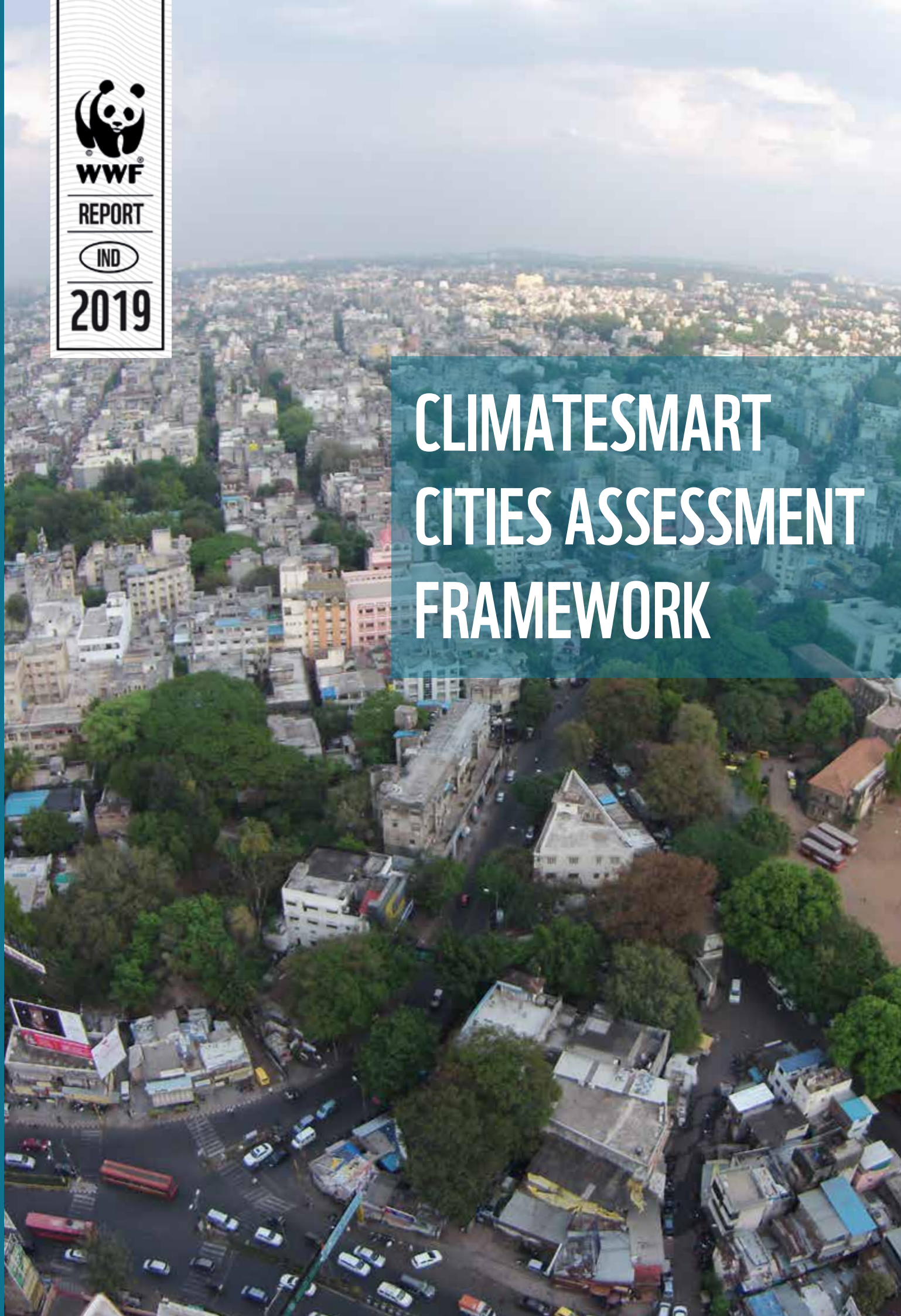
WWF

REPORT

IND

2019

CLIMATESMART CITIES ASSESSMENT FRAMEWORK



Preface

Climate Change is the biggest global challenge that we are faced with today, impacts of which are compounded further from unplanned urban growth in many developing countries. These include lack of access to clean and adequate water, air pollution, heat island impacts, disastrous floods, reduced labour productivity, loss to infrastructure and eventually massive loss to the economy. Cities, therefore, are an area of increased attention for the Government of India. The Government's "Smart City Mission" helps cities to adopt an approach for a sustainable and climate friendly development. India accounts for about 6.5% of the global GHG emission and thereby the cities can play a significant role for contributing toward Nationally Determined contributions. To enable local governments in understanding these challenges, the Ministry of Housing and Urban Affairs has introduced a "ClimateSMART Cities Assessment Framework".

Large urban areas in India are usually concentrated in high productivity landscapes and at the crossroads of major trade routes that represent regional ecotones, such as transitions from mountains to plains, river estuaries and coasts. High productivity landscapes and ecotones often translate to high ecological diversity and therefore the concentration of urban areas is disproportionately high in biodiversity rich areas. The situation in India is of global concern as, according to Futures of global urban expansion: uncertainties and implications for biodiversity conservation by B Güneralp and K C Seto published 19 February 2013, , India shows the highest concentration of Protected Areas threatened by urban expansion globally.

WWF India, has been working towards biodiversity conservation and natural resource management for five decades. While much of the prior focus has been on conservation of natural landscapes, more recently agricultural and urban areas have also been prioritised. Towards supporting this initiative of the GoI, WWF India has worked to develop the initial guidance for urban local bodies that promotes the conservation, enhancement and regeneration of urban biodiversity. The five pillars integral to strengthening urban biodiversity include: addressing climate vulnerabilities while working toward reducing emissions; building the disaster resilience capacity of cities especially considering the destructive floods in the last decade; enhancement of green cover in general and native species in particular; regeneration & conservation of wetlands, waterbodies and watersheds; and conserving the overall urban biodiversity in cities.

Having worked at the field level, the action points are targeted at the Urban local bodies, simplified and easy to implement and integrate as well as secure finance towards implementation of the same.

Dr . Sejal Worah,
Programme Director,
WWF India

Contents

Disclaimer

This is to certify that the material sent herewith is wholly produced by WWF India, and follows all the necessary referencing, IPR and copyright protocols as applicable. The material is meant purely as advisory or guidance documents for the ClimateSmart Cities Assessment Framework (CSCAF) of the Ministry of Housing & Urban Affairs (MoHUA or Ministry), Govt. of India; and will be along with several such documents to help guide the cities in an unbiased & non-partisan manner, towards better performance in various indicators of the assesment framework.

The material derives from standard international protocols (such as the UNFCC, or of other global agencies) and such best practices thereof, that are credited accordingly. They do not state or imply covertly any recommendation to any proprietary technology, process, documentation format or material that is copyrighted, by us or any organization. If it does contain any reference it would be cited as among several such that are commonly available.

We understand that the Ministry by accepting this document and using it (including hosting it on public websites) for the benefit of the cities does not necessarily ascribe to, recommend, give warranties to or endorse any technology, process, format or material; but intends it as purely knowledge resources for hand-holding cities on technical topics such as are part of the CSCAF and its indicators. The Ministry accepts no liability for any damages, including without limitation, direct, indirect, incidental, consequential or punitive damages, arising out of or due to use of the information given herein.

3.2 URBAN PLANNING, GREEN COVER AND BIODIVERSITY

Indicator 4: Proportion of Green Cover

Rationale

Sufficiently large and protected greenspaces reduce the impact of human activities on climate. The ecosystem services provided by the urban greenspaces help the city in general and its citizens to adapt to the adverse effects of climate change and disasters.[1]

Description

'Green cover' refers to a broad range of strategies to integrate green, permeable and reflective surfaces into cities and towns, which are home to 89 per cent of our population. Surface temperatures in urban areas can be 10°C to 20°C higher than in the air temperatures because buildings, roads and other hard surfaces absorb and store heat. High temperatures, due to climate change, will further intensify the impacts of urban heat. Unlike hard surfaces, trees and vegetation often known as green infrastructure provide cool and clean the air by evapotranspiration. They provide shade as well as other benefits such as better health and wellbeing for urban-dwellers, more biodiversity and wildlife in urban areas, and better regulation of localised flooding. Types of urban green cover include bushland, private and community gardens, parks, greenways, habitat corridors, street trees, roof gardens and plant-covered walls, as well as reflective and permeable walls, pavements and other surfaces. Protecting local green spaces, designing eco-friendly buildings and creating urban networks of green space can help to minimise the impacts of urban heat in the city.[2]

[1] https://smartnet.niua.org/csc/pdf/2._Urban_Planning_Green_Cover_and_Bio-_Diversity.pdf
[2] https://climatechange.environment.nsw.gov.au/Adapting-to-climate-change/Green-Cover

Government of India Initiatives

The National Forest Policy of India aims to ensure that a minimum of one-third of the total land area of the country remains under forest or tree cover. It encourages planting of trees alongside roads, railway lines, rivers, streams, and canals. Raising of "green belts" has been recommended in urban/industrial areas and in arid tracts (Ministry of Environment & Forests, India 1988).[3]

Table 1: Initiatives by the Indian Government for Protection of Green Cover and Biodiversity

Policies/Acts	Objectives
India's Nationally Determined Contribution (NDC) submitted to UNFCCC, 2015	To create an additional carbon sink of 2.5 to 3 billion tonnes of CO_2 equivalent through additional forest and tree cover by 2030.
National Green Tribunal Act, 2010	Provides for establishment of a National Green Tribunal for effective and expeditious disposal of cases related to environment protection including enforcement of any legal right relating to environment.
National Action Plan for Climate Change, 2008	National Mission for Green India with a view to launch a national mission to enhance ecosystem services including afforestation of 10 million hectares of land.
Environmental Impact Assessment (EIA) Notification, 2006	To identify, examine, assess, and evaluate the likely and probable impacts of a proposed project on the environment. It makes prior environmental clearance mandatory for the development activities listed in the notification.
National Environment Policy, 2006	Intended as a guide to regulatory reforms and environmental projects, review and enactment of legislation by Government bodies. It seeks to stimulate partnership of different stakeholders to strengthen environmental management.
Biological Diversity Act, 2002	Conserve biological resources and associated knowledge and facilitate access to them in a sustainable manner.
National Afforestation and Eco-Development Board (established in 1992)	Promotes afforestation, tree planting, ecological restoration, and eco-development activities.
Environmental Protection Act, 1986	Provides for protection of the environment which is inclusive of water, air, land, and the inter-relationship existing between the environment, human beings, and living creatures.
Forest Conservation Act, 1980	Provides for regulating diversion of forest land for non-forestry purpose in different states of India.
Wildlife Protection Act, 1972	Control poaching, smuggling, and illegal trade in wildlife and its derivates. Protection of the listed species of flora and fauna. Establishment of ecologically important protection areas.
Indian Forest Act, 1927	Consolidate the law relating to forests, the transit of forest-produce, and the duty leviable on timber and other forest-produce

Source: Government of India, pmindia.gov.in/en/major-initiatives/

[3] http://asbb.gov.in/Downloads/National%20Forest%20Policy.pdf

Methodology

Acquiring the data

Satellite imagery:

Satellite imagery (also Earth observation imagery or spaceborne photography) are images of Earth or other planets collected by imaging satellites operated by governments and businesses around the world. Recent imagery can be procured from the State Remote Sensing Centre or National Remote Sensing Centre (NRSC) (https://bhuvan.nrsc.gov.in/) or USGS website (https://earthexplorer.usgs.gov/). The baseline year would be 2019.

