringa glareola</i>	M	No
175	Common Greenshank	<i>Tringa nebularia</i>	M	No
176	Green Sandpiper	<i>Tringa ochropus</i>	M	Yes
177	Common Redshank	<i>Tringa totanus</i>	M	No
178	Yellow-billed babbler	<i>Turdoides affinis</i>	R	Yes
179	Jungle Babbler	<i>Turdoides striata</i>	R	Yes
180	Barn Owl	<i>Tyto alba</i>	R	Yes
181	Red-wattled Lapwing	<i>Vanellus indicus</i>	R	Yes
182	Yellow-wattled Lapwing	<i>Vanellus malabaricus</i>	R	No
183	Terek Sandpiper	<i>Xenus cinereus</i>	M	No



Table 12: Flora of Kochi (extracted from Sunil *et al.* (2015))

Sl. No.	Scientific Name	Habit	Exotic / Native
1	<i>Abelmoschus esculentus</i>	Herb	Native
2	<i>Abelmoschus rugosus</i>	Herb	Exotic
3	<i>Abroma augusta</i>	Shrub	Exotic
4	<i>Abrus precatorius</i>	Climber	Native
5	<i>Acacia nilotica</i>	Tree	Exotic
6	<i>Acalypha amentacea</i>	Shrub	Exotic
7	<i>Acalypha hispida</i>	Shrub	Exotic
8	<i>Acalypha paniculata</i>	Herb	Native
9	<i>Acampe praemorsa</i>	Herb	Native
10	<i>Acanthus ilicifolius</i>	Shrub	Native
11	<i>Achyranthes aspera</i>	Herb	Native
12	<i>Acmella sp.</i>	Herb	Native
13	<i>Acorus calamus</i>	Herb	Exotic
14	<i>Adenanthera pavonina</i>	Tree	Native
15	<i>Adenium obesum</i>	Shrub	Exotic
16	<i>Adenocalymma alliaceum</i>	Climber	Exotic
17	<i>Aegiceras corniculatum</i>	Shrub	Native
18	<i>Aegle marmelos</i>	Tree	Native
19	<i>Aerva lanata</i>	Herb	Native
20	<i>Aeschynomene aspera</i>	Shrub	Native
21	<i>Agave salmiana</i>	Shrub	Exotic
22	<i>Agave vivipara</i>	Shrub	Exotic
23	<i>Ageratum conyzoides</i>	Herb	Exotic
24	<i>Ailanthus excelsa</i>	Tree	Native
25	<i>Ailanthus triphysa</i>	Tree	Native
26	<i>Albizia chinensis</i>	Tree	Native
27	<i>Albizia saman</i>	Tree	Exotic
28	<i>Allamanda blanchetii</i>	Climber	Exotic
29	<i>Allamanda cathartica</i>	Climber	Exotic
30	<i>Alocasia macrorrhiza</i>	Herb	Exotic
31	<i>Aloe vera</i>	Herb	Exotic
32	<i>Alpinia purpurata</i>	Herb	Exotic
33	<i>Alstonia scholaris</i>	Tree	Native
34	<i>Alternanthera bettzickiana</i>	Herb	Exotic
35	<i>Alternanthera brasiliana</i>	Herb	Exotic
36	<i>Alternanthera philoxeroides</i>	Herb	Exotic
37	<i>Alternanthera sessilis</i>	Herb	Native
38	<i>Alysicarpus vaginalis</i>	Herb	Native
39	<i>Amaranthus hybridus</i>	Herb	Native
40	<i>Amaranthus spinosus</i>	Herb	Exotic
41	<i>Amaranthus tricolor</i>	Herb	Native
42	<i>Amaranthus viridis</i>	Herb	Native
43	<i>Amorphophallus paeoniifolius</i>	Herb	Native
44	<i>Ananas comosus</i>	Herb	Exotic
45	<i>Angelonia salicariaefolia</i>	Herb	Exotic



Sl. No.	Scientific Name	Habit	Exotic / Native
46	<i>Aniseia martinicensis</i>	Climber	Native
47	<i>Anisochilus carnosus</i>	Herb	Native
48	<i>Anisomeles indica</i>	Herb	Native
49	<i>Annona reticulata</i>	Tree	Exotic
50	<i>Annona squamosa</i>	Tree	Exotic
51	<i>Anthurium andraeanum</i>	Herb	Native
52	<i>Antigonon leptopus</i>	Climber	Exotic
53	<i>Apocopsis mangalorensis</i>	Herb	Native
54	<i>Aponogeton natans</i>	Herb	Native
55	<i>Araucaria heterophylla</i>	Tree	Exotic
56	<i>Areca catechu</i>	Tree	Native
57	<i>Areca triandra</i>	Tree	Exotic
58	<i>Arenga wightii</i>	Tree	Native
59	<i>Argyreia nervosa</i>	Climber	Native
60	<i>Artanema longifolium</i>	Herb	Native
61	<i>Artocarpus hetrophylla</i>	Tree	Native
62	<i>Artocarpus hirsutus</i>	Tree	Native
63	<i>Artocarpus incisus</i>	Tree	Exotic
64	<i>Asparagus racemosus</i>	Climber	Native
65	<i>Asparagus setaceus</i>	Climber	Exotic
66	<i>Asystasia dalzelliana</i>	Herb	Native
67	<i>Averrhoa bilimbi</i>	Tree	Exotic
68	<i>Averrhoa carambola</i>	Tree	Exotic
69	<i>Avicennia marina</i>	Tree	Native
70	<i>Avicennia officinalis</i>	Tree	Native
71	<i>Azadirachta indica</i>	Tree	Native
72	<i>Bacopa monnieri</i>	Herb	Native
73	<i>Bambusa bambos</i>	Shrub	Native
74	<i>Bambusa tuldoides</i>	Shrub	Exotic
75	<i>Bambusa vulgaris</i>	Shrub	Exotic
76	<i>Barringtonia racemosa</i>	Tree	Native
77	<i>Bauhinia acuminata</i>	Shrub	Exotic
78	<i>Bauhinia racemosa</i>	Tree	Native
79	<i>Bauhinia variegata</i>	Tree	Exotic
80	<i>Benincasa hispida</i>	Climber	Exotic
81	<i>Bidens sulphurea</i>	Herb	Exotic
82	<i>Biophytum reinwardtii</i>	Herb	Native
83	<i>Biophytum sensitivum</i>	Herb	Native
84	<i>Bixa orellana</i>	Shrub	Exotic
85	<i>Blumea axillaris</i>	Herb	Native
86	<i>Blumea laevis</i>	Herb	Native
87	<i>Blyxa octandra</i>	Herb	Native
88	<i>Boerhavia diffusa</i>	Herb	Native
89	<i>Borassus flabellifer</i>	Tree	Exotic
90	<i>Bougainvillea glabra</i>	Shrub	Exotic

