



Urban Forestry Handbook for Bengaluru

A Bengalurean's guide to greening the city
effectively and collaboratively.

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Curated by
Bangalore Political Action Committee (B.PAC)
With inputs from experts



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Intent of this Handbook

Trees are the most effective and inexpensive solutions to a number of urban issues in Bengaluru - air quality, water quality, groundwater recharge, stormwater retention, reducing urban heat island, increasing building efficiency, health, encouraging walking and cycling, enhancing safety, stimulating the economy, and adding beauty and aesthetics. Many Bengalureans recognize this, and invest significant efforts into tree planting to help Bengaluru return to the “Garden City” it once was.

However, these well intended efforts can often fail to deliver the required long term benefits because of a gap in knowledge on how to implement urban reforestation in a way ensures long term success and enhances the ecosystem of the entire city. Examples of practices leading to unintended consequences may include -

- Planting trees on land that might be developed within the short term future
- Planting the wrong species for the given context
- Inadequate care or ownership to the saplings, beyond planting, that reduces it's success rate.
- Construction occurring without consideration of damage to existing root systems
- A lack of big picture planning and integrating the surrounding ecosystem into the tree planting project

To address this need for deeper guidance on successful urban forestry, the Bangalore Political Action Committee (B.PAC) is collaboratively developing this *Urban Forestry Handbook for Bengaluru*. While this guide is by no means exhaustive, we hope it can provide valuable introductory guidance to inform citizens and ensure that their efforts deliver the intended maximum long term benefits to the city.

Feedback

To provide any comments or feedback on this Handbook, please reach out to Sumedha Rao at sumedha@bpac.in. We will do our best to incorporate updates into the live document that will be published on the B.PAC website.

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What is urban forestry?

In the report “Guidelines on Urban and Peri-urban Forestry”, the Food and Agriculture Organization of the United Nations defines urban forests as follows:

“Urban forests can be defined as networks or systems comprising all woodlands, groups of trees, and individual trees located in urban and peri-urban areas; they include, therefore, forests, street trees, trees in parks and gardens, and trees in derelict corners. Urban forests are the backbone of the green infrastructure, bridging rural and urban areas and ameliorating a city’s environmental footprint”

Further, the report goes on to describe the scope of urban forestry:

“Urban and peri-urban forestry (UPF) is the practice of managing urban forests to ensure their optimal contributions to the physiological, sociological and economic well-being of urban societies. UPF is an integrated, interdisciplinary, participatory and strategic approach to planning and managing forests and trees in and around cities. It involves the assessment, planning, planting, maintenance, preservation and monitoring of urban forests, and it can operate at scales ranging from single trees to landscapes.”

We follow this description in this guidebook in the context of Bengaluru, where urban forests comprise all vegetated and green infrastructure within the city’s boundary, are vital to the performance and quality of life in the city, and must be promoted via a comprehensive and inclusive process.

While the predominant focus in this guidebook is on urban trees, we encourage the integration of different types of green infrastructure - herbs, shrubs, indoor plants, terrace gardens/green roofs, kitchen gardens, etc. to achieve the larger goals of creating a livable and sustainable city.

Why urban forestry?

Benefits of urban trees

The benefits of urban trees go far beyond the commonly known uses of delivering oxygen and adding beauty to a space. Some of the additional benefits - direct and indirect - include -

- Environmental benefits -
 - Improving air quality, sequestering carbon gas emissions, regulating microclimate, and reversing climate change
 - Reducing urban heat island effect, which creates a rise in temperature in urban areas through absorption and reflection of heat from building and infrastructure surfaces. This rise in ambient temperature increases the cooling load on building mechanical systems, thereby making buildings more energy inefficient, while decreasing outdoor comfort levels. Trees help regulate the microclimate and reverse this effect.
 - Absorbs and filters rainwater, recharges groundwater, and purifies nearby water bodies.
 - Prevents soil erosion and dust and remediates contaminated soils.
 - Promotes habitat restoration, enables the survival of urban flora and fauna, increases the resilience of urban ecosystems.
- Social benefits -
 - Various research studies show that an increase in greenspace can lead to better health and a greater incentive to be outdoors. This fosters community connection and increased eyes on the streets, which reduces crime rates and improves safety. Access to green space is also known to improve happiness and quality of life, which supports education, productivity, and collaboration.
 - Preserving trees also preserves the local natural heritage of a land.
- Economic benefits -
 - The environmental benefits discussed above point towards cost reductions in energy (from energy efficiency) and water (from improved water security which reduces the need to transport water from elsewhere).
 - The social and health benefits discussed above point to economic vitality through increased productivity.
 - Trees can also enhance beauty and tourism, which in itself is a valuable revenue source.