Municipal Area/Ward Wise Area:

Notified area within the city limits or as per the management plan of the city is the municipal area. The data can be obtained from the urban planning or the development authority.

Population Data:

Population dynamics can be obtained from the Census data/ Census handbook for the district.

GRID Based Sampling:

Grid sampling is a favoured method for site specific data collection as it is unbiased, simple, and relatively quick, and software exists to facilitate it. After the samples have been pulled, georeferenced and analysed, a map is made by either filling in the grid cells with the sample value (grid cell method) or assigning the sample value to a point and then interpolating between points (grid point method). Grid sampling results in either a “checkerboard” map (grid cell method) or a “smoothed” map (grid point method).

Toposheets:

Toposheet is map which provides information about all main topographical features with specified legend and symbology. It is found in various scales of maps according to user requirements. This data acts as a baseline data for any geographical studies. It can be obtained from the SOI nakshe (Survey of India) website.

Workflow of Thematic Maps

Supporting Data

The supporting data used for thematic mapping are procured and added to ArcGIS. The Administrative boundaries, road network, ward data are collected from open sources and exported to ArcGIS. The coordinate system of each data is transformed into projected coordinate system of “WGS_1984_UTM_Zones” using “Project feature of Projections and Transformations in Data Management Tools”.

Satellite Data

Satellite images are used to prepare land use/ land cover (LU/LC) maps. In the preparation of LU/LC map of any area, ancillary data in the form of toposheets , and other published relevant material are used as reference data. Survey of India digital topographical maps on 1:50,000 scales can be used for identification of base features and planning ground data collection. \ Satellite images downloaded from the USGS Earth Explorer /Bhuvan. Landsat 8 or Sentinel 2 can be used. The satellite data is of pre-monsoon period. Pre-processing of satellite images are performed before preparation of LU/LC maps. It includes layer stacking, mosaicking and clipping of study area. Radiometric enhancement technique i.e., histogram matching is carried out to improve the brightness level of similar features and provide uniform information.

Image Interpretation

Visual or digital (computer based) image interpretation techniques are applied to extract information from image data. For an accurate image classification, data collected from the field (ground truthing / field surveys) are linked to image data. In this way, a map showing various land cover types of the area are produced. The different visual image interpretation elements like shape, size, texture, association, pattern, tone (or hue) etc. are used for identification of various land cover features. A normal False Color Composite (FCC) for the imagery is created by applying appropriate band combinations i.e Band 5 (near-infrared), 4(red) and 3(green) for a Landsat image.

a. Unsupervised Classification
The classification of the imageries is performed by using unsupervised classification. In this particular type of classification spectral classes are grouped first, based solely on the numerical information in the data, and are then matched by the analyst to information classes. Unsupervised classifiers do not utilize training data as the basis for classification. Rather it involves clustering algorithms, that examine the unknown pixels in an image and

aggregate them into a number of classes based on the natural groupings or clusters present in the image values. The analyst specifies the desired number of classes. Thus, unlike supervised classification, it does not start with a pre-determined set of classes; however, it is neither done completely without human intervention. The classes that result from unsupervised classification are spectral classes. Because they are based solely on the natural groupings in the image values, the identity of the spectral classes will not be initially known. The analyst must compare the classified data with some form of reference data (such as imagery or maps) to determine the identity and informational value of the spectral classes. Thus, in the supervised approach useful information categories are defined and then examined on the basis of their spectral separability; in the unsupervised approach we determine spectrally separable classes and then define their informational utility (Lillesand and Kiefer, 2000).

b. Normalized Difference Vegetation Index
Normalized Difference Vegetation Index (NDVI) gives an idea about vegetation areas by measuring the difference between near-infrared band (which vegetation strongly reflects) and red band (which vegetation absorbs). The value of NDVI ranges from -1 to +1. A value closer to the + 1 indicates vegetation areas, whereas negative values indicates water bodies.

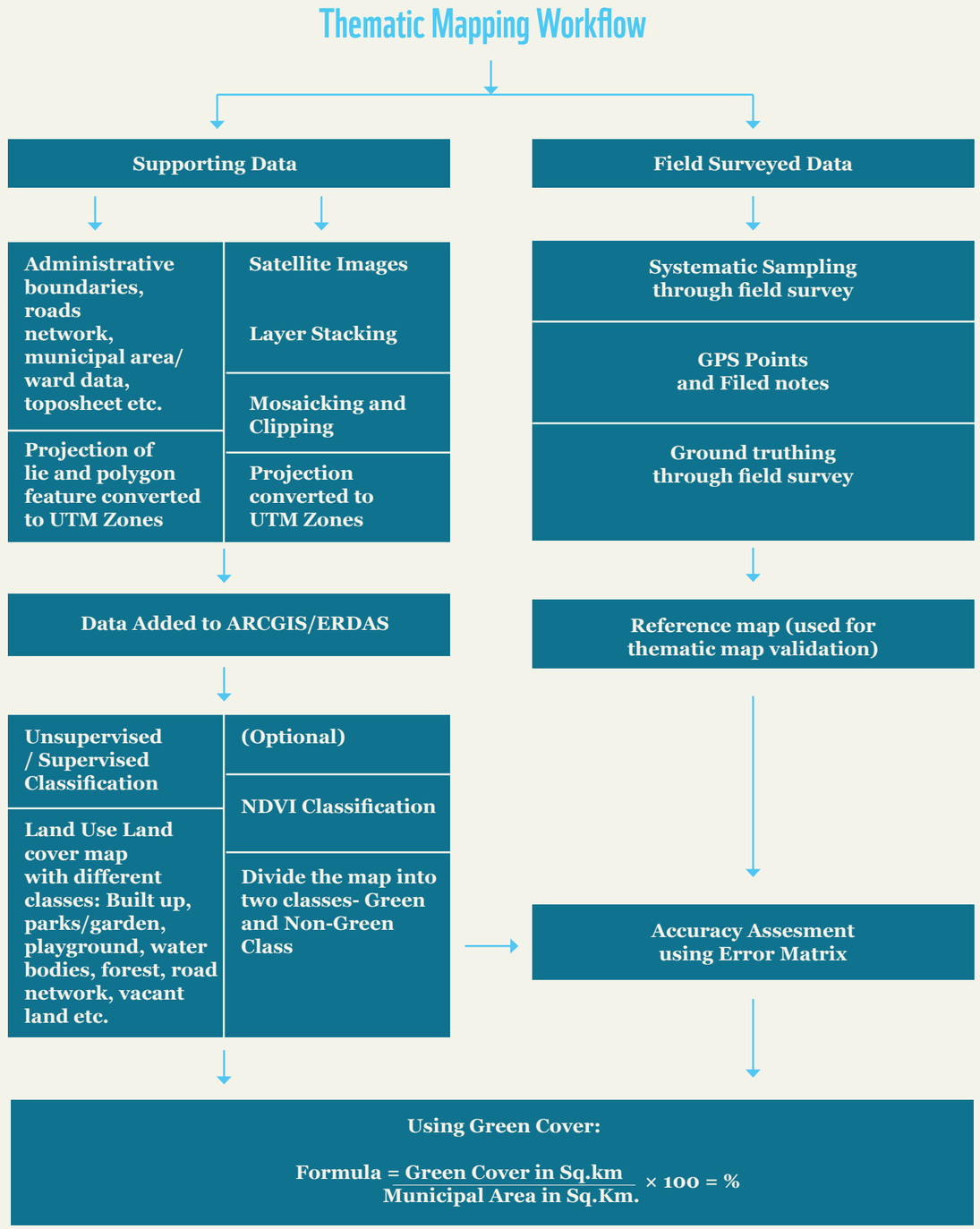


Figure 1: Thematic mapping workflow

Field Survey Data

The aim of field survey is to collect the truth points using a GPS device and make additional observations to support the thematic map preparation and validation, as well as take note of added attributes to update on the status of green cover. The entire study area is visited using a systematic random sampling method. The study area is divided into smaller grids of 1 × 1 km. The GPS points for parks, gardens, and playgrounds etc. in the city can be taken using Garmin.

Validation and Accuracy Assessment

The accuracy of the thematic map is dependent on several factors such as classification, mapping unit or image quality and may contain errors which need quantification. The accuracy represents the correctness or degree to which the attributes of the map agree with the truth reference dataset. Thus, the quantified error is used to communicate the validity of results for their intended application and is calculated through accuracy assessment. While several methods are used to measure the accuracy, the most commonly used method is confusion or error matrix, for a series of descriptive and statistical analysis. Accuracy assessment is calculated in ERDAS imagine software.