Sl. No.	Scientific Name	Habit	Exotic / Native
91	<i>Brachiaria reptans</i>	Herb	Native
92	<i>Briedelia retusa</i>	Tree	Native
93	<i>Briedelia stipularis</i>	Shrub	Exotic
94	<i>Brugmansia suaveolens</i>	Shrub	Exotic
95	<i>Bruguiera cylindrica</i>	Tree	Native
96	<i>Bruguiera gymnorrhiza</i>	Tree	Native
97	<i>Brunfelsia americana</i>	Shrub	Exotic
98	<i>Bryophyllum pinnatum</i>	Herb	Exotic
99	<i>Butea monosperma</i>	Tree	Native
100	<i>Cabomba caroliniana</i>	Herb	Exotic
101	<i>Caesalpinia coriaria</i>	Tree	Exotic
102	<i>Caesalpinia mimosoides</i>	Climber	Native
103	<i>Caesalpinia pulcherrima</i>	Shrub	Exotic
104	<i>Caesalpinia sappan</i>	Tree	Native
105	<i>Caladium bicolor</i>	Herb	Exotic
106	<i>Calliandra emarginata</i>	Shrub	Exotic
107	<i>Calophyllum inophyllum</i>	Tree	Native
108	<i>Calotropis gigantea</i>	Shrub	Native
109	<i>Calycopteris floribunda</i>	Climber	Native
110	<i>Cananga odorata</i>	Tree	Exotic
111	<i>Canna indica</i>	Herb	Exotic
112	<i>Capsicum annuum</i>	Shrub	Exotic
113	<i>Capsicum chinense</i>	Herb	Exotic
114	<i>Capsicum frutescens</i>	Herb	Exotic
115	<i>Cardiospermum halicacabum</i>	Climber	Native
116	<i>Carica papaya</i>	Shrub	Exotic
117	<i>Carissa carandas</i>	Shrub	Native
118	<i>Caryota urens</i>	Tree	Native
119	<i>Cassia fistula</i>	Tree	Native
120	<i>Cassia roxburghii</i>	Tree	Exotic
121	<i>Cassytha filiformis</i>	Climber	Native
122	<i>Casuarina equisetifolia</i>	Tree	Exotic
123	<i>Catharanthus roseus</i>	Herb	Exotic
124	<i>Cayratia trifolia</i>	Climber	Native
125	<i>Ceiba pentandra</i>	Tree	Exotic
126	<i>Celosia argentea</i>	Herb	Exotic
127	<i>Centella asiatica</i>	Herb	Native
128	<i>Centipeda minima</i>	Herb	Native
129	<i>Centrosema molle</i>	Climber	Exotic
130	<i>Cerbera odollam</i>	Tree	Native
131	<i>Cereus pterogonus</i>	Shrub	Exotic
132	<i>Chamaecrista mimosoides</i>	Herb	Native
133	<i>Chassalia curviflora</i>	Shrub	Native
134	<i>Chromolaena odorata</i>	Shrub	Exotic
135	<i>Chrysothemis pulchella</i>	Herb	Exotic

Sl. No.	Scientific Name	Habit	Exotic / Native
136	<i>Cinnamomum verum</i>	Tree	Native
137	<i>Cissus quadrangularis</i>	Climber	Native
138	<i>Citharexylum spinosum</i>	Tree	Exotic
139	<i>Citrus aurantifolia</i>	Shrub	Exotic
140	<i>Citrus maxima</i>	Tree	Exotic
141	<i>Citrus pennivesiculata</i>	Tree	Native
142	<i>Clematis recta</i>	Climber	Exotic
143	<i>Cleome viscosa</i>	Herb	Native
144	<i>Clerodendrum incisum</i>	Shrub	Exotic
145	<i>Clerodendrum inerme</i>	Shrub	Native
146	<i>Clerodendrum infortunatum</i>	Shrub	Native
147	<i>Clerodendrum paniculatum</i>	Shrub	Exotic
148	<i>Clerodendrum thomsonae</i>	Climber	Exotic
149	<i>Clitoria ternatea</i>	Climber	Exotic
150	<i>Coccinia grandis</i>	Climber	Native
151	<i>Cocos nucifera</i>	Tree	Native
152	<i>Codiaeum variegatum</i>	Shrub	Exotic
153	<i>Colocasia esculenta</i>	Herb	Native
154	<i>Cordia obliqua</i>	Tree	Native
155	<i>Cordia sebastiana</i>	Tree	Exotic
156	<i>Cordyline fruticosa</i>	Shrub	Exotic
157	<i>Coreopsis grandiflora</i>	Herb	Exotic
158	<i>Cosmostigma racemosum</i>	Climber	Native
159	<i>Couroupita guianensis</i>	Tree	Exotic
160	<i>Crassocephalum crepidioides</i>	Herb	Exotic
161	<i>Crescentia cujete</i>	Tree	Exotic
162	<i>Crossandra infundibuliformis</i>	Shrub	Native
163	<i>Crotalaria pallida</i>	Shrub	Native
164	<i>Crotalaria retusa</i>	Herb	Native
165	<i>Cucumis melo</i>	Climber	Native
166	<i>Cucurbita maxima</i>	Climber	Exotic
167	<i>Cuphea hyssopifolia</i>	Shrub	Exotic
168	<i>Curcuma aromatica</i>	Herb	Native
169	<i>Curcuma longa</i>	Herb	Native
170	<i>Cuscuta chinensis</i>	Climber	Native
171	<i>Cycas revoluta</i>	Shrub	Native
172	<i>Cyclea peltata</i>	Climber	Native
173	<i>Cynodon dactylon</i>	Herb	Native
174	<i>Cyperus rotundus</i>	Herb	Native
175	<i>Cyperus sp.</i>	Herb	Native
176	<i>Cyrtostachys renda</i>	Tree	Exotic
177	<i>Dactyloctenium sp.</i>	Herb	Exotic
178	<i>Dahlia hortensis</i>	Herb	Exotic
179	<i>Dalbergia latifolia</i>	Tree	Native
180	<i>Dalbergia sissoo</i>	Tree	Exotic

