



Ministry of Housing and Urban Affairs
Government of India



Rejuvenation and Conservation of Water Bodies and Open Areas

TRAINING MANUAL



Supported by:
 Federal Ministry for the Environment, Nature Conservation and Nuclear Safety



based on a decision of the German Bundestag

ClimateSmart Cities Assessment Framework
Urban Planning, Green Cover & Biodiversity



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Training module

Developed by:

Climate Centre for Cities, NIUA in association with Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and The Deutsches Institut für Urbanistik (DIFU) (English: German Institute of Urban Affairs).

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Photo Credit: Mahim

Executive Summary

On one hand, cities are a significant contributor of carbon emissions aggravating climate change and on the other, cities are considerably impacted by climate disasters. The recently released Global Climate Risk Index 2021 ranks India as the 7th most affected country from climate related extreme weather events (storms, floods, heatwaves etc.). Further, studies indicate that poor planning and urban management are expected to cost Indian cities somewhere between \$2.6 and \$13 billion annually.¹ Cities are increasingly at the forefront of addressing both urbanization and climate change and to strengthen climate-sensitive urban development, a holistic understanding of the urban development from a climate lens is crucial. The ClimateSmart Cities Assessment Framework (CSCAF) launched in 2019 by the Ministry of Housing and Urban Affairs (MoHUA), Government of India aimed to address this gap. This first-of-its-kind assessment with 28 progressive indicators across 5 thematic areas helps cities to benchmark their development, understand the gaps and further prioritize climate relevant development.

With a focus on building local capacities to develop and adopt climate measures, the Climate Centre for Cities (C-Cube) at the National Institute of Urban Affairs (NIUA) initiated a series of training aligned to the thematic areas of CSCAF - Energy and Green Buildings, Urban Planning, Green Cover & Biodiversity, Mobility and Air Quality, Water Management, Waste Management. The focus of the training is to provide a step-by-step approach of conducting studies, assessments and stakeholder consultations, establishing committees, developing action plans and implementing relevant measures that not only makes the cities climate resilient but also helps them progress across the assessment of CSCAF.

Urban water bodies and open areas in cities play crucial role in climate change mitigation and adaptation as they help in combating urban heat islands. With rapid urbanization and demand for built space, open areas and urban water bodies have been either reclaimed or

¹Mani, M. et al., 2018. South Asia's Hotspots: The Impact of Temperature and Precipitation Changes on Living Standards, Washington D.C.: World Bank Group.



encroached for development. The intent of this module on 'Rejuvenation and Conservation of Water Bodies and Open Areas', is provide learners with knowledge on the various measures to successfully preserve and rejuvenate waterbodies and open areas. This report embodies information on national circumstances, key concepts – impacts on urban environment, urban environment assessment, mitigation and conservation measures, strategies for rejuvenation and conservation projects. The module is developed by the National Institute of Urban Affairs (NIUA) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) along with the Ministry of Housing and Urban Affairs (MoHUA), Government of India, and lay out the benefits of applying this framework to improve livelihoods and living conditions in Indian cities.

Rejuvenation and conservation of water bodies and open areas, emphasizes on implementation of an interconnected system of urban environment comprising green spaces, recreational places, biodiversity and natural conservation areas. This manual aims to help cities to adapt integrated policies and plans for resource efficiency, mitigation and adaptation to climate change as well as disaster resilience. Adopting urban rejuvenation solutions would help city level and zonal/district authorities to protect, conserve and manage biodiversity, ecosystem services and enables them to take informed actions by the municipal authorities for combating challenges.

For carrying out the training to local stakeholders, key concepts of urban environment and climate change is explained and how to combat heat island effect through local actions is proposed. The outcome of the training is to support the local government to formulate integrated local plans and raise awareness about climate risks.





Who is the training manual designed for?



What is the focus of the training manual?



How to make use of this manual?



What are the Learning outcomes of the training?



Scope and limitations of the training

The manual is designed primarily for urban local bodies and smart city SPVs, followed by town planning department/ urban development agencies/ infrastructure development agencies or state line departments and other district administration departments related to urban forestry, resilience in water sector and water security, public health, drainage and sanitation.

The manual provides a broad overview of the following topics:

- Understanding the importance of rejuvenation of water bodies and open areas in mitigating climate risks.
- Introducing conservation strategies for water bodies and open areas
- Simple ways to spatially map the water bodies to inform decision making.

The manual has various chapters with general description and background information, exercise that reflect the content to increase the participant's knowledge and experience.

The learning includes skills to spatial map with Google Earth Pro, develop strategies for mitigating the urban heat island effect, and strategies for rejuvenation of water bodies and open spaces.

The manual is designed to guide readers to achieve basic understanding of the concepts around rejuvenation and conservation of water bodies and open areas. The manual may focus mainly on water bodies and additional reading is recommended for open areas.



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Abbreviations

ADB	Asian Development Bank
AMC	Ahmedabad Municipal Corporation
C-Cube	Climate Centre for Cities
CIPS	Centre for Innovations in Public Systems
CO2	Carbon dioxide
CSCAF	Climate Smart Cities Assessment Framework
DPR	Detailed Project Report
FDCM	Forest Development Corporation of Maharashtra
GHGs	Greenhouse Gases
GIS	Geographic Information System
GPS	Global Positioning System
HUDCO	Housing and Urban Development Corporation
IL&FS	Infrastructure Leasing and Financial Services Limited
IDFC	International Development Finance Club
KUIDFC	Karnataka Urban Infrastructure Development Finance Corporation
NHB	National Housing Bank
NPCA	National Plan for Conservation of Aquatic Ecosystems
NGOs	Non-Governmental Organisation
O&M	Operation and Management
OECD	Organisation for Economic Cooperation and Development
SOUL	Saving Open Space and Urban Lakes
SRDDCL	Sabarmati River Front Development Corporation Limited
TAGD	Tree Authority and Garden Department
UN	United Nation
ULBs	Urban Local Bodies
URDPFI	Urban and Regional Development Plans Formulation & Implementation Guidelines, 2014
UHI	Urban Heat Island
VCF	Value Capture Financing
ZAK	Zoo Authority of Karnataka

1

Introduction

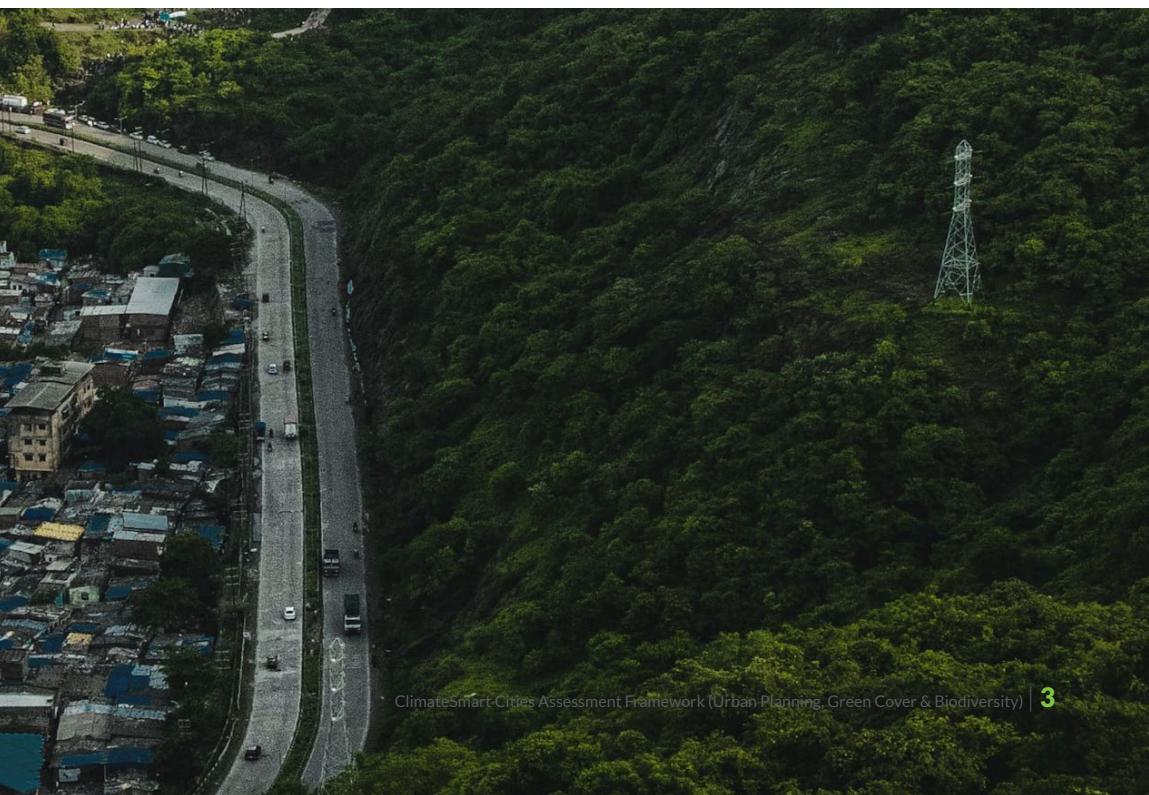
1.1. Context

The urban environment consists of many aspects including water bodies, open spaces and built-up area. From a climate adaptation and mitigation perspective, all three aspects play a critical role. Water bodies are essential as reservoirs for drinking water, as retention basins for groundwater recharge, for protection in case of floods and for maintaining biodiversity. Having local sources of fresh water decreases the dependence on energy for pumping purposes. Open spaces, namely recreational spaces, organised green and other common spaces, in any city play a critical role in terms of climate mitigation and adaptation,



Photo Credit: Md Mahdi on Unsplash

by decreasing local temperature and helping recharge groundwater. Increase in built up areas and decrease of water bodies and open spaces lead to an increase in the local temperature within a city, called the urban heat island effect. The various departments that are responsible to undertake such tasks are the Urban Local Bodies, Development Authority, Town Planning Department, National Remote Sensing Agency, State Remote Sensing Agency, Horticulture department', Environment officer.