Calculation of Green cover

After having all the thematic layers, we can calculate percentage of green cover using formula below :

$$\text{Formula} = \frac{\text{Green Cover in Sq.km}}{\text{Municipal Area in Sq.Km.}} \times 100 = \%$$

	0	1	2	3	4
Progression Levels	0% to < 5% Green Cover	5% to < 9% Green Cover	9% to < 12% Green Cover	12% to < 20% Green Cover	≥ 20% Green Cover

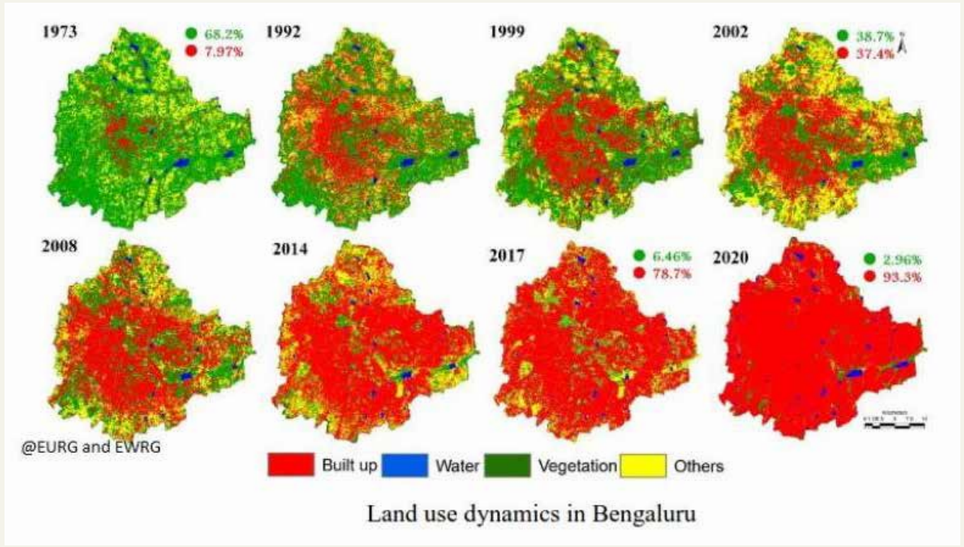
Source: ClimateSMART CITIES, Assessment Framework 2019

Figure 2: Evaluation progression levels

Case study of Bangalore from a Garden City to the Silicon Valley of India

In a research by a team of scientists from Indian Institute of Technology, Kharagpur and the Indian Institute of Science, Bangalore[4], it was found that Bangalore had more than 2000 species of trees (including natural and specifically planted), as well as numerous individual gardens in small households that contributed to the biodiversity. As the 'Garden City' transformed into the 'Silicon Valley of India', the city's rapid, uncontrolled growth turned this biodiversity haven to a concrete jungle.

Using satellite imagery, the team calculated the number of trees that form the green cover over Bangalore over a period of 45 years. Once these images were processed, various techniques were used to estimate the green cover and classify the land use. The tree cover was extracted the 198 wards that constitute Bangalore city. To validate the tree count thus obtained, actual field data was collected by counting the number of trees in select wards. Image data over a period of time was also analysed.



Source: Ramachandra, T V & Aithal, Dr. Bharath & Shivamurthy, Vinay. (2018). Bangalore to Bengaluru & Dead city by 2020 (in Kannada). 50.

Figure 3: Land use Dynamics of Bengaluru

Using multi-temporal satellite imageries and a predictive modelling technique it was found that the paved surfaces of Bangalore have increased by 1005 per cent, in the past 40 years. This came at the sacrifice of the green cover, reducing from 68 per cent in 1973 to merely 25 per cent in 2012. The area of ponds and lakes reduced from 3.4 per cent to just one per cent. The study predicted that, if the trend continues, Bangalore would be left with merely three per cent of green cover in the next couple of years. The ward-wise tree count showed a lot of variation in the number of trees in each ward. Some wards had more than 40,000 trees whereas some others had less than 100 trees. The tree density also varied ranging from less than one tree per 500 persons to 1.25 trees per person. In addition, the study indicates that for every person in Bengaluru, there should have been 8 trees to offset the human respiratory carbon or to have adequate oxygen. However, in Bangalore, there is just one tree for every seven persons, as compared to four trees per person in Gandhinagar, Gujarat, and two trees per person in Nashik, Maharashtra.

[4] Ramachandra, T V & Aithal, Dr. Bharath & Shivamurthy, Vinay. (2018). Bangalore to Bengaluru & Dead city by 2020 (in Kannada). 50.

Successful case studies of enhancing urban green cover

Oslo, Norway

The Norwegian capital Oslo is surrounded by forested hills and lakes. Out of 454 square kilometres of total area, 242 square kilometres of area of this city is covered by dense forest. In fact, two-thirds of Oslo city are protected areas. Strict environmental laws protect its natural resources and beauty. There are a large number of parks, open areas and 343 lakes in Oslo city. The city government also has a mission to make the city carbon neutral by 2020.[5]

In the Indian Context

India is ranked tenth in the world in terms of percentage of forest area. With rapid urbanisation and development activities such as mining, the ambitious target of bringing 33% of the country under forest cover can only be attained by concerted focus on improvement of green cover.

The State of Forest Report 2017 released by the Forest Survey of India (FSI) reveals that the forest cover of the country is 21.54 per cent of the total geographical area showing a marginal increase from the assessment in 2015 at 21.34 per cent. The bulk of the increase has come from improvement in forest covers in three states, Andhra Pradesh, Karnataka and Kerala.

Parts of the country have seen a decline in forest cover due to reasons such as use of cultivation and forest land for development purposes, encroachment of forest land, mining and felling.[6]

While the National Forest Policy stresses on the greening of arid and industrial tracts, adequate greening of private lands has not been emphasised. Further, the rapid pace of development since early 1990s has extended urbanisation beyond the carrying capacity of cites. While various states have launched afforestation programs to varying degrees of success, urban forestry and tree cover in India's major cities is a cause for concern. A number of measures have been initiated at the national level to maintain natural heritage, check soil erosion, and denudation, but an imbalance is observed between the built and natural cover in cities. The increase in forest cover seen in certain regions can be attributed to increased plantation and protection activities, afforestation drives and successful agro-forestry practices. Several Indian cities are also taking conscious efforts to enhance green cover. A few examples are presented in the section below. According to India Times, top 10 Greenest cities of India are Chandigarh, Nagpur, Gandhinagar, Guwahati, Mysore, Dehradun, Jamshedpur, Shimla, Bhopal, and Bhubaneshwar.

Chandigarh

Chandigarh is considered as the first well planned city of India. It is also known as the Green city of India. The city was given the title of Greenest City of India for the year 2015-16 due to the widespread green cover within the city. Apart from the commonly known gardens, the city has numerous parks in each sector. Not just this, all roads in Chandigarh have lush green trees on both sides. The city is surrounded by a massive tree area on all its four sides. Towards the east, Chandigarh has a huge area of mango trees on the road dividing the residential sectors 28, 29 31 with the industrial area. Towards the south, it has a forest area on the main road dividing Chandigarh and Mohali. In the north, Chandigarh has Kansal Forests and the Sukhna Lake Forest area. The total green cover area of Chandigarh is 53.26 sq.km, the green cover percentage is 38.04 of the total geographical area of the city, and the forest area in UT is 34 sq.km (29 per cent).[7]

Naya Raipur

At a time when cities across India are rapidly losing green cover, Naya Raipur, the administrative capital of Chhattisgarh, stands out in its endeavour to ensure that the city has adequate greenery. The Naya Raipur Development Authority (NRDA) was established with the aim of creating a greenfield city with parks, botanical garden and a jungle safari. Naya Raipur's greening efforts aim to make it a model city with the target of 27 per cent green cover under the Harihar Chhattisgarh mission. The 25-year development plan for the city envisions a 500-meter wide green belt of an area of 15.09 square kilometres surrounding the core area spanning 80.13 sq.km. Conscious planning to ensure there is adequate tree cover is a salient feature of the city. The planning authorities have earmarked open spaces in its residential areas, with 30 per cent land reserved as green in each residential sector. This will drastically help increase the green cover of the city through tree-planting drives. The green belt adds to the lung space of the city. The banks of all water bodies have been developed in a manner that they are lined with trees. The development plan sets a target of 2031 to achieve the above as Naya Raipur looks to grow as a green, smart city.[8]

[7] https://www.indiatimes.com/culture/travel/11-of-the-greenest-cities-in-india-232232.html
[8] http://citizenmatters.in/green-cover-in-indian-cities-naya-raipur-example-6896
[9] Abbasi S.A and Khan F.I, "Greenbelts for Pollution Control: Concepts, Design, Applications", Discovery Publishing House, New Delhi, 2000a 10 http://www.journal.bonfring.org/abstract.php?id=3&archiveid=15

Designing greenbelts for air pollution control

A research by Tasneem Abbasi, S.M. Tauseef, F.I. Khan, and S.A. Abbasi9 focused on green belt designing and development to combat air pollution. Even though air pollution control may be the primary motivation to raise greenbelts, numerous objectives can be fulfilled by greenbelt development such as enhancement of socio-economic value of the region serving as a cushion against accidental fires, explosions, and toxic releases, protection of soil from erosion, improving the micrometeorology of the area, and beautification of the landscape. Another major benefit can be employment generation as well as fostering a sense of participation towards environmental protection. The study presented a mathematical model to assist in the design of greenbelts. The application of the model demonstrates its validity. The study also underscores the fact that without determining the correct geometry of the greenbelt on the basis of pollutant dispersion attenuation modelling, it is not possible to derive much benefit from a greenbelt. Green belt development mainly depends upon factors such as climate, nature and extent of pollution load, assimilative capacity of the ecosystem, and soil and water quality. The key variables to be considered for optimum design of greenbelt include height and canopy of trees, mean wind velocity and direction, distance from source or occurrence of maximum ground level concentration, pollutant concentration, nature of pollutants, dry deposition velocity of plants (specific to pollutants and plants), and topography and size of the land available.[10]