Sl. No.	Scientific Name	Habit	Exotic / Native
181	<i>Delonix regia</i>	Tree	Exotic
182	<i>Derris scandens</i>	Climber	Native
183	<i>Derris trifoliata</i>	Climber	Native
184	<i>Dianthus chinensis</i>	Herb	Exotic
185	<i>Dieffenbachia seguine</i>	Herb	Exotic
186	<i>Dioscorea alata</i>	Climber	Native
187	<i>Diospyros buxifoli</i>	Tree	Native
188	<i>Diospyros peregrina</i>	Tree	Native
189	<i>Dolichandrone spathacea</i>	Tree	Native
190	<i>Dracaena reflexa</i>	Shrub	Exotic
191	<i>Duranta erecta</i>	Shrub	Exotic
192	<i>Dyopsis lutescens</i>	Tree	Exotic
193	<i>Eclipta prostrata</i>	Herb	Native
194	<i>Eichhornia crassipes</i>	Herb	Exotic
195	<i>Elaeis guineensis</i>	Tree	Exotic
196	<i>Elaeocarpus sphaericus</i>	Tree	Exotic
197	<i>Emilia sonchifolia</i>	Herb	Native
198	<i>Epiphyllum oxypetalum</i>	Shrub	Exotic
199	<i>Epipremnum pinnatum</i>	Climber	Exotic
200	<i>Eragrostis tenella</i>	Herb	Native
201	<i>Erythrina stricta</i>	Tree	Native
202	<i>Erythrina variegata</i>	Tree	Native
203	<i>Eucalyptus globulus</i>	Tree	Exotic
204	<i>Euphorbia cotinifolia</i>	Shrub	Exotic
205	<i>Euphorbia heterophylla</i>	Herb	Exotic
206	<i>Euphorbia hirta</i>	Herb	Exotic
207	<i>Euphorbia milii</i>	Shrub	Exotic
208	<i>Euphorbia pulcherrima</i>	Shrub	Exotic
209	<i>Euphorbia thymifolia</i>	Herb	Native
210	<i>Euphorbia tirucalli</i>	Shrub	Exotic
211	<i>Excoecaria agallocha</i>	Tree	Native
212	<i>Ficus auriculata</i>	Tree	Exotic
213	<i>Ficus benghalensis</i>	Tree	Native
214	<i>Ficus benjamina</i>	Tree	Exotic
215	<i>Ficus exasperata</i>	Tree	Native
216	<i>Ficus hispida</i>	Tree	Native
217	<i>Ficus microcarpa</i>	Tree	Native
218	<i>Ficus racemosa</i>	Tree	Native
219	<i>Ficus religiosa</i>	Tree	Exotic
220	<i>Ficus tinctoria</i>	Tree	Native
221	<i>Ficus tsihela</i>	Tree	Native
222	<i>Fioria vitifolia</i>	Shrub	Native
223	<i>Flacourtia jangomas</i>	Tree	Exotic
224	<i>Gaillardia pulchella</i>	Herb	Exotic
225	<i>Garcinia gummi-gutta</i>	Tree	Native

Sl. No.	Scientific Name	Habit	Exotic / Native
226	<i>Garcinia mangostana</i>	Tree	Exotic
227	<i>Gardenia jasminoides</i>	Shrub	Exotic
228	<i>Gerbera jamesoni</i>	Herb	Exotic
229	<i>Gigantochloa atraviolacea</i>	Tree	Native
230	<i>Gliricidia sepium</i>	Tree	Exotic
231	<i>Gloriosa superba</i>	Climber	Native
232	<i>Glycosmis pentaphylla</i>	Shrub	Native
233	<i>Gmelina arborea</i>	Tree	Native
234	<i>Gomphrena celosioides</i>	Herb	Exotic
235	<i>Gomphrena globosa</i>	Herb	Exotic
236	<i>Grangea maderaspatana</i>	Herb	Native
237	<i>Grevillea robusta</i>	Tree	Exotic
238	<i>Hamelia patens</i>	Tree	Exotic
239	<i>Hedychium coronarium</i>	Herb	Native
240	<i>Heliconia bihai</i>	Herb	Exotic
241	<i>Heliconia psittacorum</i>	Herb	Exotic
242	<i>Heliconia rostrata</i>	Shrub	Exotic
243	<i>Helicteres isora</i>	Shrub	Native
244	<i>Heliotropium indicum</i>	Herb	Native
245	<i>Heteropogon contortus</i>	Herb	Native
246	<i>Hibiscus hispidissimus</i>	Shrub	Native
247	<i>Hibiscus mutabilis</i>	Shrub	Exotic
248	<i>Hibiscus rosa-sinensis</i>	Herb	Native
249	<i>Hibiscus surattensis</i>	Shrub	Native
250	<i>Holarrhena pubescens</i>	Tree	Native
251	<i>Holigarna arnottiana</i>	Tree	Native
252	<i>Hydnocarpus pentandra</i>	Tree	Native
253	<i>Hygrophila schulli</i>	Herb	Native
254	<i>Hymenocallis littoralis</i>	Herb	Exotic
255	<i>Impatiens diversifolia</i>	Herb	Native
256	<i>Impatiens walleriana</i>	Herb	Exotic
257	<i>Indigofera longiracemosa</i>	Shrub	Native
258	<i>Ipomoea aquatica</i>	Herb	Native
259	<i>Ipomoea batatas</i>	Climber	Exotic
260	<i>Ipomoea cairica</i>	Climber	Exotic
261	<i>Ipomoea carnea</i>	Shrub	Exotic
262	<i>Ipomoea mauritiana</i>	Climber	Exotic
263	<i>Ipomoea pes-caprae</i>	Herb	Native
264	<i>Ixora coccinea</i>	Shrub	Native
265	<i>Ixora javanica</i>	Shrub	Exotic
266	<i>Jasminum grandiflorum</i>	Climber	Exotic
267	<i>Jasminum multiflorum</i>	Climber	Native
268	<i>Jasminum sambac</i>	Climber	Native
269	<i>Jatropha curcas</i>	Shrub	Exotic
270	<i>Jatropha integerrima</i>	Shrub	Exotic

Sl. No.	Scientific Name	Habit	Exotic / Native
271	<i>Justicia adhatoda</i>	Shrub	Native
272	<i>Justicia carnea</i>	Herb	Exotic
273	<i>Justicia gendarussa</i>	Shrub	Exotic
274	<i>Kalanchoe blossfeldiana</i>	Herb	Exotic
275	<i>Kandelia candel</i>	Tree	Native
276	<i>Kleinhovia hospita</i>	Tree	Native
277	<i>Kyllinga bulbosa</i>	Herb	Native
278	<i>Kyllinga nemoralis</i>	Herb	Native
279	<i>Kyllinga polyphylla</i>	Herb	Exotic
280	<i>Lablab purpureus</i>	Climber	Native
281	<i>Lagenaria siceraria</i>	Climber	Native
282	<i>Lagerstroemia speciosa</i>	Tree	Native
283	<i>Lannea coromandelica</i>	Tree	Native
284	<i>Lantana camara</i>	Shrub	Exotic
285	<i>Lantana montevidensis</i>	Shrub	Exotic
286	<i>Laportea interrupta</i>	Herb	Native
287	<i>Lawsonia inermis</i>	Shrub	Exotic
288	<i>Leea indica</i>	Shrub	Native
289	<i>Leucas aspera</i>	Herb	Native
290	<i>Licuala grandis</i>	Shrub	Exotic
291	<i>Litchi chinensis</i>	Tree	Exotic
292	<i>Livistona chinensis</i>	Tree	Exotic
293	<i>Lobelia alsinoides</i>	Herb	Native
294	<i>Ludwigia hyssopifolia</i>	Herb	Native
295	<i>Luffa cylindrica</i>	Climber	Native
296	<i>Lycopersicon esculentum</i>	Herb	Exotic
297	<i>Macaranga peltata</i>	Tree	Native
298	<i>Madhuca neriifolia</i>	Tree	Native
299	<i>Magnolia champaca</i>	Tree	Native
300	<i>Magnolia nilagirica</i>	Tree	Native
301	<i>Malvaviscus penduliflorus</i>	Shrub	Exotic
302	<i>Mangifera indica</i>	Tree	Native
303	<i>Manihot esculenta</i>	Shrub	Exotic
304	<i>Manilkara zapota</i>	Tree	Exotic
305	<i>Maranta arundinacea</i>	Herb	Native
306	<i>Melampodium paludosum</i>	Herb	Exotic
307	<i>Melastoma malabathricum</i>	Shrub	Native
308	<i>Melia azedarach</i>	Tree	Exotic
309	<i>Melicope denhamii</i>	Shrub	Exotic
310	<i>Mentha arvensis</i>	Herb	Exotic
311	<i>Merremia dissecta</i>	Climber	Exotic
312	<i>Merremia vitifolia</i>	Climber	Exotic
313	<i>Mikania micrantha</i>	Climber	Exotic
314	<i>Millingtonia hortensis</i>	Tree	Exotic
315	<i>Mimosa diplotricha</i>	Climber	Exotic