1.2. Aligning indicator with CSCAF

The training aligns to an indicator in the ClimateSmart Cities Assessment Framework. The indicator on 'rejuvenation and conservation of water bodies and open areas, helps cities to progress across 5 levels.

	1	2	3/4	5
Progression Levels	No Action Initiated	Assessment of urban water bodies and open areas	Allocation of Budget and Implementation	Monitoring, Review & Maintenance
Evidence/ Data sources	No Action Initiated	<ul style="list-style-type: none">• Mapping of water bodies which includes their location, area, depth, volume and current status (ownership, encroachment, protected/ conserved/ maintained as per prescribed guidelines) has been carried out for the current year.• Mapping of open areas (planned greens) with details of current status (including ownership, encroachment, protected/ conserved/ maintained as per prescribed guidelines) has been carried out for the current year.• Urban heat island map for the city has been prepared	<ul style="list-style-type: none">• Informed actions for rejuvenation and conservation of water bodies and open areas have been initiated (with supporting documents: photographs, proof of contracts, etc.) based on mapping and assessments conducted at level 2.• Proof of fund allocation and expenditure for conservation and rejuvenation	<ul style="list-style-type: none">• Monitoring, review & maintenance mechanisms in place for long-term sustainability of rejuvenation & conservation actions• Evidence on change/ improvement in status and quality of open areas and water bodies, as per relevant guidelines• Map of rejuvenated & conserved water bodies & open areas as a.kml file (polygon geometry)

Figure 1: Indicators of the ClimateSmart Cities Assessment Framework 2.0



2

Introduction to Urban Environment

2.1. Concepts

Cities are a complex system of natural and built environments. Urban environment consists of many aspects including water bodies, open spaces, and built-up area, and all three plays a critical role from climate adaptation and mitigation perspective.

Water Bodies, are essential as reservoirs for drinking, as retention basins for groundwater recharge, for protection in case of floods and for maintaining biodiversity. All natural and manmade water bodies bound on all sides, will be considered for the purpose of this indicator.

Open Areas, namely recreational spaces planned and green buffer zones (as per URDPFI Guidelines, 2014) in any city play a critical role in terms of climate mitigation and adaptation aspects by decreasing local temperature and help recharge groundwater. Increase in build-up areas and decrease of water bodies and open spaces lead to an increase in the local temperature within a city, resulting urban heat island that is significantly warmer than its surrounding areas/rural areas due to human activities.

Urban Environment has 3 dimensions within it – Natural, Built and Socio-economic.

2.2. Functions of Urban Environment

Water bodies and Open areas in cities play crucial role not limited to only aesthetics or improve quality life but also support in carbon storage and sequestration. They also help recharge water reserves and regulate extreme weather events such as cyclones. They act as natural shock absorbents and help regulate the urban heat island effect in urban

Figure 2: Dimensions of Urban Environment

Natural	Built	Socio-economic
 <ul style="list-style-type: none"> • Water-bodies • Open Spaces • Human beings • Flora and Fauna 	 <ul style="list-style-type: none"> • Residential buildings • Commercial buildings • Roads and Paved surfaces • Other Infrastructures like Railways, drainage, power, gas etc 	 <ul style="list-style-type: none"> • Human activities • Arts and culture • Economic and business activities • Heritage • Lifestyle

areas. They also help to preserve and act as habitats for the urban biodiversity. On a more localised level, presence of water bodies and green spaces help preserves physical human health and psychological well-being. Moreover, they improve property value, liveability and quality of urban life.

Figure 3: Functions of water bodies, open spaces and green spaces

PROVISIONING SERVICES	REGULATING SERVICES	CULTURAL SERVICES	SUPPORTING SERVICES
 <ul style="list-style-type: none"> • Food • Fresh Water • Fiber & Fuel • Biochemical Products • Genetic Material 	 <ul style="list-style-type: none"> • Climate Regulation • Hydrological Regime • Pollution Control & Detoxification • Natural Hazard Mitigation • Erosion Protection 	 <ul style="list-style-type: none"> • Spiritual & Inspirational • Educational • Recreational • Aesthetics 	 <ul style="list-style-type: none"> • Biodiversity • Soil Formation • Nutrient Cycling • Pollination
 <ul style="list-style-type: none"> • Food • Fiber & Fuel 	 <ul style="list-style-type: none"> • Mitigation of UHI • Carbon sequestration • Reduce Noise Pollution • Improve Air Quality • Reduce Impacts of extreme weather events • Reduce Energy Consumption 	 <ul style="list-style-type: none"> • Cultural significance • Aesthetic Contribution, Scenic Beauty 	 <ul style="list-style-type: none"> • Improves Urban Biodiversity especially bird's life

Source: Urban Wetland/Water Bodies management Guidelines Vol I 2021

2.3. Impacts on Urban Environment

2.3.1. Effects of Urbanization on Urban Environment

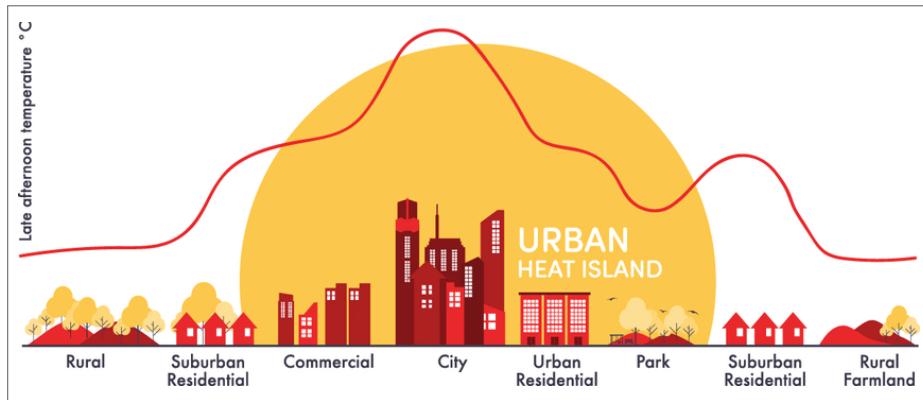
The visible outcome of land use change in the wake of urbanization is the spatial expansion of built-up areas accompanied by changes in the urban spatial structure and the urban form. Increased population leads to increased land demand that have consequences on the use of natural assets such as water bodies and open areas. Conversion of water bodies and open spaces to support urbanization is significant. It is not only the quantity of land converted to urban uses that needs to be considered, but also the previous land use and land cover, the dominant purpose of the new urban use, the corresponding land cover features, the location and pattern of new urban land and the efficiency of land use (Nuissl & Siedentop, 2021). Effects of urbanization on water bodies can be seen in the degradation of the water bodies, decline in nearby vegetation cover, reduction of water table and frequent flooding during normal rainfall.

2.3.2. Impact of Climate Change on Urban Environment

There are multi-fold impacts of climate change on the urban environment, mainly translated in the form of water scarcity, decrease in green cover, urban heat island effect, salt water intrusion and urban flooding. Out of these the main impact is seen mostly through increasing temperatures in urban areas resulting in the heat island effect.

Heat Island Effect: Heat island is simply an area, volume, or region in which the temperature is higher than that of the surroundings. Urban Heat Island (UHI) is the difference between the temperature in a certain urban location and that at a given reference point in a nonurban location.

Figure 4: Urban Heat Island1



Heat islands occur in urban areas because of the following reasons - thermal bulk and surface radiation properties of concrete and asphalt, lack of shading and cooling effect of trees, increased reflective and absorptive surfaces of tall buildings, higher levels of pollution and wind blocking by high rises.

The impact of climate change on heat island effect is circular as the increase in urban heat island effects also result in further climate change. The impact of heat island effect on climate change is two-fold. As temperatures increase due to climate change and global warming, it results in higher temperatures seen across urban areas. This leads to an increased heating effect that enhances global warming further. This also increases demands for cooling mechanisms which result in increased emissions of greenhouse gases – which ultimately results in global warming.