[10] http://www.journal.bonfring.org/abstract.php?id=3&archiveid=15

Table 2: Green Initiatives in various cities and countries

City/ Country	Initiatives pertaining to			
	Preservation	**Maintenance**	**Growth & development**	**Public participation**
New Delhi	The Delhi Preservation of Trees Act, 1994	Provision for recovery of expenditure from people who fail to plant trees as per directive or from owners who fail to protect trees from danger.	More than a million trees planted under the City Plants a Million Tree Campaign by the government in 2011	The Green Leap Delhi initiative by the Department of Environment started in 2011 provided for distribution of free seeds/saplings
	Establishment of Tree Authority including Tree Officer for preservation, development, and maintenance of trees	In lieu of permission for removal of tree, compensatory planting of 10 trees to be done	Roundabouts, road sides, and central verges identified for tree plantation	The Tree Ambulance service by New Delhi Municipal Corporation provides emergency help to residents to save trees
	Need of permission from Tree officer prior to felling/cutting/ removal/disposal of tree	Selection of trees and plants to be made keeping in mind distinctive avenue development, round the year flowering in parks, and shade requirements		
	Establishment of Tree Help line where information can be given about illegal felling of trees			
Pune	The Maharashtra (Urban Areas) protection and Preservation of Trees Act, 1975		NGO-Tree Public Foundation has planted 50, 000 trees	Pune Municipal Corporation provides advertisement rights to public and private agencies in return for development and maintenance of landscaping of road medians, traffic islands etc.
	No tree can be felled without written permission from Tree Authority			
Visakha-patnam	No restriction on felling of trees on private lands		12 major parks proposed involving investment of INR 14 crores.	
	In case of Tree Patta, felling can be done at the end of rotation period when the Divisional forest officer authorises itat the end of rotation period when the Divisional forest officer authorises it		The Umar Alisha Rural Development Trust is working on the planting of one million trees through a time span of 5 years.	

City/ Country	Initiatives pertaining to			
	Preservation	**Maintenance**	**Growth & development**	**Public participation**
Chennai	Tamil Nadu Tree Protection Act No tree can be felled without permission of District Committee Species marked as “royal trees” cannot be felled even on private lands without the permission of Chief Conservator of forests.		Tree plantation schemes initiated by government- 64,00,000 saplings in 2012 and 65,00, 000 saplings in 2013	
Singapore	Mandatory provision of planting verges along public roads and private properties	Carefully laid out guidelines for tree species to be planned along roads with recommendations for spacing	15% increase in roadside greenery from 1999 to 2010	Encourage roof gardens
Sydney, Australia	Vision to promote and support	Support liveable green network of streets	Aim for increase in city’s urban forestry	Promote green roofs and green walls on new building developments.
		Planting trees in unused road spaces	50% by 2030	Explore provision of grants program for residents and businesses to maintain large canopy trees on their property.
		Replace paving with trees and landscape plantings	75% by 2075	
London, UK	Stress on promotion of accessibility to green areas	Maximisation of urban greening through planting of trees and soft landscaping where applicable	Planting of two million trees by 2025	
		Principle of “right place, right tree”		
New York City, USA	Well-developed Tree Census providing details of city trees inclusive of species richness, age, diameter at breast height, canopy cover, and condition of trees		Million Tree Initiative	Tree giveaways to volunteers Mulchfest used for recycling holiday trees and nourishing city plantings. TreesCount 2015 by the New York City Department of Parks and Recreation aimed at mapping street trees and engaged locals through voluntary participation

Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4824703/

Policy and Planning recommendations

☐ Provision of green walls and green/cool roofs in dense neighbourhoods, can prove crucial in the cooling of microclimate and compensating for dearth of material resources.

☐ The high density of Indian roadways can be utilised as green corridors for attenuating atmospheric pollution, and inducing uniform cooling. Evergreens should be selected for roadways to minimise accidents due to leaf shedding from deciduous varieties. This should be backed with guidelines for choice of tree species and tree spacing as observed in Singapore.

☐ In keeping with the National Forest Policy, trees should be planted and maintained along railway lines, canals, and streams. Green belts should be raised in derelict lands.

☐ Incorporation of permeable pavements such as grassed footpaths and greening of parking lots will help to decrease the proportion of paved areas, aid in storm water retention, and reduce surface heating.

☐ Flat-roofed buildings provide ample scope for development of roof gardens also resulting in added benefit of rain water harvesting and storm water runoff collection which could address acute water shortage in cities.

☐ Tax abatements can be provided to incentivise maintenance of roof gardens, box plantations, and green terraces.

☐ Public participation is a prerequisite for the success of any urban development programme. The youth should be educated and engaged in voluntary activities of plantation, care, and maintenance of tree saplings.

☐ Tree giveaways will help to instil a sense of responsibility towards protection of the natural environment.

☐ Smart City initiative promoting development of urban green spaces can be coupled with strategic landscaping to optimise benefits of greening programs.

☐ Government database should provide information about choice of tree species as per climatic requirements to ensure maximum efficiency at minimum cost. The policy of “right place, right tree” as observed in London provides technical support towards intelligent greening of cities. Tree databank providing detailed assessment of the physical, economical, and ecological value of city flora can be helpful for afforestation in cities.

☐ Tree census should be initiated and must include a study of the physical attributes of trees, such as species variety, richness, health, age etc., and generate information about the ecological value of species. The findings can be used to educate residents about the intangible benefits of trees.

☐ Studies on increase in property value due to the vegetative presence will provide an assessment of the economic value of city flora, and help to convince residents about the monetary benefits emanating from maintenance and development of green areas. Studies investigating the impact of environmental amenities on real estate prices in Mumbai and Chandigarh serve as noteworthy examples.[11]

[11] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4824703/

3.2 URBAN PLANNING, GREEN COVER AND BIODIVERSITY

Indicator 6: Urban Biodiversity

Rationale

Urban biodiversity provides significant ecosystem services contributing to climate change mitigation and adaptation, such as carbon sequestration, air and water purification, mitigation of impacts of environmental pollution, noise reduction, and regulation of microclimate. High biodiversity increases the resilience of the city.

Description

Cities in particular are home to more than half of the world's population, and are responsible for a disproportionately large ecological footprint, which threatens the health of the planet's ecosystems. The growth of cities may cause biodiversity to decline by fragmenting or destroying large areas of natural habitat on which many species depend. The rising human population is driving the expansion of urban areas and increasing the demand for natural resources such as timber and fossil fuels. This inevitably leads to habitat destruction.

"Urban biodiversity" refers to the variety and variability among living organisms found in a city and the ecological systems in which they occur. Overall, urban biodiversity responds to a combination of biogeography and anthropogenic factors, with a strong influence of the latter. With the rapid urbanization in the world and the pressing threat of climate change, there is a growing interest in understanding how cities benefit from local biodiversity and how these benefits can be under threat due to climate change. [1]

Ecosystems and biodiversity need to be managed and valued as part of cities' infrastructure and integrated into all aspects of local governance including financial planning, transportation urban planning, trade and economic incentive mechanisms, procurement policies, infrastructure development and service delivery. India also has a long and rich

[1] Nowak, D. J. (2010). Urban Biodiversity and Climate Change. Urban biodiversity and design, 101.

tradition of stewardship of nature based in different cultural and religious belief systems. Even today, sacred groves are protected in many peri-urban areas and smaller towns, while massive, centuries-old sacred trees are commonly protected even in densely congested urban neighbourhoods. More than 30% of India's population lives in cities now and this proportion is expected to increase to 50% in the coming two decades.[2]

Hence it is becoming increasingly important to have a good understanding of the processes that shape ecology and conservation in the cities of India. However, we have very little information to draw on. As the attention of Indian ecologists and conservation biologists has largely been focused on understanding "natural" ecosystems such as forests in protected areas, the cities have largely remained in the background of ecological conversation. The Biological Diversity Act, 2002 (No. 18 of 2003) was notified by the Government of India on 5th February, 2003. The Act extends to the whole of India and reaffirms the sovereign rights of the country over its biological resources. Subsequently the Government of India published Biological Diversity Rules, 2004 (15th April, 2004). The Rules under section 22 state that 'every local body shall constitute a Biodiversity Management Committee (BMC's) within its area of jurisdiction.[3]

Benefits of Green Space and Urban Biodiversity:

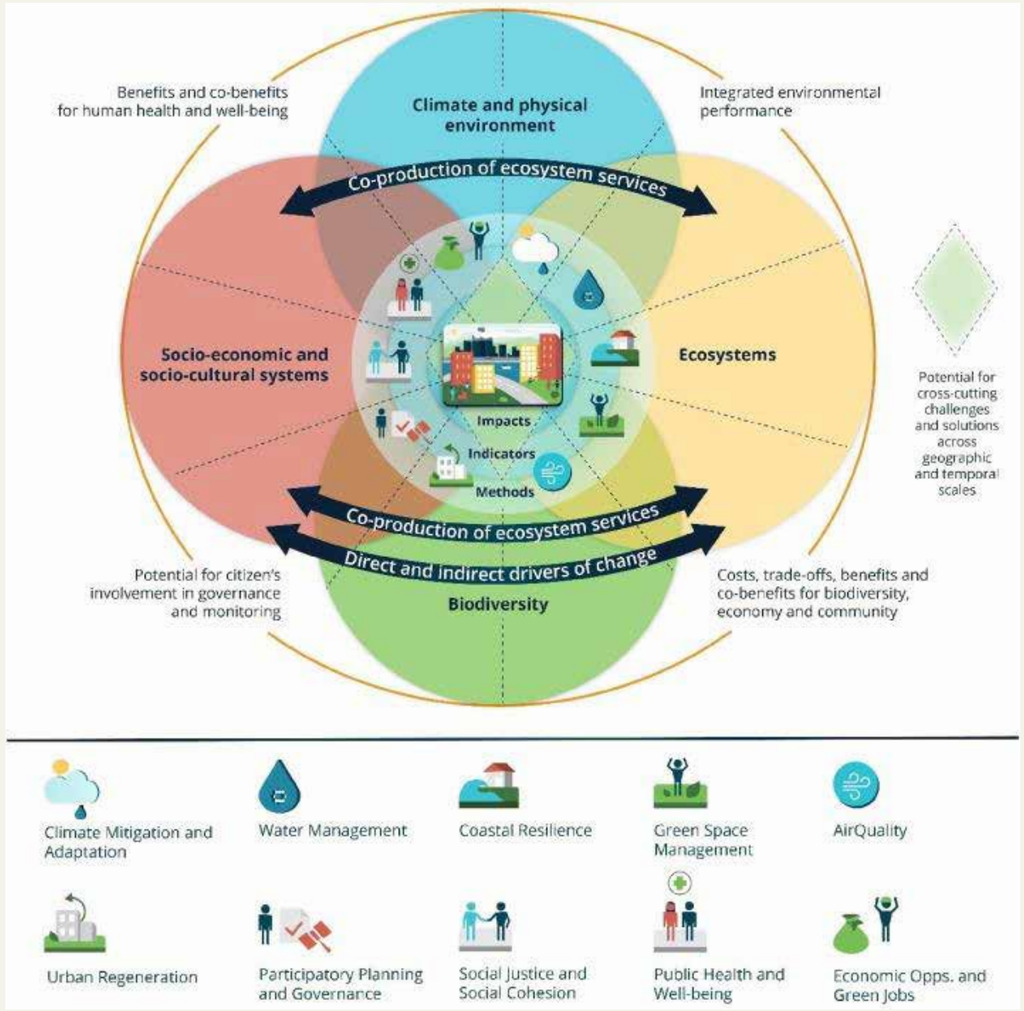
Social
☐ Recreational opportunities
☐ Improvement of home/work environment
☐ Impact on physical/mental health
☐ Cultural and historical values