Evolution of Bengaluru's urban green space

Bengaluru's changing landscape has seen a rapid loss of trees, which is directly reflected in the loss of many of the benefits listed above. It is important to understand these changes to discover future pathways to restoring urban forests.

The Karnataka Forest Department classifies Bengaluru rural and urban areas as falling within the Eastern Dry agro-climatic zone. In the 1600s, Bengaluru's vegetation was drier and included thorny

forests, but after the creation of Lalbagh by Hyder Ali and Cubbon Park by the British, Bengaluru started to gain prominence as the Garden City, and urban forests began to become part of the city's culture and identity (Ramachandra, et. al., 2014). Subsequently, factors including the creation of tanks and water bodies across the city, the soil quality, and pleasant climate of the city provided the ideal environment for many native and exotic species to thrive.

Several distinguished urban forestry practitioners since, such as Sri S. G. Neginhal, through the Department of Forestry, have made incredible contributions to tree planting in the city, especially along streets and on vacant institutional lands. However, following the population explosion, rapid urbanization, and unplanned land-use development associated with Bengaluru's IT boom in the 1990s, green spaces in the city have severely shrunk. Recent research from the Indian Institute of Science has found a 66% decrease in vegetated cover in Bengaluru over the last 40 years (Ramachandra, et. al, 2012).

Consider the evolution of roads in Bengaluru. Old Bengaluru was known for its wide roads and avenue trees. Along the sides of roads were parallel wide foot paths with enough space to plant trees, and a stormwater drain further parallel to that on the far ends, beyond which building entrances and gates were placed. But as development occurred and roads were widened for construction, the buildings were built closer to the gate, and the footpaths were eliminated. Currently, some of these common challenges exist -

- Many roads don't have a footpath. The road is immediately next to a building.
- Where they do have a footpath, it is usually just the granite stones covering storm / sewage drains, with little to no space for tree planting.
- Where there is some planting space, it is very minimal. This is not usually sufficient to plant a tree, and is better suited for shrubbery.
- Where there is adequate space to plant a small or large tree, there are wires overhead that restrict the tree's height, and also the roots are completely covered in concrete, reducing infiltration capabilities.
- Where none of these physical restrictions exist, we may come across sociological restrictions from people living and working in the vicinity. Dr. Harini Nagendra's (APU) ongoing research is discovering interesting findings in this area -
 - Safety considerations - some residents are concerned that people shouldn't be able to climb into apartment buildings via the trees, and therefore don't want trees planted close to a building.
 - Convenience considerations - people are concerned about trees shedding fruit, flowers, and sticky material on cars parked under the trees. That could create resistance to planting certain tree varieties from the community.

Other challenges to increasing greenspace include:

- The Karnataka Working Plan for Bangalore Urban Forest Division (2002-2012), published in 2003, states that a lack of data for decision-making, and a lack of land record updating has been a major challenge to protecting and advancing green space in Bengaluru. It states:

“Major constraints encountered in preparing of the plan were the absence of proper record maintenance in the division. Vital information on growth parameters, past management details and land records were not updated besides unsystematic and ad hoc management system of the past. Hence some predictions and prescriptions prescribed are based on limited field records.” and

“It is the duty of revenue authorities to update revenue records as and when any land is notified as Reserved forest. But it has not been done in many cases.”

- At the BBMP level, forestry targets are set in terms of number of saplings planted, rather than land-use goals. As such, ensuring success rate and equitable access to green space becomes challenging.
- We also heard from government representatives that education and coordination between different government departments and tree interest groups is necessary to increase green space.

Still, efforts are being made by the government and citizens groups to save green space. BBMP has a policy to replace every felled tree with 10 trees, but a majority of these are planted in the peri-urban areas as the city core has less space but also houses more existing parks.

Aligning with national goals

Under India’s National Forest Policy 2018, which is aligned with our COP21 climate action goals, India has declared that a third of the land area in India will be forested by 2030. Similarly, the Karnataka State Tree Cover Enhancement Policy of 2016 has set a goal of 33% land for state-wide tree cover, but in Bengaluru, there is no land-use based target for forestry. The city has goals to plant 1.5 lakh trees every year, but the success rate is about 60%, and actual success rate is difficult to track. Trees also may not always be planted where citizens feel like they need them the most.