¹Sharma. S (2021). Urban heat island – causes, impact and solutions: Explained, Pointwise. Forumias. [Online] Available here: <https://blog.forumias.com/urban-heat-island-and-its-impact/> (Accessed on 14th December 2021)

2.3.3. Rules and Regulations monitoring the urban environment

The various guidelines, rules, acts and policies for urban planning or rejuvenation have been formulated at the national and state levels. These legislations or guidelines are to be translated at the regional levels as per the context and socioeconomic and ecological conditions of the region. These guidelines also provide benchmarks to be followed while designing strategies and act as a guiding document for urban local bodies for a holistic understanding of the process of implementation.

Figure 5: Acts/Guidelines, and Plans for Urban Environment; NIUA

Acts/Guidelines, and Plans for Urban Environment
Environmental Protection Act, 1986 National Water Policy, 2002 National Water Mission Under National Action Plan on Climate Change, 2008 National Mission on Sustainable Habitat, 2009
Indicator Specific Guidelines/Plans
Guidelines for National Lake Conservation Plan, 2008 Advisory On Conservation and Restoration of Water Bodies in Urban Areas, 2013 Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines, 2014 Model Building Bye Laws 2016 Urban Greening Guidelines Guidelines for Urban Water Conservation National Plan for Conservation of Aquatic Ecosystems (NPCA), 2019



Photo Credit: Chuttersnap on Unsplash

3

Assessment and Conservation Measures

Mapping of water bodies and open spaces aides in understanding the efforts taken, or are required to be taken, for the rejuvenation and conservation of the same. The spatial information provided by the maps not only helps in urban planning but also in monitoring the urban environment components during and after the implementation of initiatives. It also helps to identify extent and status of water bodies and open areas and the spatial and temporal changes in them. Assessment for urban water bodies and open spaces also include understanding how the presence of water bodies and green spaces affect surface temperatures and the presence of Urban Heat islands. Visualization and mapping for urban heat island generally undertaken through 2 methodologies: mapping air temperature or mapping surface temperature.

3.1. Strategies for rejuvenation of water bodies

The strategies for the rejuvenation of the water bodies includes measures to prevent pollution and treatment of catchment areas to ensure removal of obstruction in inlet and outlet of water bodies. The strategies can be categorised into:

1. In-situ conservation
2. Area Treatment
3. Quality
4. Restrictions and Awareness

Figure 6: Rejuvenation of Water Bodies

Area Treatment	In-Situ Conservation
afforestation, storm water drainage management, silt traps	De-silting and de-weeding
Removal of obstructions in the inlet and outlet of the water body	Bio-manipulation
Plantation of trees along the sides of water bodies	Bioremediation
Removal of encroachments in the water body boundary/spread area	Green Bridge
Strengthening of bund, fencing/re-fencing	Sedimentation Basin
Wetland plantations near the inlet to filter water	Rainwater Harvesting

Quality Monitoring	Restrictions and Awareness
<ul style="list-style-type: none"> Prevention of any outfall of domestic/industrial sewage Ensuring only treated effluent dispose into the water bodies Monitoring of water quality of the Water Body weekly basis by the concerned ULB A separate tank for religious/cultural festivities that require immersion 	<ul style="list-style-type: none"> Land around water body should be declared as eco-sensitive area Impose ban on uses of ‘potable water’ for purposes other than drinking Uses of water for remaining purposes available through re-cycling and re-use process Walking track may be constructed around the water body to increase public awareness Display notice boards in the surrounding areas of the lake, informing Do’s and Don’ts, etc To promote community participation by organizing awareness programmes, etc

3.1.1. In-situ Conservation

In-situ conservation measures involve prevention of pollution in the water body like cleaning of water bodies. This includes de-silting, de-weeding, aeration, removal of invasive plant species and reduction of nutrients. Some of the measures are:

- 1. Bioremediation:** It is the process of breaking down the toxic pollutants of water bodies into less or non-toxic elements by the help of naturally occurring microorganisms like yeast, fungi and bacteria. The process includes steps like physical cleaning, aeration and by use of specifically cultured products, containing beneficial bacteria and/or enzymes
- 2. Bio-manipulation:** This process helps to control the eutrophication in the water bodies through biological engineering. This involves selective removal or encouragement of growth of herbivorous fishes which can be graze algae in the water bodies.
- 3. Sedimentation Basin:** The first flush of storm water brings in organic content and silts into the lake, which change the water chemistry as well and is hazardous in nature. Sedimentation basins are created to arrest this content to enter the lake at the space before the entry point using a biological approach.
- 4. Green Bridge:** This measure includes formation of bridged using Cellulosic or fibrous materials like coconut coir or dried-up water hyacinth and strengthening them by stones or sand. The bridge helps in trapping the coarse pollutants thereby maintaining the turbidity of water of the water bodies.
- 5. Rainwater Harvesting:** Harvesting storm water is a practice for in-situ augmentation. The rainwater can be collected from the catchments and by creating storm water storage in the flow accumulation points.

3.1.2. Area Treatment

The strategy includes treatment of the catchment area and area around the water bodies. The catchment area treatment is done through afforestation, silt traps, storm water drainage management and ensuring removal and avoidance of obstruction in the inlet and outlet of the waterbody. Area around the water bodies need to be maintained by beautification of the waterfronts, plantation of trees to maintain biodiversity, and create habitation of natural flora and fauna. The encroachment around the waterbody boundary spread area should be removed to avoid further degradation and bunds and fencing to be provided or strengthened. Wetland plantation would enhance the filter of water naturally as soon as it enters the lake or water bodies.

3.1.3. Quality

The flow of industrial, domestic, and agricultural effluents into the waterbody leads

to deterioration of the quality of water. This decline in the quality leads to growth of algae that reduce the oxygen content. Apart from making water non-potable it also leads to death of the aquatic organisms. Therefore, the quality of water bodies needs to be monitored regularly and efforts are to be taken to ensure maintenance of the same as per

the given standards. Any outfall of domestic/industrial sewage into the waterbody should be prevented and ensuring only disposal of effluent treated as per the effluent standards of the state pollution control board into the water bodies. The monitoring of water quality should be conducted on a regular basis, weekly, by the urban local bodies to take measures to improve or take actions towards maintaining. For religious or cultural festivities like Ganesh Chaturthi and Durga Puja that involve immersion, a separate tank should be.

3.1.4. Restrictions and Awareness

To ensure the sustainability of measures taken for the rejuvenation and conservation of water bodies, public participation is a crucial aspect. This also involves raising awareness of citizens and imposing restrictions to prevent pollution and ensure maintenance. To generate awareness among people, notice boards with the prohibitions and activities allowed to be displayed near water bodies. The creation of walking tracks and recreational activities for the public can help raise awareness. Awareness programmes through various seminars and workshops can be organised to promote community participation in activities like cleaning, beautification, and conservation of water bodies. Certain restrictions and prohibitions that need to be imposed are:

1. Declaring the land around waterbodies and at a certain distance from shore as eco-sensitive zones.
2. Dumping of waste into eco-sensitive areas to be made a punishable offence.
3. Imposing bans on the usage of potable water for purposes other than drinking and water from other purposes should be made available through re-cycling and reuse considering the feasibility and health implications.

3.2. Strategies for Rejuvenation of Open Spaces

Rejuvenation of open spaces in the urban areas can be categorised into area treatment that involves plantation measures and maintaining and conserving the existing open green

3.2.1. Area Treatment

Area treatment includes a plethora of activities that involve greening measures inclusive of plantations, maintenance, and conservation. Development and maintenance of parks is one of the measures to enhance the green cover in an urban region like district parks, neighbourhood parks, tot lots and playgrounds. Impermeable surfaces lead to loss of moisture and lack of air and restricted plant growth. The excessive loss of trees due to construction as well as uprooting of trees due to storms at the street sides calls for greening of urban streets. Landscaping and beautification of areas adjacent to heritage buildings will add both aesthetic and economic value. Provisions of conserved areas, natural landscape areas, and social forests are to be made within the cities. Various other measures include development of green squares, green belts, greenways, city/urban forests.

- Green Belts:** These are the large open areas or space in and around cities where urban development is prohibited through zoning, public ownerships, easements or development restrictions. They play an important environmental role by reducing air pollution and providing habitat for biodiversity. Examples are Delhi Ridge forests, Sanjay Gandhi National Park in Mumbai, Guindy National Park in Chennai, and Maidan in Kolkata
- Greenways:** Greenways are the vegetated corridors used for improving environmental quality, while also providing recreation services and alternative transportation routes for bicycles and pedestrians.
- City forest:** These are the forested areas located within the boundaries of cities or within close proximity. Activities related to wood production are prohibited in these regions.
- Green Squares:** These are compact green spaces surrounded by residential and public buildings.