Aesthetic and Architectural
☐ Landscape variation through different colours, textures, forms and densities of plants
☐ Growth of trees, seasonal dynamics and experiencing nature
☐ Defining open space, framing and screening views, landscaping buildings
☐ Climatic and physical Benefits
☐ Cooling, Wind, humidity, and temperature control
☐ Air pollution reduction, sound control, glare and reflection reduction
☐ Flood prevention and erosion control

Ecological
☐ Biotopes for flora and fauna in Urban Environment

Economic
☐ Increased property values
☐ Tourism

[2] https://www.currentconservation.org/keeping-room-for-biodiversity-in-indias-urban-future/
[3] http://nbaindia.org/uploaded/Biodiversityindia/Legal/31.%20Biological%20Diversity%20%20Act,%202002.pdf



Source: Research Paper by Christopher M. Raymond, Niki Frantzeskaki, Nadja Kabisch, Pam Berry, Margaretha Breil, Mihai Răzvan Niță, Davide Geneletti and Carlo Calfapietra

Figure 1: Framework for assessing and implementing the co-benefits of nature-based solutions in urban areas

Formula: NA Unit: NA Maximum Score: 30

Performance Evaluation Levels:

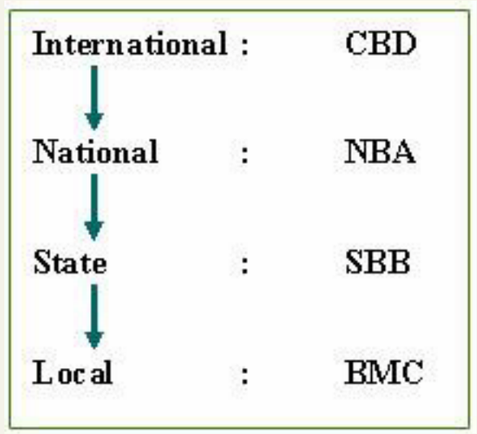
Progression Levels	0	1	2	3	4
Progression Levels	**No consideration of biodiversity takes place**	**Institutional Set-Up**	**Baseline Assessment**	**Plan**	**Implementation**
Evidence/ Data Sources		• Establishment of City Level Biodiversity Management Committee (as per Biological Diversity Act, 2002; City council resolution; announcement to State Biodiversity Board)	• People's Biodiversity Register (based on the Biological Diversity Act, 2002, Letter of State Biodiversity Board validating register) • Inventory (all forms of technical reports/ studies) of urban ecosystems and species (including International Union for Conservation of Nature, IUCN listed ones)	• Funds/ Municipal Budget allocated • Identification of measures to increase biodiversity within master plan/ greening plans/ rejuvenation plans (see indicator no. 3)	• Calculation of City Biodiversity Index (Report with the calculated index) • Implementation of measures initiated (defined in level 3)
Responsible Agency/ Department		ULB; Biodiversity Management Committee, State Horticulture Department, State Forest Department			
Score	0	5	10	20	30

Source: ClimateSMART CITIES, Assessment Framework 2019

Figure 2: Evaluation progression levels

STAGE 1. Institutional set up

The Biological Diversity Act envisages a three tier system for implementation, with the National Biodiversity Authority (NBA) headquartered in Chennai at the apex, State Biodiversity Boards (SBB), and Biodiversity Management Committees (BMC) in local bodies.



Source: NBA India

Figure 3: Legal Institutions

Biodiversity Management committee (BMC)

As per the Act, the local bodies constitute the BMC in accordance with Section 41, within their area of jurisdiction for the purpose of promoting conservation, sustainable use and documentation of biological diversity including preservation of habitats, conservation of land races, folk varieties and cultivars, domesticated stocks and breeds of animals, micro-organisms and chronicling of knowledge relating to biological diversity. The BMC consists of a Chairperson, and six persons nominated by local bodies, including 1/3rd women and 18% SC/ST.[4] The mandate of the Biodiversity Management Committee has been highlighted in the Biological Diversity Rules 2002[5] as follows:

> The main function of the BMC is to prepare People's Biodiversity Register in consultation with the local people. The Register shall contain comprehensive information on availability and knowledge of local biological resources, their medicinal or any other use.
>
> The other functions of the BMC are to advice on any matter referred to it by the State Biodiversity Board or Authority for granting

approval, to maintain data about the local vaids (traditional medical practitioners) and practitioners using the biological resources.

The Authority shall take steps to specify the form of the People's Biodiversity Registers, and the particulars it shall contain and the format for electronic database.

The Authority and the State Biodiversity Boards shall provide guidance and technical support to the Biodiversity Management Committees for preparing People's Biodiversity Registers.

The guidelines for setting up BMCs are available in the NBA India website (http://nbaindia.org - http://nbaindia.org/uploaded/pdf/Guidelines%20for%20BMC.pdf).

[4] http://nbaindia.org/text/14/BiodiversityManagementCommittees.html
[5] http://www.nbaindia.nic.in/

Table 1: Biodiversity Management Committees in various States

1.	Andhra Pradesh	6031
2.	Arunachal Pradesh	139
3.	Assam	229
4.	Bihar	-
5.	Chhattisgarh	223
6.	Goa	191
7.	Gujarat	7661
8.	Haryana	-
9.	Himachal Pradesh	609
10.	Jammu & Kashmir	-
11.	Jharkhand	3384
12.	Karnataka	6228
13.	Kerala	1043
14.	Madhya Pradesh	23,431
15.	Maharashtra	23,772
16.	Manipur	95
17.	Meghalaya	263
18.	Mizoram	250
19.	Nagaland	110
20.	Odisha	1700
21.	Punjab	74
22.	Rajasthan	113
23.	Sikkim	35
24.	Tamil Nadu	385
25.	Telangana	3200
26.	Tripura	502
27.	Uttarakhand	948
28.	Uttar Pradesh	58782
29.	West Bengal	433
	Total	**139831**

Source: NBA India

STAGE 2. Baseline Assessment

The Biological Diversity Act envisages a three tier system for implementation, with the National Biodiversity Authority (NBA) headquartered in Chennai at the apex, State Biodiversity Boards (SBB), and Biodiversity Management Committees (BMC) in local bodies.

Inventory of Species and Ecosystems

An extensive and comprehensive inventory of all species and ecosystems in the city would need to be created using PBR and other technical reports. The inventory would contain the species listings using various sources such as technical reports, PBRs, IUCN species data, etc.

People's Biodiversity Registers (PBR)

The growing importance of biodiversity, bio-resources and associated knowledge is fairly well understood. The first step towards conservation is sustainable utilization of biodiversity and its documentation. Biodiversity and associated knowledge is found in different ecosystems, under different legal management regimes and hence the results and manner of documentation will also differ.

PBR Preparation

• Step 1: Formation of Biodiversity Management Committee (BMC)
• Step 2: Sensitization of the public about the study, survey and possible management
• Step 3: Training of members in identification and collection of data on biological resources and traditional knowledge
• Step 4: Collection of data. including review of literature on the natural resources of the districts, Participatory Rural Appraisal (PRAs) at village level, household interviews, individual interviews with village leaders and knowledgeable individuals, household heads, key actors of the panchayat raj institutions and NGOs, and direct field observations
• Step 5: Analysis and validation of data in consultation with technical support group and BMC
• Step 6: Preparation of People's Biodiversity Register (PBR)
• Step 7: Computerization of information and resources

The present manual guidelines have been drafted taking into consideration different ecosystems and include the rural, urban and protected areas. The guidelines may be customized and further information may be added to enrich the effort. It is important to keep in mind some of the issues related to PBRs:

☐ It is to be undertaken in a participatory mode involving varying sections of village society.

☐ While documenting, the knowledge and views of both genders are to be recorded.
☐ Information provided by people need to be collated, analysed and cross checked by the members of the Technical Support Group (TSG) before documentation.
☐ The PBR is important base document in the legal arena as evidence of prior knowledge and hence careful documentation is necessary.
☐ The document should be endorsed by the BMC and later publicized in the Gram Sabha / Gram Panchayat / Panchayat Samiti. The document can be a very useful tool in the management and sustainable use of bioresources. The document can also be a very useful teaching tool for teaching environmental studies at schools, colleges and university level
☐ The document should be periodically updated with additional and new information as and when generated.
☐ The People's Biodiversity Registers shall be maintained and validated by the Biodiversity Management Committees.

People's Biodiversity Registers and the role of National Biodiversity Authority (NBA):

The National Biodiversity Authority shall provide guidance and technical support to the Biodiversity Management Committee (BMC) for preparing People's Biodiversity Register.