Developing an appropriate land-use based target for greening the city can give Bengalureans a more concrete goal to work towards and create stronger accountability. Research by Dr. T. V. Ramachandra and team at the Indian Institute of Science states that in order to at least ensure one tree per person and maintain some vital ecosystem services, Bengaluru must, following our national and state goals, also aim to achieve 33% of urban forest cover in the city.

While this may seem like a very idealistic goal, we must acknowledge that it is a necessity and collaboratively develop a plan to work towards that in the long term. Please read further for ideas on how we can begin to meet 33% effectively and collaboratively and take ownership of our city’s greening.

Where to create urban forests?

Prioritizing and finding land for urban green spaces

The main challenge to setting a goal such as 33% green cover is finding the land within the city that can be dedicated to green space. Given rapid and sprawling development in Bengaluru, the shrinking footpaths and open spaces, how can we begin to increase green space?

The following pathways can be used to secure and expand land needed for urban forest ecosystems::

- **Protection of existing green spaces.** Ensure that all current forest lands, public park areas, street trees, sacred trees, and other greenery are not under threat of destruction and development. Engage in advocacy and help with maintenance to protect these - replacing fallen or damaged trees.
- **Afforest areas that are readily available** for the purpose tree planting -
 - Streets, footpaths, and medians
(very important, but lower success rate due to lack of space and protection)
 - Government schools and colleges
 - Temple and other religious campus grounds
 - Public playgrounds
 - Railway lands
 - Defense lands
 - All Government of India land
 - Large campuses, universities and other institutional property
 - Department of Horticulture land - BBMP Horticulture Department has communicated that approximately 500 acres are available currently for planting.
 - KEB land under high tension wires
 - Buffer areas around lakes, rivers, wetlands must be planted and increased, etc.
- **Advocate for the creation of new designated urban green cover:** Innovative land use policies can help advance green space. Some potential policy interventions include:
 - Mandating minimum green space percentage in all new development,
 - Increasing buffer zones around water bodies and critical ecosystems,
 - Mandating a minimum number of trees in each stretch of street,

Such policies might aid the creation of continuous green spaces across the city, rather than a few isolated pockets.

How to create a thriving urban forest ecosystem

The big picture and considerations for a changing Bengaluru

Development and sustainability are not opposites. In fact, creating a vibrant forest ecosystem within a highly urbanized city can improve the living experience, culture, and economy of the city, as discussed earlier.

To maximise the benefits of urban forests, urban trees, parks, and forests must not be looked at in isolation, but as part of the whole urban ecosystem fabric. As such, the following considerations must be kept in mind while creating a city-level green space plan:

- **Land-use based target:** Creating a city-wide land use based target improves transparency and accountability (as discussed earlier)
- **Non-invasive varieties:** Bengaluru comprises both native species and many exotic species that have become naturalized over the years. Either of these type are good for planting as long as they are non-invasive and non-resource intensive, such that they allow other species to thrive and promote biodiversity. Species such as Eucalyptus and Acacia can be avoided due to their invasive nature. Some species endemic to Bengaluru can be given emphasis, such as Shorea talura (Jalari tree).

In the 1960s and 70s, the government extensively planted species like Eucalyptus and Acacia, which were a fast growing variety to provide timber and fuel for economic development. To this day, these species are still planted in rural Bangalore for economic purposes, and harvested and burned every few years. There is an expected increase in this practice as it provides quick income as there is a great demand for this timber from the construction, pulp, and gasifier fuel industries. While these species may have provided a needed economic value at the time, given the changing times, more diverse species need to be planted as appropriate to the current context and needs.

- **Diverse varieties:** For genetic resilience and long term health of the urban ecosystem, diverse and complementary species must be selected. For example, having trees at different heights promotes biodiversity. Similarly slow and fast growing species are both important - fast growing varieties remove carbon and pollutants from the atmosphere more quickly, but slow growing varieties may have other uses, such as economic value, medicinal value, habitat for native fauna, etc. Additionally, the use of shrubs, climbers, medicinal herbs, green roofs, vertical gardens, etc. enhance the resilience of the ecosystem.
- **Connectivity:** Ecosystems are healthier when they are connected, because pollinators like bees, birds, and other fauna can travel between parks through corridors. When urban parks and forests are connected by tree covered streets, the overall resilience of the ecosystem is boosted.
- **Accessibility:** Green spaces must be accessible to the public equitably. If they are restricted to private areas, then a majority of citizens will not receive benefits. Living and growing up around trees also inspires communities, especially children, to value them. As such, if we want to

create a new generation of citizens that value green cover, we must ensure they have exposure, access, and appreciation for green spaces as they grow up.