3.2.2. Maintenance and Conservation

- Conservation of green areas and ensuring certain areas are not encroached or subject to construction such as areas around flood plains, coastal zones in case of coastal cities or towns, in case of hilly towns, area under mountainous slopes, and area around natural drains.
- To enhance the accessibility of green spaces for the public, different open spaces need to be inter-linked by providing connectivity and should be maintained in an integrated manner.
- Public participation is one of the major aspects for the rejuvenation and conservation of the greens. Involving Resident Welfare Associations, students and other groups to enhance public participation for maintenance of green helps in sensitising people about the importance of urban green and open spaces.

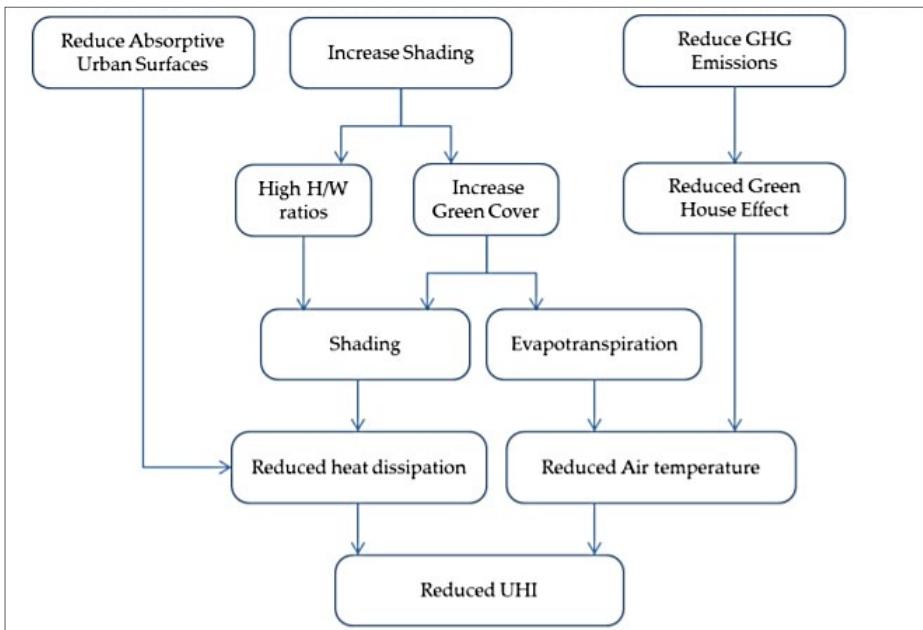
Figure 7: Area treatment and maintenance & conservation measures

Area Treatment	Maintenance and Conservation
<ul style="list-style-type: none"> Development and maintenance of parks Greening of urban streets Landscaping and beautification of areas adjacent to heritage buildings Provision of conserved areas, natural landscape areas, and social forests Development of Green Squares, Green Belts, Green ways Development of city/urban forest 	<ul style="list-style-type: none"> Conservation of green spaces Ensuring no encroachment or construction in flood plains, coastal zones, mountains, natural drains Declaring the environmental sensitive zone as no construction/development zone Ensuring different open spaces need to be inter-linked by providing connectivity/linkages Sensitisation of people through Resident Welfare Association

3.3. Strategies for mitigating urban heat island effect

The strategies to mitigate the urban heat island effect includes greening measures by the provision of shade to the building surfaces and deflecting radiation from the sun. The strategies to mitigate urban heat island can be broadly categorised into Urban Plantation, Cool/green roof Measures, and Anthropogenic Heat reduction measures.

Figure 8: Steps to reduce UHI



3.3.1. Urban Plantation

Vegetation helps in reducing the air and surface temperatures by providing shade, minimising ground temperature differences and through evapo-transpiration. Evapotranspiration alone, as well as when combined with shading can reduce the summer temperatures by 1-5 degree Celsius. Shading reduces direct solar radiation from getting absorbed by the urban impervious surfaces. When planted in the strategic locations, the trees and vegetation thus act as a mitigation strategy for the urban heat island. In addition, the trees capture the atmospheric CO₂ and also reduces the anthropogenic emissions by decreasing the energy demands required for thermal comfort (TERI, 2017), (Jain & Sarkar, 2017).



Source: <https://unu.edu/urban-agriculture-what-does-the-future-hold.html>

3.3.2. Cool roof/Green roof measures

Green roof or cool roof measures help in reducing the surface and air temperature and thus contributes towards energy savings and reduced emissions. Green roof is a cover of vegetation on a roof top that provides shade, reduces air temperature and temperatures of the roof surfaces. The temperatures of such roofs can be up to 4 degree Celsius lower than the conventional roofs and can reduce energy use of a building by 0.7% (EPA United States Environmental Protection Agency, n.d.). Apart from lowering energy demands for cooling, reducing air pollution and Greenhouse gasses emissions, green roofs also enhance the aesthetic value and helps in storm water management by reducing run offs (EPA United States Environmental Protection Agency, n.d.).



The green rooftops in the city of Chicago provide multiple benefits. While they help in regulating temperature and saving energy. They brought back the fauna that were displaced due to urban development and also complement the supply of vegetables and herbs from local vendors and farms.

Cool roofs are the roofs that are built from materials that are highly reflective and emissive. These roofs are coated with materials that retain less heat by reflecting more sunlight and are therefore cooler than the conventional roofs; this keeps the temperature inside the building cooler. Cool roofs help in reducing indoor temperature to up to 5 degree Celsius as compared to the conventional roofs (Natural Resources Defense Council, 2020). These roofs thus save energy costs and reduce cooling load of a building and therefore carbon emissions. Different materials that are used are: coated cool roofs that involve coating with high reflectivity paints that are made up of lime wash or acrylic polymer or specific pigments. Mostly they are white in colour; Membrane cool roofs use prefabricated materials such as membranes or sheets like polyvinyl chloride or bitumen based to cover an existing roof; Tiled cool roofs involve white coloured mosaic tiles on top of existing roof.

3.3.3. Other Anthropogenic Reduction Measures

Anthropogenic heat like that emitted from vehicles get trapped in urban canyons that lead to increasing temperatures. So, the mitigative measures include steps to reduce the anthropogenic heat by promoting public transportation, switching to cleaner fuels and e-vehicles, promoting pedestrians and cyclists. This would help in reducing air pollution as well as reducing urban temperatures.



Copenhagen has been at the forefront in building bridges meant for cycling so as to enable efficient and easy cycling and promoting bicycle usage as daily means of transport.

4

Key Implementation Strategies

A successful strategy for rejuvenation and conservation of waterbodies and open spaces in urban areas is a function of various key measures. These measures include translation of legislations into practice, understanding the baseline, and essential components to be included in documents pertaining to the projects.

4.1. Supportive policy and Institutional Environment

The various guidelines, rules, acts and policies for urban planning or rejuvenation have been formulated at the national and state levels briefly mentioned in section 2.4.

4.2. Assessment of Baseline Status

A baseline assessment is always required before the execution of the project to understand the current status of the water body or the open/green space to be rejuvenated or conserved and the reasons for the deterioration. The assessments are often carried out by preparing maps to compare the data of the current status and the status of the same area 10-20 years back. This helps to understand trends of the past decades and identifying reasons like encroachments and changes in settlements in the surrounding regions. The baseline status also includes assessing the quality of water and soil to understand the extent of degradation by comparing it with the prescribed norms, sources of pollution or degradation like disposal of waste, physical conditions like growth of weeds or invasive species, socio-economic, social, and aesthetical aspects of the area to be rejuvenated.

4.3. Constituting a Committee

Implementation of rejuvenation strategies require coordination and close collaboration of multiple government departments, non-government stakeholders such as civil society organisations, developmental organisations, academic and research institutes as well as members from the communities. The committee formation aides in better planning, ease the intra-, as well as inter-departmental coordination and communication within the government machinery involved and also between government departments and non-government entities.

4.4. Project Execution and Monitoring

A systematic analysis of information based on planned activities and set targets during the implementation of the rejuvenation initiatives is required to measure progress. Evaluation exercises have to be conducted to compare actual outcomes and impacts against the agreed strategic plan (or Master Plan) at different stages of their implementation. Continued and direct communication with community members, local Non-Governmental Organisations (NGOs) and government representatives to monitor project implementation, keeping track of project priorities and results are required to initiate course correction, as necessary. A comprehensive project report provides an overview of the fields of action and priorities. What should be included in such a report is listed in below figure 15.