People's Biodiversity Registers and the role of State Biodiversity Board (SBB):

The State Biodiversity Board (SBB) would provide necessary training to the Technical Support Group (TSG) of the district and enable smooth functioning and aid in networking for creation and maintenance of People's Biodiversity Registers (PBRs).[6]

People's Biodiversity Registers and Role of the Technical Support Group (TSG):

The Technical Support Group (TSG) will consist of experts from various disciplines and line departments, universities, research institutes, colleges and schools and non-governmental organizations. The Technical Support Group will provide technical inputs and advice to the BMCs on identification of plants and animals, monitor and evaluate the PBR exercise, examine confidential information and advice on legal protection, maintain a database of local and external experts on biodiversity.[7]

[6] http://nbaindia.org/uploaded/pdf/PBR%20Format%202013.pdf
[7] Ecology is for the People: A Methodology Manual for People's Biodiversity Register by Madhav Gadgil

STAGE 3: Plan

The planning stage would be divided into 2 sub stages, namely:

Funding and Allocation of Budget

The funds required to design, plan and implement this can be through budgetary allocations of the state at the local/state or central level, private investment as well as international collaborations. Sufficient funds need to be allocated for the implementation to be effective.

Identification of measures to increase biodiversity

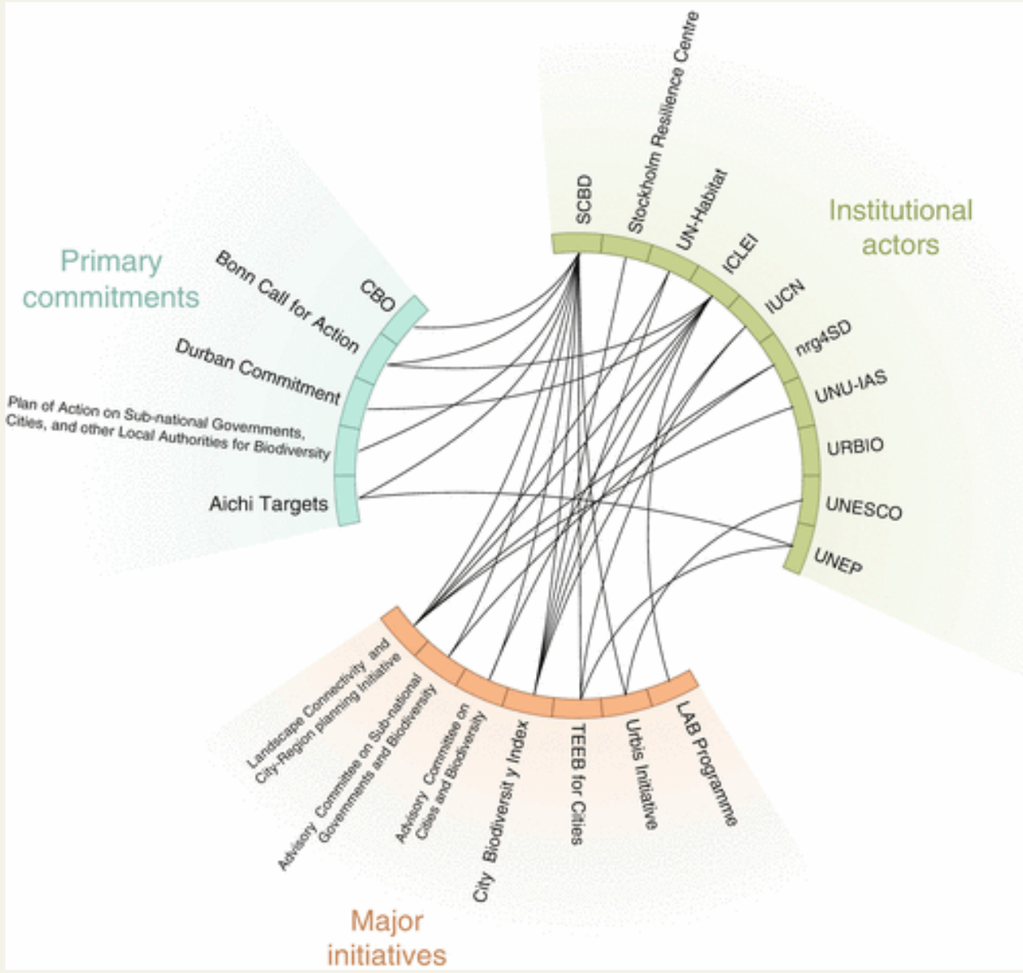
Cities could take several measures to promote biodiversity conservation through the management of the urban environment. The rejuvenation of the urban environment would include several aspects such as water bodies, open spaces, and the built up area in the city. The open spaces in the city help address both climate mitigation as well as adaptation by lowering local temperature increase which leads to urban heat islands in built up areas. Green spaces also act as carbon sinks as well as help in groundwater recharge.

Some of the strategic plans for biodiversity conservation compiled from available literature and studies are:

☐ Manage the urban environment to benefit biodiversity including the conservation of rivers, wetlands and streams.
☐ Develop an afforestation plan.
☐ Implement strategic city and regional planning to reduce urban sprawl. Prevent the advancement of urban areas over remaining vegetation fragments and safeguard the existing biodiversity.
☐ Zoning policy for landscape cover aligned with environmental macro-zoning, restricting in this way the conversion and occupation of fragile areas (floodplains, endemic species habitat) and allowing a territorial planning that respect the local peculiarities.
☐ Manage the entire landscape through an ecosystem approach
☐ Manage urban agriculture and nurture supply links to city markets
☐ Facilitate sustainable consumption of resources that impact biodiversity
☐ Establish synergistic partnerships with government and the private sector. Also greater collaboration between environmental agencies and universities/research institutes to enable further research and monitoring of biodiversity.
☐ Raise biodiversity awareness and importance amongst the public
☐ Support and join global or regional networks of cities and local authorities with common missions related to biodiversity.

Efforts around the World

- Singapore:Green Mark, CUGE
- Hong Kong:Inventory, Rent a Kitchen Garden, Volunteering opportunities for school/ college students
- Malaysia:Live Assets Audit
- Sri Lanka:Agricultural Enclaves in Cities
- Thailand/China:National Awards
- India : Delhi:Tree Protection Act, City plants a million trees campaign



Source: Wilkinson, Cathy & Sendstad, Marte & Parnell, Susan & Schewenius, Maria. (2013). Urban Governance of Biodiversity and Ecosystem Services. 10.1007/978-94-007-7088-1_27.

Figure 4: Urban Biodiversity and Ecosystem services

STAGE 4. Implementation Stage

Calculation of City Biodiversity Index

The City Biodiversity Index, also referred to as the Singapore Index on Cities' Biodiversity or the Singapore Index (SI), is a self-assessment tool for cities to evaluate and monitor the progress of biodiversity conservation efforts against their own individual baselines. It comprises: a) the "Profile of the City", which provides background information on the city; and b) the 23 indicators that measure native biodiversity, ecosystem services provided by biodiversity, and governance and management of biodiversity based on guidelines and methodology provided in the User's Manual on the Singapore Index on Cities' Biodiversity.[8]

The scoring of the Index is quantitative in nature. Each indicator is assigned a scoring range between zero and four points, with a total possible maximum score of 92 points. The year in which a city first embarks on this scoring will be taken as the baseline year, and this will be measured against future applications of the Index to chart its progress in conserving biodiversity. It is not a tool for comparing and contrasting the performance of different cities, as context is core to performance, nor is it a tool to be used only once. Cities should make an initial baseline measurement; identify policy priorities based on their measurements and then monitor again at periodic intervals.

The Singapore Index helps cities to accomplish their biodiversity goals via three interrelated mechanisms, which are vital to positive policy outcomes. First, the Index is a tool that allows cities to create baseline measurements of their current biodiversity profiles and then monitor and assess these over time. Secondly, it serves as a public platform upon which biodiversity awareness raising exercises can be launched. Finally, the Index acts as portal among various departments within city governance, academics, NGOs and the public, encouraging better communication, stronger networks and operations, through data collection and sharing of mutual goals, which ultimately results in better policy outcomes. Indicators can serve as important policy tools in the measurement of economic, social and environmental variables.

The Singapore Index also serves as a valuable method of awareness-raising allowing cities to mobilize their citizenry in efforts to protect and enhance locally important populations of species and ecosystems. The Index provides opportunities for citizen and city collaboration and potential media exposure which can help cities create momentum behind biodiversity conservation efforts. In a study conducted by Corporate Knights on good sustainable development practices in Canadian cities, Edmonton and Montreal scored a perfect score for their biodiversity monitoring efforts, attributing their performance to the use of the Singapore Index.

The Singapore Index has also been instrumental in helping local, national and regional government departments to exchange information and ideas on measuring biodiversity. This creates a new network of policy actors around the issue of biodiversity and further embeds the idea into policy discourse. There has been growing participation of NGOs, universities and consultancy firms and this has benefited biodiversity policy in the cities that applied the Index by presenting new policy opportunities that might not have readily existed without the synergies created by the networks involved in data collection. For example, in Lisbon, Portugal, the application of the Singapore Index led to the development of a Local Biodiversity Strategy and Action Plan. It has also been creatively used in Singapore by city planners in the master planning of new districts and the Building and Construction Authority in their Green Mark for Districts scheme. Here the Index helped to create new networks of actors who came together to formulate policies that would not have been possible otherwise. The Singapore Index helps capture the city's baseline data as well as promote biodiversity actions and create new policy networks that will further conservation and enhancement efforts.[9]

[8] https://www.cbd.int/authorities/doc/Singapore-Index-User-Manual-20140730-en.pdf

[9] Further information or clarifications regarding the application of the Singapore Index, please contact Singapore_Index@nparks.gov.sg.