Sl. No.	Scientific Name	Habit	Exotic / Native
316	<i>Mimosa pudica</i>	Herb	Exotic
317	<i>Mimusops elengi</i>	Tree	Native
318	<i>Mirabilis jalapa</i>	Herb	Exotic
319	<i>Momordica charantia</i>	Climber	Native
320	<i>Monochoria vaginalis</i>	Herb	Native
321	<i>Morinda citrifolia</i>	Tree	Native
322	<i>Moringa pterygosperma</i>	Tree	Native
323	<i>Morus alba</i>	Shrub	Exotic
324	<i>Mucuna pruriens</i>	Climber	Exotic
325	<i>Muntingia calabura</i>	Tree	Exotic
326	<i>Murraya koenigii</i>	Tree	Native
327	<i>Musa paradisiaca</i>	Herb	Native
328	<i>Mussaenda erythrophylla</i>	Shrub	Exotic
329	<i>Mussaenda frondosa</i>	Shrub	Native
330	<i>Mussaenda philippica</i>	Shrub	Exotic
331	<i>Myriophyllum aquaticum</i>	Herb	Exotic
332	<i>Myristica fragrans</i>	Tree	Exotic
333	<i>Nelumbo nucifera</i>	Herb	Native
334	<i>Neolamarckia cadamba</i>	Tree	Native
335	<i>Nephelium lappaceum</i>	Tree	Exotic
336	<i>Nerium oleander</i>	Shrub	Exotic
337	<i>Nopalea cochenillifera</i>	Shrub	Exotic
338	<i>Nyctanthes arbor-tristis</i>	Shrub	Exotic
339	<i>Nymphaea caerulea</i>	Herb	Exotic
340	<i>Nymphaea pubescens</i>	Herb	Native
341	<i>Ochna integerrima</i>	Shrub	Exotic
342	<i>Ocimum americanum</i>	Herb	Exotic
343	<i>Ocimum gratissimum</i>	Shrub	Native
344	<i>Ocimum tenuiflorum</i>	Shrub	Native
345	<i>Oroxylum indicum</i>	Tree	Native
346	<i>Oryza sativa</i>	Herb	Native
347	<i>Pachystachys lutea</i>	Shrub	Exotic
348	<i>Pandanus odorifer</i>	Shrub	Native
349	<i>Passiflora edulis</i>	Climber	Exotic
350	<i>Passiflora foetida</i>	Climber	Exotic
351	<i>Pedilanthus tithymaloides</i>	Shrub	Exotic
352	<i>Peltophorum pterocarpum</i>	Tree	Exotic
353	<i>Pennisetum pedicellatum</i>	Herb	Native
354	<i>Pennisetum polystachyon</i>	Herb	Exotic
355	<i>Pentas lanceolata</i>	Shrub	Native
356	<i>Peperomia pellucida</i>	Herb	Exotic
357	<i>Persicaria glabra</i>	Herb	Native
358	<i>Petunia x hybrida</i>	Herb	Exotic
359	<i>Phyllanthus acidus</i>	Tree	Exotic
360	<i>Phyllanthus amarus</i>	Herb	Native

Sl. No.	Scientific Name	Habit	Exotic / Native
361	<i>Phyllanthus emblica</i>	Tree	Native
362	<i>Phyllanthus myrtifolius</i>	Shrub	Exotic
363	<i>Phyllanthus reticulatus</i>	Shrub	Native
364	<i>Phyllanthus urinaria</i>	Herb	Exotic
365	<i>Physalis angulata</i>	Herb	Exotic
366	<i>Pimenta dioica</i>	Tree	Exotic
367	<i>Piper betle</i>	Climber	Native
368	<i>Piper longum</i>	Shrub	Native
369	<i>Piper nigrum</i>	Climber	Native
370	<i>Pithecellobium dulce</i>	Tree	Exotic
371	<i>Platyclusus orientalis</i>	Tree	Exotic
372	<i>Plectranthus amboinicus</i>	Herb	Exotic
373	<i>Plumbago indica</i>	Shrub	Native
374	<i>Plumbago zeylanica</i>	Shrub	Native
375	<i>Plumeria obtusa</i>	Tree	Exotic
376	<i>Plumeria pudica</i>	Tree	Exotic
377	<i>Plumeria rubra</i>	Tree	Exotic
378	<i>Podranea ricasoliana</i>	Climber	Exotic
379	<i>Polyalthia longifolia</i>	Tree	Exotic
380	<i>Polyscias balfouriana</i>	Shrub	Exotic
381	<i>Polyscias fruticosa</i>	Shrub	Exotic
382	<i>Pongamia pinnata</i>	Tree	Native
383	<i>Portulaca grandiflora</i>	Herb	Exotic
384	<i>Portulaca oleracea</i>	Herb	Native
385	<i>Pouteria campechiana</i>	Tree	Exotic
386	<i>Premna serratifolia</i>	Shrub	Native
387	<i>Pritchardia pacifica</i>	Tree	Exotic
388	<i>Pseuderanthemum reticulatum</i>	Shrub	Exotic
389	<i>Psidium guajava</i>	Tree	Exotic
390	<i>Punica granatum</i>	Shrub	Exotic
391	<i>Quassia amara</i>	Shrub	Exotic
392	<i>Quassia indica</i>	Tree	Native
393	<i>Quisqualis indica</i>	Climber	Exotic
394	<i>Racosperma auriculiforme</i>	Tree	Exotic
395	<i>Racosperma mangium</i>	Tree	Exotic
396	<i>Rauvolfia serpentina</i>	Shrub	Native
397	<i>Rauvolfia tetraphylla</i>	Shrub	Exotic
398	<i>Rhizophora apiculata</i>	Tree	Native
399	<i>Rhizophora mucronata</i>	Tree	Native
400	<i>Ricinus communis</i>	Shrub	Exotic
401	<i>Rosa multiflora</i>	Shrub	Exotic
402	<i>Roystonea regia</i>	Tree	Exotic
403	<i>Ruellia elegans</i>	Herb	Exotic
404	<i>Russelia equisetiformis</i>	Herb	Exotic
405	<i>Saccharum arundinaceum</i>	Shrub	Native