Figure 9: Components of detailed project report

Project Background	Introduction, Project Purpose, Objectives, Scope of Work, Relevance of the interventions
Existing Condition	<ul style="list-style-type: none"> • Mapping and assessment • Socio-economic study of the surrounding and land use pattern • Rainfall pattern of last 10 years • Geographical and hydrological details of the water bodies • Soil characteristics, area encroached, area under green cover
Statutory and Legal Framework	Legislations, rules, guidelines, plans at National and State Level
Benchmarking and Gap	Existing status VS benchmarks mentioned in guidelines
Impact of Rejuvenation/Conservation	Social, Economic, and Environmental Impacts
Detail Design	Project Components, Strategies, master plan etc
Cost Estimation	All relevant cost components of the proposed interventions
Implementation and Management arrangements	<ul style="list-style-type: none"> • Institutional Capacity; • Institutional framework; • Implementation schedule; • Quarterly component wise investment schedule • Project Management Set-up • Monitoring mechanism at State/ULB/Community level
Operation & Maintenance Plan	Proposed Mechanism

4.5. Financing Mechanisms

The finances of the urban local bodies can be categorised as conventional and Innovative financial mechanisms. While conventional mechanisms are the funds that are allocated generated through various sources, innovative mechanisms offer alternative routes to access funds for the implementation of the projects. Some of the innovative mechanisms include:

- 1. Issuance of Municipal Bonds:** Municipal bonds and debentures issued to the general public or specific institutions at fixed long term interest rates. These bonds can either be taxable or tax free. E.g., Pune Municipal Corporation raised INR 200 crore through the sale of municipal bonds to finance water supply projects under the Smart Cities Mission.
- 2. Operations and Management:** Factoring in O&M cost in financial plans helps to allocate separate funds for the same. Another mechanism is to implement user charges for the operations and management that can enhance the revenues of urban local bodies. E.g., Kankaria Lakefront Development project had imposed user charges.
- 3. Value Capture Financing (VCF):** This mechanism ensures that the private land and buildings that benefit from public investments in infrastructure and policy decisions of the government, should pay for it. E.g. The Ahmedabad Municipal Corporation (AMC) loaned money to Sabarmati River Front Development Corporation Limited

(SRFDCL), was supplemented by AMC's investment in the share capital of SRFDCL. Housing and Urban Development Corporation (HUDCO) also provided a loan for the Riverfront Project. A small portion of the reclaimed land will be sold for commercial development, to generate adequate resources to pay for developing the riverfront and managing it.

4. **Public-Private Partnership:** An arrangement between a government or statutory entity or government owned entity and a private sector entity for the provision of public assets and/ or related services for public benefit, through investments being made by and/or management undertaken by the private sector entity for a specified. E.g. The AMC has outsourced several recreational activities as well as activities like housekeeping, operations & maintenance and security to qualified private sector parties.
5. **Loans from financial institution:** Specialized financial institutions e.g. International Development Finance Club (IDFC), National Housing Bank (NHB), Housing and Urban Development Corporation (HUDCO) and Infrastructure Leasing and Financial Services Limited (IL&FS) are some agencies which provide loans and a variety of instruments for infrastructure financing or from multilateral funding agencies like various United Nation (UN) bodies, World Bank, Organisation for Economic Cooperation and Development (OECD), Asian Development Bank (ADB). E.g. In the case of Karanji lake restoration in Mysore Assistance was sought from the Asian Development Bank, the Karnataka Urban Infrastructure Development Finance Corporation (KUIDFC) and the Zoo Authority of Karnataka (ZAK).

If processes and tasks are outsourced to external consultants, figure 15 provides an overview of the requirements of request for proposals and the preparation of tender documents.

Table 1: Components of tender document; NIUA

Preparation of Tender Documents/ Request for Proposal	
Instruction to Consultants	Criteria and sub-criteria, Cost of Bidding, Language of Bid, Currency of Bid, List of Deliverables and Duration, Terms of payment
Technical Proposal	Brief background of the applicant firm, letter of intent, Profile and Business licenses, Evidence of undertaking similar work, latest audited financial statement, Certificates and accreditation, Summary of methodology and timelines
Financial Proposal	Cost breakdown; Per-deliverable, by Cost component
Terms of Reference	

4.6. Monitoring and Maintenance Mechanisms

Setting up a monitoring system is essential to assess the changes in the context of urban water bodies and open spaces over a period of time. It entails collecting information in order to assess whether progress is made towards the envisaged results. It also gives the key stakeholders regular feedback and indicators of progress (or lack of) and therefore an opportunity to review the assumptions and strategies at key junctures to assess their validity. Management of rejuvenation initiatives include actions or provisions for long term sustainability of the actions: This long-term sustainability can be ensured through engaging the community throughout the process from planning to implementation and raising awareness through organising programmes. The management of the initiatives can also be allocated to private entities to undertake operations and maintenance of the parks or water bodies rejuvenated.



Photo Credit: Chirag Saini on Unsplash

5

Exercise – Mapping of Water Bodies

Mapping of water bodies and open spaces aides in understanding the efforts taken, or are required to be taken, for the rejuvenation and conservation of the same. The spatial information provided by the maps not only helps in urban planning but also in monitoring the various indicators during and after the implementation of initiatives.

The objectives of the exercise were as follows:

1. Mapping water bodies and open spaces to assess their location and area
2. Extent to which the land use and land cover has changed over the years especially focusing on the water bodies and open spaces

The following steps were undertaken as a part of the exercise:

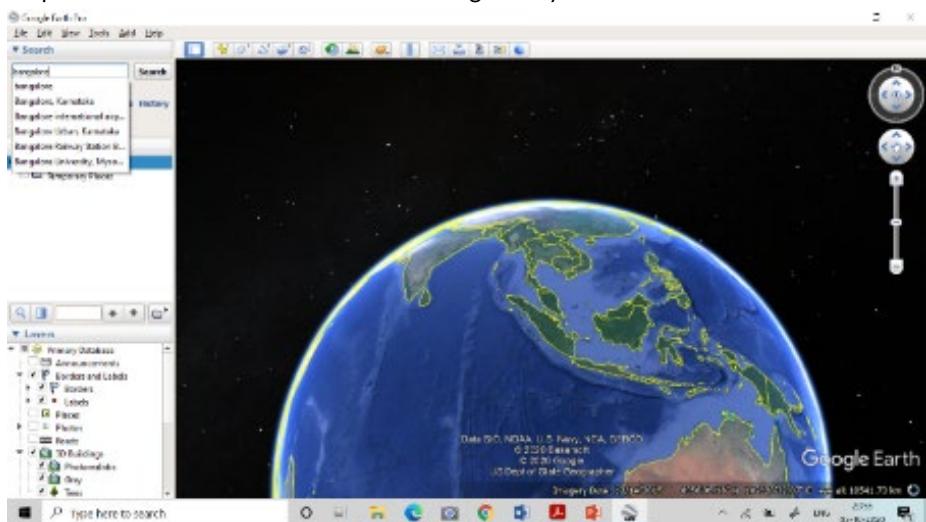
- Step 1** Search for a region/city
- Step 2** Locate a water body or open space of interest and zoom in using the slider
- Step 3** From the tool bar, click on 'Add Polygon' and edit the specification as per the requirements.
- Step 4** Select multiple points around the waterbody or open space and close the polygon/outline by selecting the starting point again.
- Step 5** In the dialog box, click on 'Measurement' tab and note the area.
- Step 6** On the 'Places' window, right click the name of the water body/open space and save file as .kmz
- Step 7** From the tool bar, select the option to print and save file as pdf

Steps to assess changes

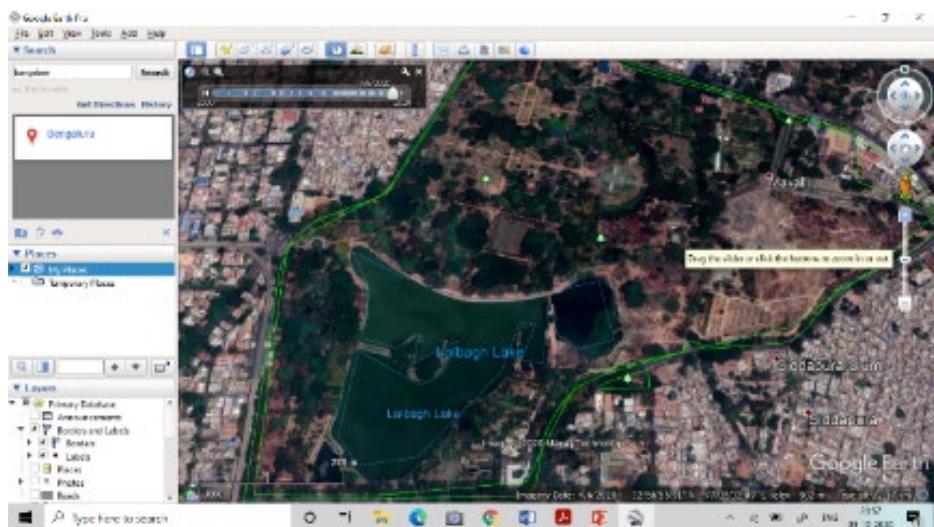
Step 1 Click on the tab for historical imagery at the bottom left of the window

Step 2 Select the timeline to from the bar at the top right corner to view the images