SINGAPORE INDEX ON CITIES' BIODIVERSITY			
PART I – Profile of the City	Location and size (geographical coordinates (latitudes and longitudes); climate (temperate or tropical); rainfall/precipitation (range and average); including maps or satellite images where city boundaries are clearly defined)		
	Physical features of the city (geography, altitude, area of impermeable surfaces, information on brownfield sites, etc.)		
	Demographics (including total population and population density; the population of the region could also be included if appropriate, and for the purpose of placing it in the regional context)		
	Economic parameters (Gross Domestic Product (GDP), Gross National Product (GNP), per capita income, key economic activities, drivers and pressures on biodiversity)		
	Biodiversity features (ecosystems within the city, species within the city, quantitative data on populations of key species of local importance, relevant qualitative biodiversity data)		
	Administration of biodiversity (relevant information includes agencies and departments responsible for biodiversity; how natural areas are protected (through national parks, nature reserves, forest reserves, secured areas, parks, etc.)		
	Links to relevant websites including the city's website, environmental or biodiversity themed websites, websites of agencies responsible for managing biodiversity		
PART II - Indicators	Core Components	Indicators	Maximum Score
	Native Biodiversity in the City	1. Proportion of Natural Areas in the City	4 points
		2. Connectivity Measures	4 points
		3. Native Biodiversity in Built Up Areas (Bird Species)	4 points
		4. Change in Number of Vascular Plant Species	4 points
		5. Change in Number of Bird Species	4 points
		6. Change in Number of Butterfly Species	4 points
		7. Change in Number of Species (any other taxonomic group selected by the city)	4 points
		8. Change in Number of Species (any other taxonomic group selected by the city)	4 points
		9. Proportion of Protected Natural Areas	4 points
		10. Proportion of Invasive Alien Species	4 points
	Ecosystem Services provided by Biodiversity	11. Regulation of Quantity of Water	4 points
		12. Climate Regulation: Carbon Storage and Cooling Effect of Vegetation	4 points
		13. Recreation and Education: Area of Parks with Natural Areas	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
	Governance and Management of Biodiversity	15. Budget Allocated to Biodiversity	4 points
		16. Number of Biodiversity Projects Implemented by the City Annually	4 points
		17. Existence of Local Biodiversity Strategy and Action Plan	4 points
		18. Institutional Capacity: Number of Biodiversity Related Functions	4 points
		19. Institutional Capacity: Number of City or Local Government Agencies Involved in Inter-agency Co-operation Pertaining to Biodiversity Matters	4 points
		20. Participation and Partnership: Existence of Formal or Informal Public Consultation Process	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
		22. Education and Awareness: Is Biodiversity or Nature Awareness Included in the School Curriculum	4 points
		23. Education and Awareness: Number of Outreach or Public Awareness Events Held in the City per Year	4 points
		Native Biodiversity in the City (Sub-total for indicators 1-10)	**40 points**
		Ecosystem Services provided by Biodiversity (Sub-total for indicators 11-14)	**16 points**
		Governance and Management of Biodiversity (Sub-total for indicators 15-23)	**36 points**
		Maximum Total:	**92 points**

Source: https://www.cbd.int/subnational/partners-and-initiatives/city-biodiversity-index

Figure 5: Singapore Biodiversity Index

Case Studies

Mobile Application based Toolkit for Biodiversity Conservation and Management in Urban and Rural Areas

The SPA (School of Planning and architecture) team comprising of Prof. Dr. Meenakshi Dhote & Himanshhu Panwar have sought for a practical approach to biodiversity planning and management using an app- based solution for assessing Urban biodiversity. The app seeks to help local governments harness available resources and opportunities to address global biodiversity loss and ecosystem degradation by providing them with a baseline database of biodiversity of the city. They have aimed to create a toolkit to provide a one stop solution for database management by collaborating different initiatives of biodiversity conservation into a single inter related concept for urban biodiversity management.This would help the local government to prepare Local Biodiversity Strategy and Action Plan (LBSAP) under the mandate of Section 41 of Biological Diversity Act -2002, enabling Municipal Corporations to perform all the activities relating to the city's overall Biodiversity Management.

The toolkit is about collaboration of different inter-related ideologies and concepts which are brought into a complete framework and when applied together can provide significant output to conservation of biodiversity in urban areas. It will act as a single window entity where all the stakeholders including volunteers, NGOs, government institutions and local government could work together at their respective planning and administrative levels and help to enhance the quality of the biodiversity as well as its conservation by mainstreaming different processes and methods. CBI section helps to formulate and analyze data of all the cities indicator wise under the sections status of natural resources, ecosystem services and governance where scoring is given. The data collected from different departments would be imported to GIS and subsequently maps would be prepared and displayed under each indicator section. Local government bodies can alter or add the data at any time and keep the data updated.

This attempt would promote awareness among the citizens and also strengthen local governance and BMCs. Similar toolkit or framework could also be adopted for villages. PBR section would be used for making the survey process easier by making it all digital. It would have options of geo-tagging the photos as well, which would be helpful in creating a better database. Presently, the survey is noted in a written format and then transferred or typed onto digital representations. This app aims to reduce the survey initiation time and would automatically generate a centralized database. Data authentication issue can be addressed through multiple interactive app based platforms to be used by different sections of the society.

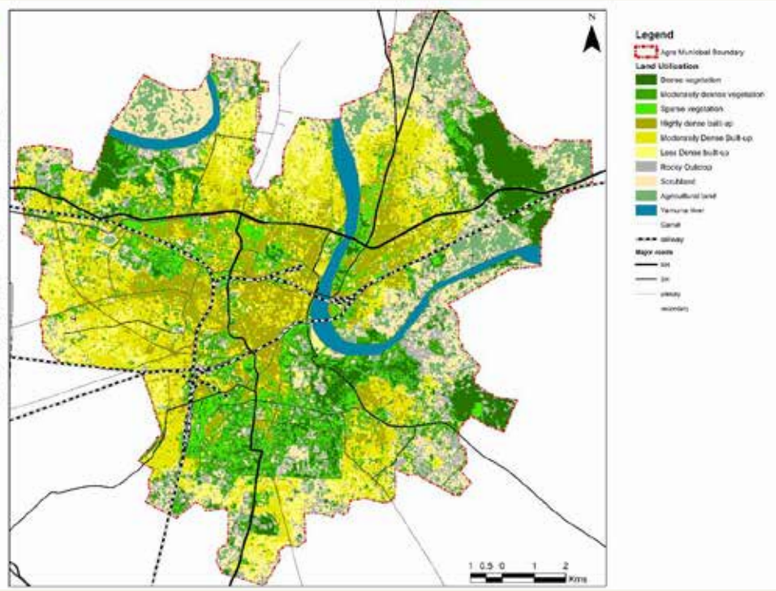
Source: Dr. Meenakshi Dhote & Himanshhu Panwar, SPA

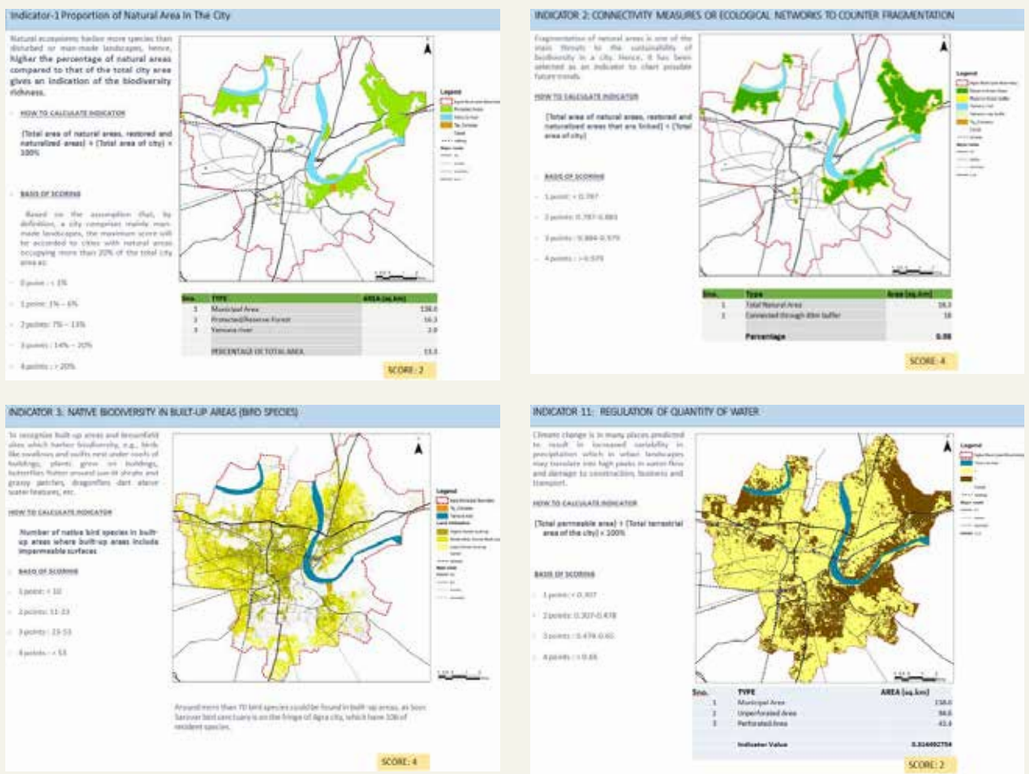
Figure 6: Biodiversity toolkit

Their study on urban biodiversity toolkit for Agra city had the following outputs:

The city of Agra inhabits the Western Bank of Yamuna River and National Highway 2. The city occupies a strategic location at the confluence of three distinct geo-physical regions namely the plain of Uttar Pradesh, the plateau of Madhya Pradesh and the desert of Rajasthan. The municipal area of Agra has an area of 138.8 sq.km in 2018 while as per Census 2011 it had an area of 120.57 sq.km.