Sl. No.	Scientific Name	Habit	Exotic / Native
406	<i>Salacia fruticosa</i>	Climber	Native
407	<i>Salvia splendens</i>	Herb	Exotic
408	<i>Sapindus trifoliatus</i>	Tree	Native
409	<i>Saraca asoca</i>	Tree	Native
410	<i>Sauropus androgynus</i>	Shrub	Exotic
411	<i>Scoparia dulcis</i>	Herb	Exotic
412	<i>Senna alata</i>	Shrub	Exotic
413	<i>Senna occidentalis</i>	Shrub	Exotic
414	<i>Senna polyphylla</i>	Shrub	Exotic
415	<i>Senna tora</i>	Herb	Exotic
416	<i>Sida acuta</i>	Shrub	Native
417	<i>Sida alnifolia</i>	Shrub	Native
418	<i>Sida cordata</i>	Herb	Native
419	<i>Sida rhombifolia</i>	Herb	Native
420	<i>Simarouba glauca</i>	Tree	Exotic
421	<i>Solanum melongena</i>	Shrub	Native
422	<i>Solanum violaceum</i>	Shrub	Native
423	<i>Solidago canadensis</i>	Herb	Exotic
424	<i>Sonneratia alba</i>	Tree	Native
425	<i>Sonneratia caseolaris</i>	Tree	Native
426	<i>Spathodea campanulata</i>	Tree	Exotic
427	<i>Spermacoce ocymoides</i>	Herb	Native
428	<i>Sphaeranthus africanus</i>	Herb	Native
429	<i>Sphaeranthus indicus</i>	Herb	Native
430	<i>Sphenoclea zeylanica</i>	Herb	Native
431	<i>Spondias pinnata</i>	Tree	Native
432	<i>Stachytarpheta jamaicensis</i>	Shrub	Exotic
433	<i>Sterculia foetida</i>	Tree	Native
434	<i>Stereospermum colais</i>	Tree	Native
435	<i>Strychnos nux-vomica</i>	Tree	Native
436	<i>Swietenia mahagoni</i>	Tree	Exotic
437	<i>Symphotrichum laeve</i>	Herb	Exotic
438	<i>Synedrella nodiflora</i>	Herb	Exotic
439	<i>Syzygium aqueum</i>	Tree	Exotic
440	<i>Syzygium aromaticum</i>	Tree	Exotic
441	<i>Syzygium cumini</i>	Tree	Native
442	<i>Syzygium samarangense</i>	Tree	Exotic
443	<i>Tabebuia rosea</i>	Tree	Exotic
444	<i>Tabernaemontana alternifolia</i>	Tree	Native
445	<i>Tabernaemontana divaricata</i>	Shrub	Exotic
446	<i>Tagetes erecta</i>	Herb	Exotic
447	<i>Talipariti tiliaceum</i>	Tree	Native
448	<i>Tamarindus indica</i>	Tree	Exotic
449	<i>Tanacetum parthenium</i>	Herb	Exotic
450	<i>Tecoma stans</i>	Tree	Exotic

Sl. No.	Scientific Name	Habit	Exotic / Native
451	<i>Tecomaria capensis</i>	Shrub	Exotic
452	<i>Tectona grandis</i>	Tree	Native
453	<i>Tephrosia maxima</i>	Shrub	Native
454	<i>Terminalia bellirica</i>	Tree	Native
455	<i>Terminalia catappa</i>	Tree	Exotic
456	<i>Terminalia cuneata</i>	Tree	Native
457	<i>Terminalia paniculara</i>	Tree	Native
458	<i>Theobroma cacao</i>	Tree	Exotic
459	<i>Thespesia populnea</i>	Tree	Native
460	<i>Thevetia peruviana</i>	Shrub	Exotic
461	<i>Thunbergia erecta</i>	Shrub	Exotic
462	<i>Tibouchina urvilleana</i>	Shrub	Exotic
463	<i>Tradescantia zebrina</i>	Herb	Exotic
464	<i>Trema orientalis</i>	Tree	Native
465	<i>Tribulus terrestris</i>	Herb	Native
466	<i>Trichosanthes anguina</i>	Climber	Native
467	<i>Tridax procumbens</i>	Herb	Exotic
468	<i>Urena lobate</i>	Shrub	Native
469	<i>Vernonia cinerea</i>	Herb	Native
470	<i>Vernonia elliptica</i>	Climber	Exotic
471	<i>Vigna unguiculata</i>	Climber	Native
472	<i>Vitex negundo</i>	Shrub	Exotic
473	<i>Wattakaka volubilis</i>	Climber	Native
474	<i>Wedelia trilobata</i>	Herb	Exotic
475	<i>Wrightia antidysenterica</i>	Shrub	Exotic
476	<i>Wrightia tinctoria</i>	Tree	Native
477	<i>Xanthosoma sagittifolium</i>	Herb	Exotic
478	<i>Zephyranthes minuta</i>	Herb	Exotic
479	<i>Zingiber officinale</i>	Herb	Native
480	<i>Zinnia elegans</i>	Herb	Exotic
481	<i>Ziziphus mauritiana</i>	Tree	Exotic
482	<i>Ziziphus oenoplia</i>	Climber	Native
483	<i>Ziziphus rugosa</i>	Shrub	Native

Table 13: List of Invasive Plants in Kochi, Used in the Calculation of Indicator 10

Sl. No.	Scientific Name	Habit	Invasive Risk
1	<i>Chromolaena odorata</i>	Shrub	H
2	<i>Mikania micrantha</i>	Climber	H
3	<i>Sphagneticola trilobata</i>	Herb	H
4	<i>Quisqualis indica</i>	Climber	H
5	<i>Ipomoea cairica</i>	Climber	H
6	<i>Ipomoea carnea</i>	Shrub	H
7	<i>Merremia vitifolia</i>	Climber	H
8	<i>Mimosa diplotricha</i>	Climber	H
9	<i>Pueraria phaseoloides</i>	Climber	H
10	<i>Senna alata</i>	Herb	H
11	<i>Pennisetum polystachyon</i>	Herb	H
12	<i>Antigonon leptopus</i>	Climber	H
13	<i>Eichornia crassipes</i>	Herb	H
14	<i>Lantana camara</i>	Shrub	H
15	<i>Ipomoea aquatica</i>	Climber	M
16	<i>Ricinus communis</i>	Shrub	M
17	<i>Racosperma auriculiforme</i>	Tree	M
18	<i>Senna hirsute</i>	Shrub	M
19	<i>Senna tora</i>	Herb	M
20	<i>Hyptis suaveolens</i>	Shrub	M
21	<i>Passiflora foetida</i>	Climber	M
22	<i>Pennisetum pedicellatum</i>	Herb	M
23	<i>Alternanthera brasiliensis</i>	Herb	L
24	<i>Amaranthus spinosus</i>	Herb	L
25	<i>Ageratum conyzoides</i>	Herb	L
26	<i>Centrosema molle</i>	Climber	L
27	<i>Mimosa pudica</i>	Herb	L
28	<i>Senna occidentalis</i>	Shrub	L
29	<i>Leucaena leucocephala</i>	Tree	L
30	<i>Alternanthera bettzickiana</i>	Herb	I
31	<i>Gomphrena celosioides</i>	Herb	I
32	<i>Catharanthus roseus</i>	Herb	I
33	<i>Caladium bicolor</i>	Herb	I
34	<i>Centrathemum intermedium</i>	Herb	I
35	<i>Tridax procumbens</i>	Herb	I
36	<i>Ipomoea quamoclit</i>	Climber	I
37	<i>Muntingia calabura</i>	Tree	I
38	<i>Euphorbia heterophylla</i>	Herb	I
39	<i>Physalis angulata</i>	Herb	I