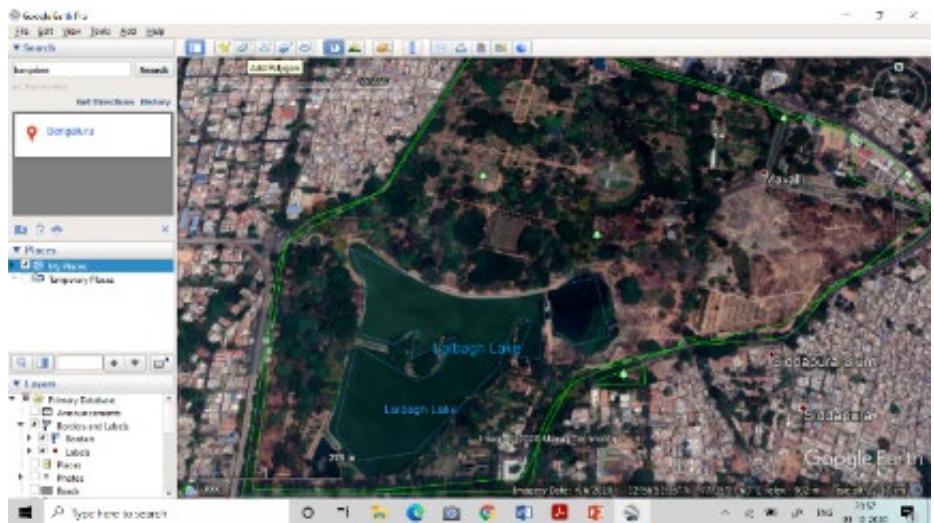
Step 1: Click on the search tab and enter a region/city

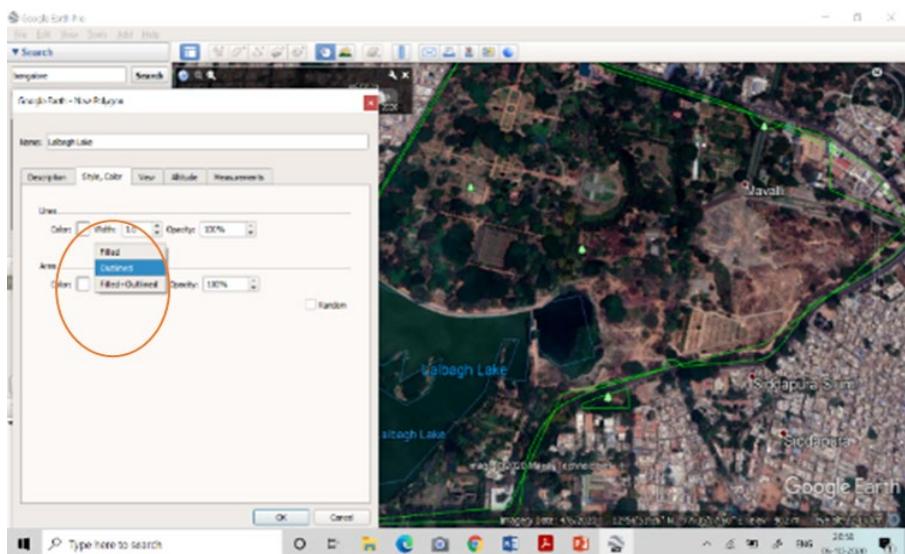


Step 2: Locate a water body or open space of interest and zoom in using the slider

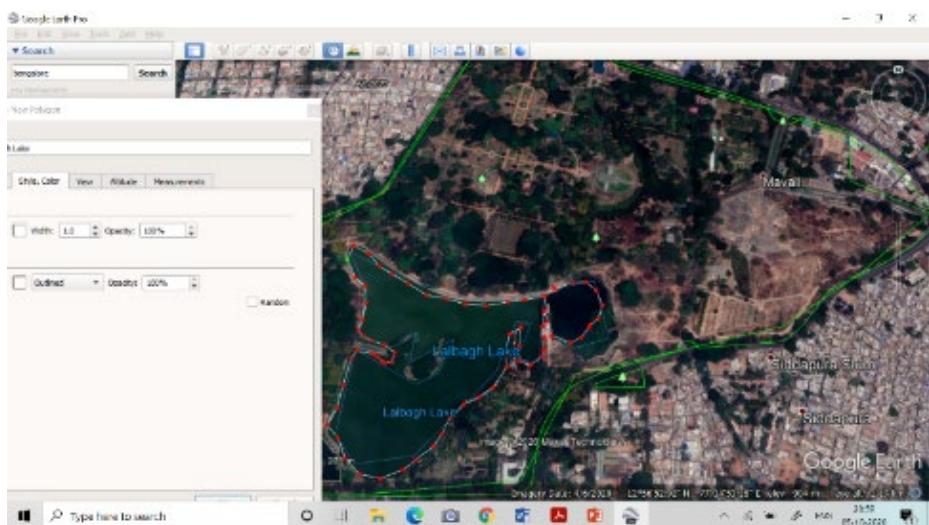


Step 3: From the tool bar, click on 'Add Polygon' and edit the specification as per the

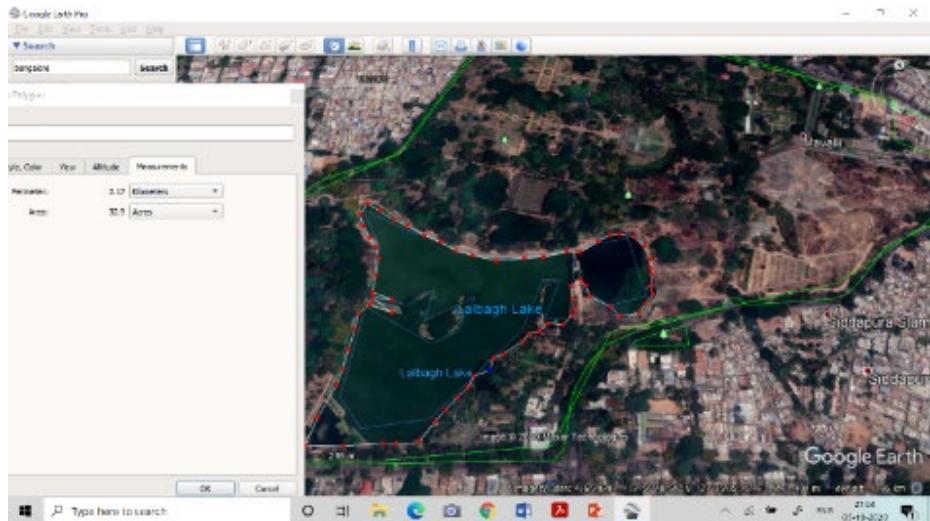




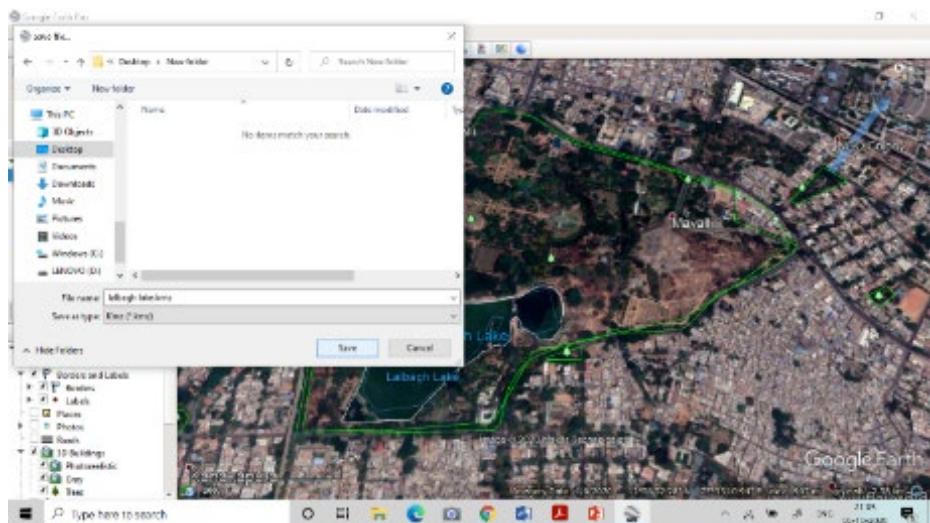
Step 4: Select multiple points around the waterbody or open space and close the polygon/outline by selecting the starting point again