S.no	Type	Area (Sq.km)
1	Dense vegetation	10.9989
2	Sparse vegetation	13.5936
3	Moderately dense vegetation	17.244
4	Highly dense built-up	18.7254
5	Moderately Dense Built-up	25.3476
6	Less Dense built-up	14.6178
7	Rocky Outcrop	15.5358
8	Scrubland	15.1335
9	Agricultural land	7.6077





Source: Dr. Meenakshi Dhote & Himanshhu Panwar, SPA

Figure 7: Some Biodiversity Indicators

Sl.No.	INDICATORS	Value Latest Manual	Score Score	Agra
1	Indicator 1: proportion of natural areas in city	13.30%	4	2
2	Indicator 2: connectivity measures or ecological networks to counter fragmentation	1800 ha	4	4
3	Indicator 3: native biodiversity in built-up areas bird species	>75	4	4
4	Indicators 4: change in number of native species vascular plants	0	4	1
5	Indicators 5: change in number of native species birds	0	4	1
6	Indicators 6: change in number of native species butterflies	0	4	1
7	Indicators 7: change in number of native species reptiles	0	4	1
8	Indicators 8: change in number of native species fresh water fishes	0	4	1
9	Indicator 9: proportion of protected natural areas	11.00%	4	2
10	Indicator 10: proportion of invasive alien species (as opposed to native species)	*	4	0
11	Indicator 11: regulation of quantity of water	31%	4	2
12	Indicator 12: climate regulation: carbon storage and cooling effect of vegetation	0.118	4	2
13	Indicator 13: recreational and educational services (area of parks with natural areas and protected or secured natural areas)*/ 1000 persons)	0.05	4	1
14	Indicator 14: recreational and educational services (number of formal educational visits per child to parks)	0	4	0
15	Indicator 15: budget allocated to biodiversity	0.50%	4	1
16	Indicator 16: number of biodiversity projects implemented by the city annually	5	4	2
17	Indicator 17: policy, rules and regulations – existence of local biodiversity strategy and action plan	0	4	0
18	Indicator 18: institutional capacity: number of essential biodiversity-related functionaries in the city	9	4	4
19	Indicator 19: institutional capacity: number of city or local government agencies involved in inter-agency cooperation pertaining to biodiversity matters	3	4	1
20	Indicator 20: participation and partnership existence and state of formal or informal public consultation process	*	4	1
21	Indicator 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	0	4	0
22	Indicator 22: Is biodiversity or nature awareness is included in the school curriculum (e.g. biology, geography, etc.)	*	4	4
23	Indicator 23: Number of outreach or public awareness events held in the city per year	>300	4	4
Total			92	39

Source: Dr. Meenakshi Dhote & Himanshhu Panwar, SPA

Figure 8: Results for the Biodiversity toolkit for Agra City

Sorocaba Municipality, São Paulo State, Brazil

The Sorocaba Municipality (São Paulo State, Brazil) has an area of 449.12 sq.km and a population of 586,625 inhabitants of which 98 per cent are living in the urban area. Revealing a high population density (1,356.98 inhabitants/km²) the municipality and had undergone several economic cycles, which deeply influenced the socioeconomic and natural environment. Currently, only 16.9 per cent of the original Sorocaba Municipality vegetation still remains little altered, mainly concentrated in the rural landscape permanent preservation areas, given that Sorocaba presents a dense and perennial mesh water resources.

Facing this scenario, Sorocaba has been developing biodiversity conservation actions since 1970, through the creation of specially protected areas (e.g. Biquinha, ÁguaVermelha and Chico Mendes Parks), as well as developing actions to protect native wildlife and threatened extinction through Quinzinho de Barros Municipal Zoo. In the 1990s, Sorocaba River decontamination and degraded areas recovery began, through intercropped nurseries with production capacity of more than 200,000 native seedlings per year, of which more than 500,000 were planted with the plan planted in 2009.

During 2009, Sorocaba Municipality, through the Municipal Secretariat of Environmental, showed by the "Programa Município Verde Azul" a significant evolution in its environmental performance, gave the actions for restoration, conservation and biodiversity protection. This program aimed to certify the best municipal practices in ten directives, and one of them was about biodiversity. It is worth mentioning that in the last decade, there has been a significant advance in the creation of new parks and plazas to protect natural resources and biodiversity. However, not all areas are well established, consolidated or have with public use, but they already positively impact the landscape and are suitable for the realization of biological connectivity, hydric resources protection, biota protection, as well as public use for recreation and environmental education.[10]

Aichi Targets

The Plan of Action on Subnational Governments, Cities and Other Local Authorities for Biodiversity under the Convention on Biological Diversity, adopted at COP 10 in Nagoya, is intended to support Parties, their partners and local authorities in implementing the Strategic Plan for Biodiversity 2011-2020.

The Aichi Biodiversity Targets follow these objectives:
Increase the engagement of subnational governments and local authorities, in support of their Parties, in the successful implementation of national biodiversity strategies and action plans, the Strategic Plan for Biodiversity 2011-2020, the 2020 target and the programs of work under the CBD;

Improve regional and global coordination and exchange of lessons learned between Parties to the Convention on Biological Diversity, regional and global organizations;

Identify, enhance and disseminate policy tools, guidelines, and programs that facilitate local action on biodiversity and build the capacity of local authorities to support their national Governments in implementing the Convention on Biological Diversity;

Develop awareness-raising programs on biodiversity for local residents (including major groups such as business, local administrators, non-governmental organizations, youth and indigenous and local communities) in line with communication, education and public awareness strategies.

[10] Smith WS, Silva FL, Amorim SR, et al. Urban biodiversity: how the city can do its management?. Biodiversity Int J. 2018;2(3):246-251.

Africa

Africa is home to a rich and diverse animal, plant, and marine biodiversity that provide critical ecosystem services, driving the continent's economy and serving as buffers to climate change. However, the continent is experiencing a dramatic loss of biodiversity.

1) The World Bank, with support from the Global Environment Facility (GEF), has been among the largest financiers of biodiversity conservation in Africa. Biodiversity work, amounting to about $360 million, is included in around 50 projects currently being implemented in the Africa region.

2) In Mozambique, the World Bank is supporting the government's Mozambique Conservation Areas for Biodiversity and Development Program (MozBio). Mozambique's Conservation Areas have been designated to protect the country's diverse habitats —which include a coastline with spectacular coral reefs and over 6,000 plant, bird and mammal species. The first phase of MozBio (2015-2019) involved over 60,000 beneficiaries (almost half of whom are women) in 10 protected areas, including the Chimanimani, Maputo Special Reserve, Gilé and Quirimbas National Parks; and leveraged over US$500 million in private investment pledges. The second phase of the project goes through 2023 and aims to further support rural communities while continuing conservation and biodiversity efforts. So far, the MozBio Program has amounted to more than $100 million.

3) The fund of $220 million by World Bank in the SWIOFish Project is helping fishing communities in Comoros, Madagascar, Mozambique, Seychelles and Tanzania as well as the Maldives to increase economic benefits from fisheries, rebuild fish stocks and restore livelihoods.

4) In South Africa, the World Bank, through a GEF grant, provided implementation support to iSimangaliso Wetland Park, a UNESCO Heritage site, to improve the ecological functioning of Lake St. Lucia. The program also helped to create sustainable job opportunities for the community in and around the park, including 75 conservation-compatible enterprises.[11]

[11] Smith, Welber & Silva, Fabio & Amorim, Sara & Stefani, Marta. (2018). Biodiversity International Journal. 2. 10.15406/bij.2018.02.00068.

Way Forward

There is are afforestation-related policies with funds to disperse from the Compensatory Afforestation Fund Act, such as the Green India Mission. Also the Ministry of Environment, Forest and Climate Change, GoI is implementing the "**Nagar Van-Udyan Yojana**" on a pilot basis to create 200 city forests in the country in the next five years.12 Going forward, there is need for specific data collection with regard to decline in green areas in cities to avoid land use changes that lead to decline in urban green spaces. There is also a need for participatory and collaborative action to maintain and expand urban green spaces including green urban planning initiatives to promote the growth of urban biodiversity. Innovative design strategies for urban biodiversity conservation must be drawn up in collaboration with varied stakeholders such as scientists, ecological experts, urban planners along with the community.

[12] http://citizenmatters.in/steps-to-increase-biodiversity-in-indian-cities-4447

WWF in numbers

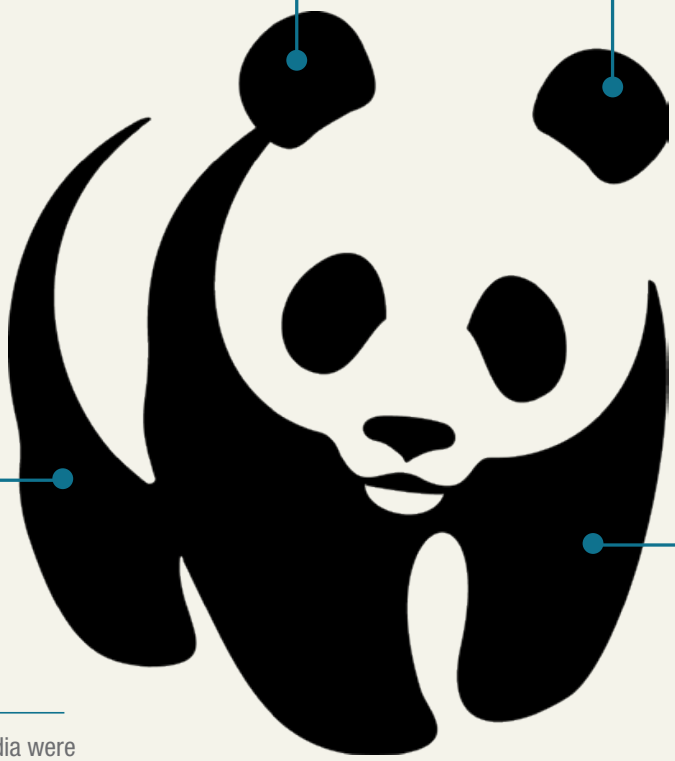
100% RECYCLED

Campaigns & Events

Individuals from across the country participated in various awareness campaigns on a range of environmental activities

Publications

Several reports on key environmental and wildlife related issues were released



Education

Students across India were engaged in several activities to benefit environment conservation

Partnerships

Partnerships were formed across a wide spectrum of organizations , communities , state governments and individuals to take the mess age of conse rvation forward

WWF-India Secretariat
172-B Lodi Estate
New Delhi
Tel: 011 4150 4814
Fax: 011 4150 4779

WWF

Why we are here
To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

www.wwfindia.org