Table 14: List of Butterfly Species for Indicator 6

Sl. No.	Common name	Scientific Name
1	Tawny Coster	<i>Acraea violae</i>
2	Pygmy Scrub hopper	<i>Aeromachus pygmaeus</i>
3	Common bush hopper	<i>Ampittia dioscorides</i>
4	Chocolate Albatross	<i>Appias lyncida</i>
5	Purple Oak Blue	<i>Arhopala centaurus</i>
6	Angled Castor	<i>Ariadne ariadne palliolior</i>
7	Common Castor	<i>Ariadne merione</i>
8	Bright Babul Blue	<i>Azanus ubaldus</i>
9	Brown Awl	<i>Badamia exclamationis</i>
10	Formosan Swift	<i>Borbo cinnara</i>
11	Angled Pierrot	<i>Caleta decidia</i>
12	Blank Swift	<i>Caltoris kumara</i>
13	Common Pierrot	<i>Castalius rosimon</i>
14	Common Emigrant	<i>Catopsilia pomona</i>
15	Mottled Emigrant	<i>Catopsilia pyranthe</i>
16	Plain Palm-dart	<i>Cephrenes acalle</i>
17	Lime Blue	<i>Chilades lajus</i>
18	Plains cupid	<i>Chilades pandava</i>
19	Long-banded silverline	<i>Cigaritis lohia</i>
20	Tamil Yeoman	<i>Cirrochroa thais</i>
21	Rustic	<i>Cupha erymanthis</i>
22	Indian Sunbeam	<i>Curetis thetis</i>
23	Plain Tiger	<i>Danaus chrysippus</i>
24	Striped Tiger	<i>Danaus genutia</i>
25	Common Jezebel	<i>Delias eucharis</i>
26	Common Guava Blue	<i>Deudorix isocrates</i>
27	Blue Banded Pierrot	<i>Discolampa ethion</i>
28	Tailed Palmfly	<i>Elymnias caudata</i>
29	Common Palmfly	<i>Elymnias hypermnestra</i>
30	Gram Blue	<i>Euchrysops cnejus</i>
31	Common Crow	<i>Euploea core</i>
32	Three-spotted Grass Yellow	<i>Eurema blanda</i>
33	Common Grass Yellow	<i>Eurema hecabe contubernalis</i>
34	Common Baron	<i>Euthalia aconthea</i>
35	Gaudy Baron	<i>Euthalia lubentina</i>
36	Giant Redeye	<i>Gangara thyrsis</i>
37	Tailed Jay	<i>Graphium agamemnon</i>
38	Common Jay	<i>Graphium doson</i>
39	Common Bluebottle	<i>Graphium sarpedon</i>
40	Narrow Banded Bluebottle	<i>Graphium teredon</i>
41	Common Awl	<i>Hasora badra</i>
42	Common Banded Awl	<i>Hasora chromus</i>
43	Great Orange Tip	<i>Hebomoia glaucippe</i>
44	Great Eggfly	<i>Hypolimnas bolina</i>
45	Danaid Eggfly	<i>Hypolimnas misippus</i>

Sl. No.	Common name	Scientific Name
46	Chestnut Bob	<i>Iambrix salsala</i>
47	Common Caerulean	<i>Jamides celeno</i>
48	Peacock Pansy	<i>Junonia almana</i>
49	Grey Pansy	<i>Junonia atlites</i>
50	Psyche	<i>Leptosia nina nina</i>
51	Commander	<i>Limenitis procris</i>
52	Yamfly	<i>Loxura atymnus</i>
53	Common Redeye	<i>Matapa aria</i>
54	Common Eveningbrown	<i>Melanitis leda ismene</i>
55	Dark-branded Bushbrown	<i>Mycalesis mineus</i>
56	Common Bushbrown	<i>Mycalesis perseus blasius</i>
57	Common Sailer	<i>Neptis hylas</i>
58	Nigger	<i>Orsotriaena medus</i>
59	Common Rose	<i>Pachliopta aristolochiae</i>
60	Crimson Rose	<i>Pachliopta hector</i>
61	Common Mime	<i>Papilio clytia</i>
62	Lime Butterfly	<i>Papilio demoleus</i>
63	Blue Mormon	<i>Papilio polymnestor</i>
64	Common Mormon	<i>Papilio polytes</i>
65	Glassy Tiger	<i>Parantica aglea</i>
66	Common Wanderer	<i>Pareronia valeria</i>
67	Oriental Straight Swift	<i>Parnara bada</i>
68	Clipper	<i>Parthenos sylvia</i>
70	Little Branded Swift	<i>Pelopidas mathias</i>
69	Small Branded Swift	<i>Pelopidas mathias</i>
71	Common Leopard	<i>Phalanta phalantha</i>
72		<i>Potanthus sp.</i>
73	Chocolate Pansy	<i>Precis iphita</i>
74	Lemon Pansy	<i>Precis lemonias lemonias</i>
75	Pale Grass Blue	<i>Pseudozizeeria maha</i>
76	Monkey puzzle	<i>Rathinda amor</i>
77	Apefly	<i>Spalgis epius</i>
78	Indian Skipper	<i>Spialia galba</i>
79	Indian Palm Bob	<i>Suastus gremius</i>
80	Suffused Snow Flat	<i>Tagiades gana</i>
81	Water Snow Flat	<i>Tagiades litigios</i>
82	Peacock Royal	<i>Tajuria cippus</i>
83	Grey Count	<i>Tanaecia lepidea</i>
84	Common Grass Dart	<i>Taractrocerma maevius</i>
85	Dark Palm-dart	<i>Telicota ancilla</i>
86	Pale Palm Dart	<i>Telicota colon</i>
87	Blue Tiger	<i>Tirumala limniace</i>
88	Common Birdwing	<i>Troides helena</i>
89	Southern Birdwing	<i>Troides minos</i>
90	Grass Demon	<i>Udaspes folus</i>

Sl. No.	Common name	Scientific Name
91	Painted lady	<i>Vanessa cardui</i>
92	Cruiser	<i>Vindula erota</i>
93	Common Five-Ring	<i>Ypthima baldus</i>
94	Common Four ring	<i>Ypthima huebneri</i>
95	Redspot	<i>Zesius chrysomallus</i>
96	Dark grass blue	<i>Zizeeria karsandra</i>
97	Lesser Grass Blue	<i>Zizina otis</i>
98	Tiny Grass Blue	<i>Zizula hylax</i>