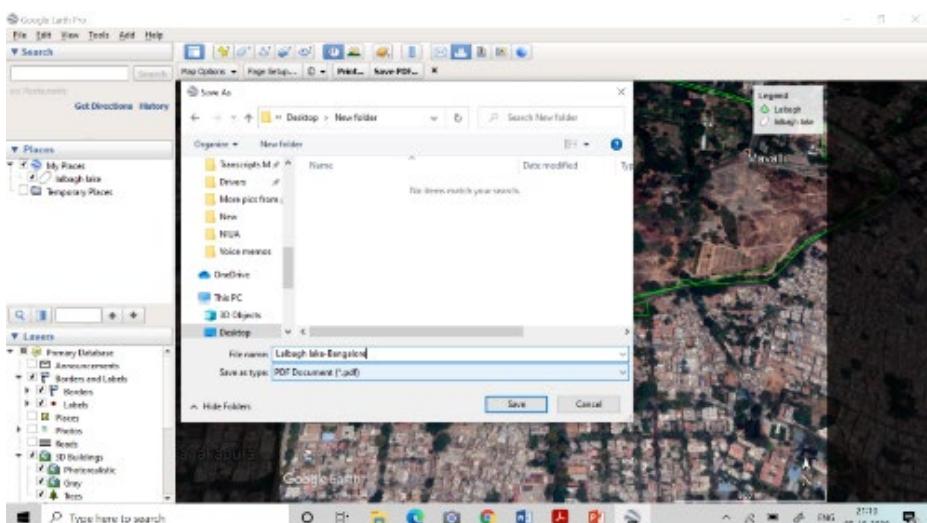
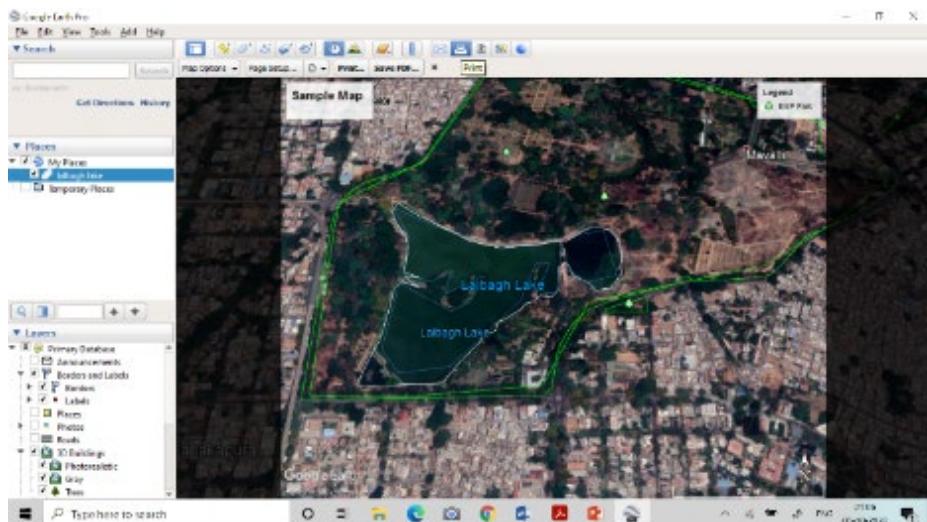
Step 5: In the dialog box, click on 'Measurement' tab and note the area.



Step 6: On the 'Places' window, right click the name of the water body/open space and save file as .kmz.

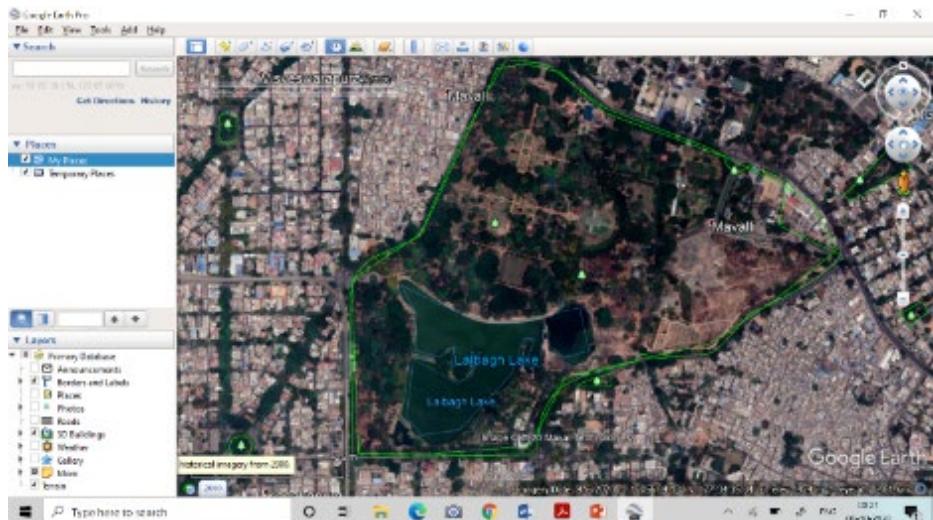


Step 7: From the tool bar, select the option to print and save file as pdf.

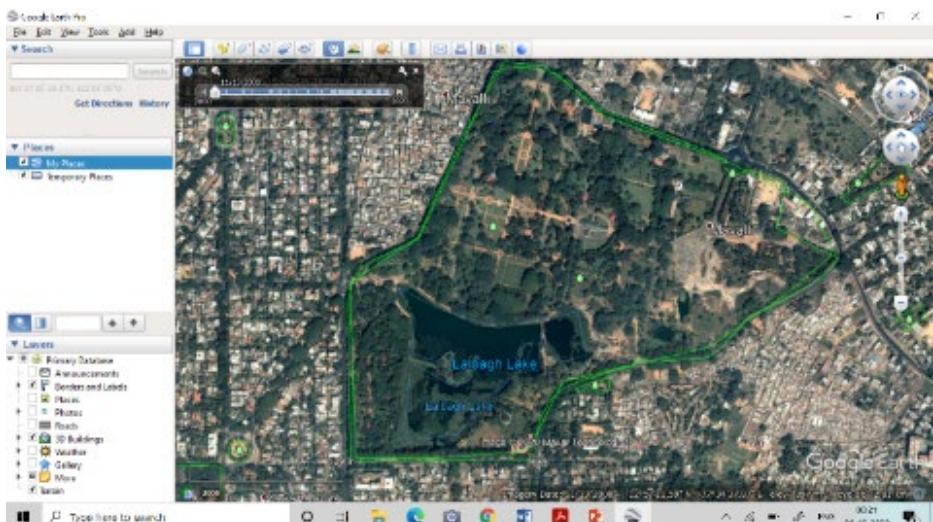


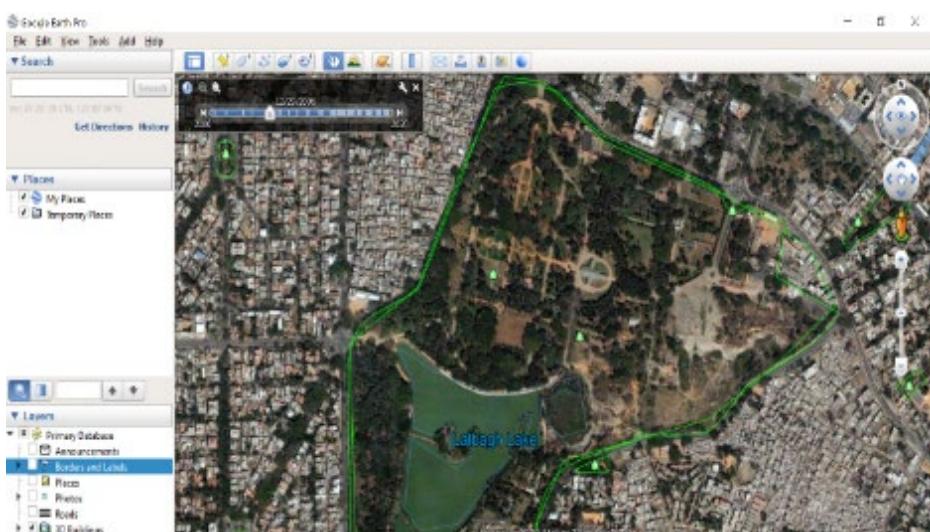
To assess the Change

Step 1: Click on the tab for historical imagery at the bottom left of the window



Step 2: Select the timeline bar from the top right corner to view the images





6

Case Studies

6.1. Saving Open Space and Urban Lakes (SOUL) and Cultural rejuvenation of Twin City of Hubli-Dharwad, Karnataka

The twin city of Hubli-Dharwad is one of largest city and in the state of Karnataka. The geographical location of the city – at the cusp of the Western Ghats and beginning of the black soil make the twin city unique. Even though the city has been blessed with natural resources but the state of the assets started to degenerate due to the drying of lakes, pollution of parks, encroachments, sewage and garbage disposal.

The municipal corporation took the initiative to rejuvenate the city by restoring its open spaces and urban lakes fearing the loss of open and recreational space in the year 2008. The efforts aimed at not only towards sustainable development but also to reinstate the trust of the citizens in the development authorities. The other key initiative was also to restore the cultural legacy of Hubli-Dharwad – the Hindustani Music.

6.1.1. Objectives of the study

1. To revive the lakes and prevent encroachment in the catchment areas.
2. To restore parks, open and recreational space through afforestation and landscaping.
3. To develop infrastructure for strengthening the cultural legacy.