- **User friendly planting and species:** Trees planting and maintenance methodologies employed must be easy so that communities can easily take stewardship without unnecessary barriers.
- **Minimum maintenance** must be ensured. This includes fencing (for protection from grazing and human disturbance) and watering in the initial 3 years. This care must be provided until the tree reaches a height of 10 feet, after which the tree will become self sustaining, These are the most critical requirements for tree planting success.
- **Planting methodology:** It is important to select a planting methodology appropriate to context. Examples:
 - Less space availability: Streets and public space availability for tree planting is low in Bengaluru. Choosing species with a tap root system, or using a root barrier can help contain roots in a narrow space and push them deeper into the ground rather than wide. This ensures that roots can grow without disturbing surrounding buildings, roads, or footpaths, and the trunks grow upright as well, not obstructing road space. Selecting varieties with the correct height and without a wide crown can also help accommodate them in narrow spaces.
 - Slightly more space: The Japanese Miyawaki method is gaining popularity in Bengaluru. Although it is more expensive and doesn't support a wider canopy, it allows for the creation of a concentrated mini forest which are dense in foliage and act as carbon sinks and noise barriers. About 25-30 sf space is required for these.
 - Large open spaces: The methodology used by the Karnataka Department of Forestry can be used to plant and maintain trees scientifically in large open areas, institutional and campus land, large public parks, etc. While the forestry department is fully maintaining land under their purview, similar protocols can be used on institutional and large private lands to create and maintain healthy and resilient ecosystems.
- **Education and Engagement:** Most importantly, it must be recognized that many stakeholders (including children, citizens/residents at all income levels, the government, private land owners, developers, timber industry, cattle owners, arborists and horticulturists, etc.) are involved in protecting urban trees, and everyone must be a part of the conversation in order to ensure long term success or urban forestry.

Identifying urban forestry goals: Overall, developing some goals for urban forestry projects before hand can go a long way in ensuring that the project is beneficial in the long run. Recommended process to identify urban forestry goals:

- Gather stakeholders that are interested in sponsoring or implementing the tree planting, and discuss what the main goals of the tree planting project are (eg., improving a specific area, beautification, remediation, clean air, preventing dust and controlling soil erosion, etc.).
- Select a site accordingly and include additional stakeholders that are relevant to the site - such as nearby residents, businesses, the local corporator, etc.
- Discuss the short term and long term needs of the space for each stakeholder, as well as opportunities and challenges.

- Try to identify synergies between competing needs and develop consensus.
- Use the guide below or approach an expert to help identify the right planting methodology, layout, species, and care plan.
- Implement accordingly.

Where to buy saplings

- GOK:
 - Karnataka Forest Department nurseries.
 - In partnership with Let's Endorse [Project Hasiru](#), saplings can be ordered and picked up from the nurseries within 7 days.
- BBMP:
 - One BBMP nursery has been established in each zone.
 - Bamboo tree guards are provided
 - They sell saplings for planting in March
- Private nurseries

Species for different contexts and use cases

To maximize the success rates and ecosystem benefits in each type of plantable space, a species list has been provided below for 4 broad categories of use cases. While the list provided here only includes approximately 120 species, several other species can be considered for planting in consultation with experts. Please refer to the category type notes for guidance on the features to keep in mind while selecting species for each use case.

Category 1: LOW SPACE AVAILABILITY

(height, canopy, and root restrictions)

Restrictions:

Height: Short to medium (within 30 feet)

Canopy: Narrow

Roots: Deep rooted - won't spread laterally on the surface

Applicable use cases:

Streets - wide and narrow (within 10 m or 30 feet)

Footpaths - wide and narrow

Medians -open and under flyovers

KEB land under high tension wires

Single buildings - with minimal space around for outdoor planting

Example photos of trees in Category 1 spaces:





Above photos: Sumedha Rao.