Table 15: List of Reptile Species for Indicator 7

Sl. No.	Common Name	Scientific Name
1	Indian Ponda Terrapin or Indian Black Turtle	<i>Melanochelys trijuga</i>
2	Indian Mud or Flap-Shell Turtle	<i>Lissemys punctata</i>
3	Asian House Gecko	<i>Hemidactylus frenatus</i>
4	Indian Garden Lizard or Changeable Lizard	<i>Calotes versicolor</i>
5	Common Green Forest Lizard	<i>Calotes calotes</i>
6	Brahminy Skink or Keeled Indian Mabuya	<i>Eutropis carinata</i>
7	Common Indian Monitor	<i>Varanus bengalensis</i>
8	Brahminy Blind Snake	<i>Ramphotyphlops braminus</i>
9	Dhaman or Indian Ratsnake	<i>Ptyas mucosa</i>
10	Checkered Keelback	<i>Xenochrophis piscator</i>
11	Dussumieri Water Snake or Kerala Mud Snake	<i>Enhydris dussumieri</i>
12	Common Indian Krait	<i>Bungarus caeruleus</i>
13	Indian Cobra	<i>Naja naja</i>
14	Russell's Viper	<i>Daboia russelii</i>
15	Cat snake	<i>Boiga sp.</i>
16	Indian chameleon	<i>Chameleon zeylanicus</i>
17	Rock agama	<i>Psammophilus blanfordanus</i>
18	Common rat snake	<i>Ptyas mucosus</i>
19	Indian Python	<i>Python molurus</i>
20	Common Skink or Keeled Indian Mabuya	<i>Eutropis carinata</i>
21	Dussumier's Litter Skink	<i>Sphenomorphus dussumieri</i>
22	Spotted House Gecko	<i>Hemidactylus parvimaculatus</i>
23	Skink species	<i>Sphenomorphus sp.</i>
24	Bridal snake	<i>Lycodon sp.</i>

Table 16: List of Spider Species for Indicator 8

Sl. No.	Common Name	Scientific Name
1	Comb-Footed Platform Spider	<i>Achaearanea mundula</i>
2	Common House Spider	<i>Achaearanea tepidariorum</i>
3	Ant-Like Crab Spider	<i>Amyciaea forticeps</i>
4	Kidney Garden Spider or Pale Orb Weaver	<i>Araneus mitificus</i>
5		<i>Araneus nympa</i>
6	Oval St Andrew's Cross Spider	<i>Argiope aemula</i>
7	Gaint Cross Spider	<i>Argiope anasuja</i>
8		<i>Argiope pulchella</i>
9	Oval Daddy-Long-Leg Spider	<i>Artema atlanta</i>
10	Tailed Jumper	<i>Asemonea tenuipes</i>
11	Scorpion Jumper	<i>Bavia kairali</i>
12		<i>Bavia sp.</i>
13	Crescented Jumper	<i>Brettus albolimbatus</i>
14		<i>Carhottus sp.</i>
15	Black and White Jumper	<i>Carrhotus viduus</i>
16	Ant-Mimicking Sac Spider	<i>Castianeira sp.</i>
17	Black Ant-Mimicking Spider	<i>Castianeira zetes</i>
18	Dark Sac Spider	<i>Cheiracanthium sp.</i>
19	Yellow Sac Spiders	<i>Cheiracanthium sp.</i>
20		<i>Clubiona sp.</i>
21	Box Spider	<i>Crossopriza lyoni</i>
22	Long-Billed Cyclosa Spider	<i>Cyclosa bifida</i>
23		<i>Cyclosa confraga</i>
24		<i>Cyclosa quinqueguttata</i>
25	Cyclosa Spider	<i>Cyclosa sp.</i>
26		<i>Cyrba sp.</i>
27	Grass Jewel Spider	<i>Cyrtarachne keralayensis</i>
28		<i>Cyrtarachne sp.</i>
29	Garden Tent Web Spider	<i>Cyrtophora cicatrosa</i>
30	Jungle Tent Web Spider	<i>Cyrtophora citricola</i>
31	White Spotted Green Jumper	<i>Epeus indicus</i>
32		<i>Erigone sp.</i>
33		<i>Eriovixia laglaizei</i>
34	Garden Spiny Spider	<i>Gasteracantha geminata</i>
35	Adanson's House Jumper	<i>Hasarius adansoni</i>
36	Two Tailed Spider	<i>Hersilia savignyi</i>
37		<i>Heteropoda sp.</i>
38	Huntsman Spider	<i>Heteropoda venatoria</i>
39	Common Funnel Web Spider	<i>Hippasa agelenoides</i>
40	Heavy Bodied Jumper	<i>Hyllus semicupreus</i>
41		<i>Hyllus sp.</i>
42	Black-Striped Orchard Spider	<i>Leucauge celebesiana</i>
43		<i>Leucauge pondae</i>
44	Soil Lycosid Spider	<i>Lycosa mackenziei</i>
45		<i>Lycosa sp.</i>

Sl. No.	Common Name	Scientific Name
46	Common Wall Jumper	<i>Menemerus bivittatus</i>
47		<i>Myrmaplata plataleoides</i>
48	Brown Ant-Mimic	<i>Myrmarachne orientales</i>
49	Red Ant-Mimic	<i>Myrmarachne plataleoides</i>
50	Common Garden Spider	<i>Neoscona mukerjei</i>
51		<i>Neoscona vigilans</i>
52	Wall Spider	<i>Oecobius navus</i>
53	Green Crab Spider	<i>Olios milleti</i>
54		<i>Opadometa sp.</i>
55	Cross Lynx Spider	<i>Oxyopes birmanicus</i>
56	Striped Lynx Spider	<i>Oxyopes javanus</i>
57	Lined Lynx Spider	<i>Oxyopes lineatus</i>
58		<i>Oxyopes quadridentatus</i>
59	White Lynx Spider	<i>Oxyopes shweta</i>
60	Orange Lynx Spider	<i>Oxyopes sunandae</i>
61	Green Crab Spider	<i>Oxytate virens</i>
62	Pond Wolf Spider	<i>Pardosa pseudoannulata</i>
63		<i>Pardosa sumatrana</i>
64	Green Lynx Spider	<i>Peucetia viridana</i>
65	Banded Phintella	<i>Phintella vittata</i>
66	Common Nursery Web Spider	<i>Pisaura gitae</i>
67	Common Zebra Jumper	<i>Plexippus paykulli</i>
68	Small Zebra Jumper	<i>Plexippus petersi</i>
69	White-mustached Portia	<i>Portia labiata</i>
70	Yellow Haired Beetle Jumper	<i>Rhene danieli</i>
71		<i>Scytodes sp.</i>
72		<i>Scytodes thoracica</i>
73	Metallic Jumper	<i>Siler semiglaucus</i>
74		<i>Tapponia sp.</i>
75	Two-Striped Jumper	<i>Telamonia dimidiata</i>
76	Cochin Tetragnathid Spider	<i>Tetragnatha cochinensis</i>
77	Dark Tetragnathid Spider	<i>Tetragnatha mandibulata</i>
78	Green Tetragnathid Spider	<i>Tetragnatha viridorufa</i>
79	Tangle-Web Spider	<i>Theridion sp.</i>
80	Cobweb Spider	<i>Theridula angular</i>
81	Metallic Blue Jumper	<i>Thiania bhamoensis</i>
82		<i>Thomisus lobosus</i>
83	Cream Crab Spider	<i>Thomisus projectus</i>
84		<i>Thomisus pugilis</i>
85		<i>Uloborus sp.</i>
86		<i>Xysticus sp.</i>