6.1.2. Approach/Strategy

1. The different departments which had the control of different water bodies were converged under one initiative for coordinated efforts towards rejuvenation.
2. Introduction of unique architectural characteristic for the buildings.
3. Rejuvenation of lakes through surveys and check on encroachments: boundary fixation, desilting, bund formation, wastewater improvement interception, diversion of sewerage water.
4. Executing facilities associated with afforestation, landscaping, boating and recreational around the lake.

Figure 10: Before Implementation of SOUL Project – and cultural rejuvenation of Twin City of Hubli-Dharwad, Karnataka;



Source: CIPS

Figure 11: Construction progress implementation of SOUL Project – and cultural rejuvenation of Twin City of Hubli-Dharwad, Karnataka;



Source: CIPS

Figure 12: After Implementation of SOUL Project – and cultural rejuvenation of Twin City of Hubli-Dharwad, Karnataka;



Source: CIPS

5. Development of pathways and amusement area with provision of water supply, electrification, toilets, and other amenities.
6. Building auditoriums to encourage cultural practices, performances and setting up open-air theatres.
7. Creation of separate trusts and set up of user fees for each infrastructure to promote culture.
8. Revenue through entry tickets, parking fees, lease of the cafeteria, and amusement park ensured for the maintenance and sustainability of the actions.
9. Involvement of communities through conducting meetings during decision making and raising awareness through advertisement, special programmes, wall writings, flexes, and hoardings thus ensuring ownership and commitment of local citizens.

6.1.3. Implementing Agencies/Partners

Hubli-Dharwad Municipal Corporation, Dharwad Revenue Department, Dharwad Nirmiti Kendra, Karnataka Urban Development Department, Kannada and Cultural Department, Karnataka Tourism Department, Karnataka Forest Department, Karnataka Irrigation Department.

The then Deputy Commissioner started the initiative and contributed to the conceptualisation of the project and converging various departments. Shri Darpan Jain, the then Deputy Commissioner, Dharwad, was the prime motivator in the conceptualization of the project and the mobilization of the funds. He also brought in various other departments to work under one initiative.

6.1.4. Funding

The funds for the initiative converged from various sources rather than distributing them for smaller insignificant items. Maximum use of the services of the district construction agency by making them the implementing authority reduced the cost of construction.

Funds were collected from all existing but less important projects. To keep the project cost low the expenditure on human resource was kept the least.

6.1.5. Achievements

Figure 13: Open Space after the Project



Source: CIPS

1. Desiltation and additional storage of more than 1 lakh cubic meter created thus enhancing water storage and harvesting capacity.
2. Restoration and strengthening of bund of around 8 km length.
3. Plantation of 5000 saplings and landscaping of 100-acre area.
4. Divergence of sewerage mixing in the lake thus improving water quality and hygiene.
5. Tourist footfall has increased to almost 1 Lakh per month and more than Rs 10 Lakh Per month revenue is being generated.
6. Hundreds of programmes and performances had been staged with more than 3 Lakh audiences.
7. The initiative has been successful in creating an environment and culture strengthening infrastructure worth Rs 40 crores.
8. Prime Minister award for Excellence in Public Administration (2011-2012) in Individual Category to the then deputy commissioner.

6.1.6. Challenges

1. Challenge faced in cleaning and diverting the stinking sewage water.
2. Mapping of encroached lands, and removing the encroachments.
3. Lack of coordinated investments in the twin cities.
4. Lack of capacities of local bodies for developmental works.

6.1.7. Key Observations

1. Importance of convergence of multi departments for the implementation of the activities to meet the expertise as well as financial requirement.
2. Involvement of communities, diverse sources of revenue, assuring operations and maintenance through generating avenues for the same contribute towards the sustainability of the initiatives.

6.2. Greening Initiatives in Thane City (Ministry of Housing and Urban Affairs and GIZ India , 2020)

Thane city is located in the Maharashtra State of India and fall under the Mumbai Metropolitan Region that consists of 8 Municipal corporations, with Thane being one of them. This rapid urbanisation poses a tremendous pressure on the city's urban environment which is endowed with lakes and green spaces. To cope with the implications of concretization, Thane Municipal Corporation launched plantation drive on June 5, 2015, intending to plant 5 lakh trees in 3 years with 1 Lakh of Indigenous Species. Considering the scarcity of the land within the city, in association with the Forest Department Thane Municipal Corporation identified the degraded forests within the city limits for the plantation. The pressure of urbanisation lead to rapid deforestation of mangroves is also visible on the rapidly increased resulting in deforestation of mangroves for reclamation of land.

6.2.1. Objectives of the study

1. Regeneration of degraded forest land within the city limits.
2. Plantation of indigenous tree species.
3. Preservation of trees and tree plantation on the roadside.

6.2.2. Approach/Strategy

Figure 14: Plantation in Urban Open Spaces;



Source - TAGD

1. Thane Municipal Corporation obtained 50 Hectares hilly areas through tri-party agreement for 5 years. A large patch of degraded forest in the hilly areas of Mumbra and Diva city was taken on lease from the forest department.
2. The tri-party agreement was between the Forest Department, Forest Development Corporation of Maharashtra and Thane Municipal Corporation.
3. Free Saplings were distributed to the local leaders, Citizens, Schools and colleges and Non-Governmental Organisations for mass plantation.
4. Geotagging of the planted trees with the help of GIS/GPS technology and making it available on their website.
5. Using technology for real-time monitoring of plantations.
6. Tree Plantation Programme along the roadside is being conducted regularly.

Figure 15: Plantation Drive;



Source: TAGD

7. Extensive campaigns with media and community engagement drive to increase mass-awareness levels.
8. Along with urban degenerated forest land, the Thane Municipal Corporation also planted about 40,000 numbers of mangrove species on the marshy land
9. TMC has planted about 40,000 nos. of Avicennia marina, mangrove species on the marshy land along the creek.
10. Adoption of soil and water conservation measures such as Nala bunding, mulching, check dams to enhance water recharge and availability of water for a longer time for the plants.
11. Maintenance of the plants for 5 years by FDCM of the plantation carried out on Forest land involving watering of plants, weeding, replacing dead plants with new, etc.
12. The plantation was also carried out on open spaces, reserved forest, private housing, public parks, and developers' area.

6.2.3. Funding

The project was funded through the annual budget of the Thane Municipal Corporation.

6.2.4. Implementing Agencies/Partners

Garden Department and Tree Authority, Thane Municipal Corporation, Forest Department

6.2.5. Achievements

1. 2015: 49,638 trees were planted
2. 2016: 1,61,554 trees were planted with 76,469 plantations carried out in a single day on the 1st of July, the Thane Municipal Corporation Anniversary Day.
3. 2017: 2,88,810 trees planted with 82,870 planted in a single day on 1st of July, the Thane Municipal Corporation Anniversary Day. The goal of plantation achieved
4. 2018: 1,19,000 trees were planted out of which 50,000 were mangroves.
5. More than 6 lakhs were planted within four years in the Thane city limits involving local leaders, celebrities, NGOs, students, citizens, on degraded forest lands, roadsides, reservation plots, dividers, etc.

6.2.6. Challenges

1. Decreased Rainfall impacts the plantation
2. Extreme impacts like cyclonic storms lead to large scale uprooting of the trees
3. A total of 600 ha of land was made available on lease but due to intense degradation, only 400 ha could be used for plantation.

6.2.7. Way Ahead

1. Inclusion of local species of fruits, flower trees in the plantation drive will help to conserve and regenerate the depleting Biodiversity in Thane City area
2. Plantation of fruit trees and flower trees can become a permanent source of income for the tribal youths

3. Development of a botanical garden with natural pathways, medicinal and aromatic plantation, herbs, spices, and rare plants plantation. The work started on approx. 39,000 Sq. Mtr. the area by planting 1200 Nos. of Trees with 90 species covering nearly 30 different families.
4. Development of a biodiversity park and butterfly park is underway.

6.2.8. Key Observations

1. Thane Municipal Corporation had a key role through its Tree Authority and Garden Department.
2. Strong and stable leadership of Forest Development Corporation of Maharashtra
3. Intensive campaigning and mass involvement for the drive
4. Raising awareness among and engaging citizens, Civil Society Organisations, Students, Local leaders for the plantation programme

7

List of Reference Material

7.1. Technical Document:

1. Using Green Roofs to Reduce Heat Islands
2. Using Cool Roofs to Reduce Heat Islands
3. Natural Resources Defense Council, Frequently Asked Questions (FAQs) Cool Roofs; 2020

7.2. Strategies & Methodology:

1. Green Roofs for Healthy Cities Awards 2008
2. Urban Heat Island: Causes, Effects & Mitigating Strategies; Gunjan Jain1 & Shuvbijit Sarkar; 2017
3. Environmental Protection Agency – Heat Islands
4. Environmental Protection Agency – Reducing Risk Strategies

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Photo Credit: Noah Buscher on Unsplash

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Notes:



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Government of India**