Table 17: List of Fishes

Sl. No.	Common Name	Scientific Name
1		<i>Acanthurus crassipinum</i>
2	Convict Sturgeon fish	<i>Acanthurus triostegus</i>
3		<i>Acanthurus bleokeri</i>
4	Spotted green Goby	<i>Acentrogobius viridipunctatus</i>
5	Grunting Toadfish	<i>Allenbatrachus grunniens</i>
6		<i>Ambassis comersoni</i>
7	Bald Glassy	<i>Ambassis gymnocephalus</i>
8	Mola Carplet	<i>Amblypharygodon mola</i>
9	Climbing Perch	<i>Anabas testudineus</i>
10	Indian Mottled Eel	<i>Anguilla bengalensis bengalensis</i>
11	Striped Panchax	<i>Aplocheilus lineatus</i>
12	Blue Panchax	<i>Aplocheilus panchax</i>
13	Flat-mouthed Catfish	<i>Arius platystomus</i>
14	Oriental-sole	<i>Brachirus orientalis</i>
15	Duckbill Sleeper	<i>Butis butis</i>
16	Crevalle Jack	<i>Caranx hippos</i>
17	Bluefin Trevally	<i>Caranx melampygus</i>
18		<i>Caranx nigripinnis</i>
19		<i>Caranx sexfasciatus</i>
20	Catla	<i>Catla catla</i>
21		<i>Chanda commersonii</i>
22	Great Snakehead	<i>Channa maulitus</i>
23	Striped Snakehead	<i>Channa striata</i>
24	Milk Fish	<i>Chanos chanos</i>
25		<i>Chelonodon tauvina</i>
26	Indian Pike Conger	<i>Congrosox talabonoides</i>
27	Bengal Tonguesole or Gangetic tongue sole	<i>Cynoglossus cynoglossus</i>
28	Spackled Tonguesole	<i>Cynoglossus puncticeps</i>
29	Speckled Tonguesole	<i>Cynoglossus puncticeps</i>
30		<i>Daysiana albida</i>
31	Goatee Croaker	<i>Dendrophysa russelii</i>
32		<i>Dichotomyctere sp.</i>
33	Slender Rainbow Sardine	<i>Dussumieria hasseltii</i>
34		<i>Eleotris carviformis</i>
35	Malabar Grouper or Greasy Grouper	<i>Epinephalus malabaricus</i>
36	Spinycheek Grouper	<i>Epinephelus diacanthus</i>
37	Orange Chromide	<i>Etroplus maculatus</i>
38	Pearlspot or Green Chromid	<i>Etroplus suratensis</i>
39	Blacktip Ponyfish	<i>Eubleekeria splendens</i>
40		<i>Garra mccalandi</i>
41	Toothpony	<i>Gazza minuta</i>
42	Whipfin Silver-Biddy	<i>Gerres filamentosus</i>
43	Saddleback Silver-Biddy	<i>Gerres limbatus</i>
44	Tank Goby	<i>Glossogobius giuris</i>
45	Barred Garfish or Spotted Halfbeak	<i>Hemiramphus far</i>

46	Sun catfish	<i>Horabagrus brachysoma</i>
47	Congaturi Halfbeak	<i>Hyporhamphus limbatus</i>
48		<i>Labeo dussumieri</i>
49	Seabass	<i>Lates calcarifer</i>
50	Shortnose Ponyfish	<i>Leiognathus brevirostris</i>
51	Common Ponyfish	<i>Leiognathus equulus</i>
52	Goldspot Mullet	<i>Liza parsia</i>
53	Golden Snapper	<i>Lutianus jhonii</i>
54	Mangrove Red Snapper	<i>Lutjanus argentimaculatus</i>
55	Blackspot Snapper	<i>Lutjanus fulviflamma</i>
56		<i>Macrogathus guentheri</i>
57	Indo-Pacific Tarpon	<i>Megalops cyprinoides</i>
58	Indo-Specific Tarpon	<i>Megalops cyprinoides</i>
59		<i>Monopterus fossorius</i>
60	Flathead Grey Mullet	<i>Mugil cephalus</i>
61	Long Whiskers Catfish	<i>Mystus gulio</i>
62		<i>Mystus malabaricus</i>
63	Gangetic Leafyfish	<i>Nandus nandus</i>
64	Japanese Threadfin Bream	<i>Nemipterus japonicus</i>
65	Butter Catfish	<i>Ompok malabaricus</i>
66	Mozambique Tilapia	<i>Oreochromis mossambicus</i>
67	Maned Goby	<i>Oxyurichthys microlepis</i>
68		<i>Oxyurichthys ormosanus</i>
69		<i>Oxyurichthys tentacularis</i>
70	Largescale Mullet	<i>Planiliza macrolepis</i>
71	Bartail Flathead	<i>Platycephalus indicus</i>
72	Guppy	<i>Poecilia reticulata</i>
73	Black-line Rasbora or Slender Rasbora	<i>Rasbora daniconius</i>
74	Indian Mackerel	<i>Rastrelliger kanagurta</i>
75	Flapnose Ray	<i>Rhinoptera javanica</i>
76	Indian Oil Sardine	<i>Sardinella longiceps</i>
77	Spotted Scat	<i>Scatophagus argus</i>
78	Spadenose Shark	<i>Scoliodon laticaudus</i>
79	Northern Whiting	<i>Silago sihama</i>
80	Pickhandle Barracuda	<i>Sphyrna jello</i>
81	Indian Anchovy	<i>Stolephorus indicus</i>
82	Crescent Grunter	<i>Terapon jarbua</i>
83	Green Pufferfish	<i>Tetraodon fluviatilis</i>
84	Moustached Thryssa	<i>Thryssa mystax</i>
85	Short-Nosed Tripodfish	<i>Triacanthus biaculeatus</i>
86	Helicopter Catfish or Wallago Catfish	<i>Wallago attu</i>
87	Freshwater Garfish	<i>Xenentodon cancila</i>







ICLEI - Local Governments for Sustainability, South Asia
C-3, Lower Ground Floor, Green Park Extension, New Delhi - 110016, India
Tel: +91 - 11 - 4974 7200; Fax: +91 - 11 - 4974 7201