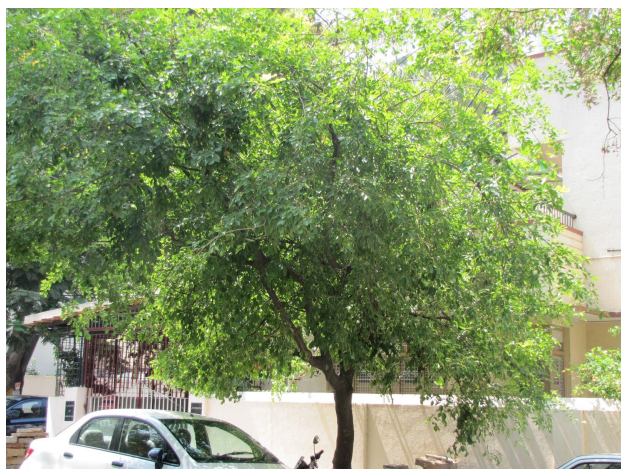


Photo: Vijay Nishant. *Pongamia*

Species	Common Name	Characteristics
LOW-MID HEIGHT (upto 30 feet)		
Anacardium occidentale	Cashew/Godambi	Edible. Short and suitable for narrow road planting.
Annona reticulata	Ramphal	Medium height and canopy. Fruit bearing. Better suited for parks, orchards, private property than the road.

<i>Annona squamosa</i>	Custard apple	Low height and canopy. Fruit bearing, provides food source for birds. Fast dispersal of seeds. Can grow in dry areas and rocky patches. Used to make seed balls. Better suited for residential buildings.
<i>Aphanamixis polystachya</i>	Pithraj tree	Fruit bearing provides food for birds.
<i>Areca catechu</i>	Areca nut	Medium height, medicinal.
<i>Bixa orellana</i>	Achiote	Shrub with small roots. Suitable for roadside planting. Fruit and flower bearing - ornamental.
<i>Brassia actinophylla</i>	Umbrella tree	Ornamental, berry bearing
<i>Broussonetia papyrifera</i>	Paper mulberry	Mid-low height and canopy. Ornamental and flower bearing. Ideal for avenue planting and parks.
<i>Buchnanania lanzan</i>	Chironji / Charoli	Edible seeds - used for spices and medicinal purposes
<i>Callistemon lanceolatus</i>	Bottle brush	Low height and small canopy. Suitable for narrow roads (3m width).
<i>Cascabela thevetia</i>	Yellow oleander	Mid sized, flowering
<i>Cinnamomum gelanicum</i>	Dalchini	Short, grows in shade, used as a spice
<i>Dellenia pentagana</i>	Karmal / Kaadu Kanigalu	Ornamental, flowering, edible fruit
<i>Lawsonia inermis</i>	Mehndi	Low height and small canopy. Suitable for narrow roads (3m width).
<i>Melia azedarach</i>	Persian lilac	Low height and small canopy. Suitable for narrow roads (3m width).
<i>Muntingia calabura</i>	Singapore cherry, Gasagase hannina mara	Mid height, wide canopy, fast growing, low maintenance, drought resistant, edible.
<i>Moringa oleifera</i>	Drumstick / Moringa	Fast growing, drought resistant, multiple edible and commercial uses - suitable for residential, slum areas
<i>Murraya koenigii</i>	Curry leaf tree, kari-bevinagida	Small tree, edible leaf spice, suitable for residential, slum areas
<i>Nyctanthes arbor-tristis</i>	Coral jasmine / Parijatha	Low height and small canopy. Fragrant flowers. Suitable for narrow roads (3m width), crowded residential/slum areas, places with low width and height restrictions.
<i>Phyllanthus acidus</i>	Kiru Nelli / Star gooseberry	Edible, sacred, medicinal Short, very suitable for planting under high tension wires,
<i>Pongamia pinnata</i>	Honge / Karanja	Low maintenance. Has multiple uses - timber, biofuel, etc. Preferred for residential streets as it has a wide shady canopy for car parking. Absorbs a lot of water and is good for marshy areas - along canals, lake shores, tank shores. Drought hardy.
<i>Psidium guajava</i>	Guava	Short, fruiting

<i>Punica grantanum</i>	Pomegranate	Short, fruit bearing, better suited for private areas
<i>Solanum grandiflorum</i>	Night shade / potato tree	Low height and small canopy. Suitable for narrow roads (3m width).
<i>Zanthoxylum rhetsa</i>	Triphala	Medicinal
LOW-GROUND (upto 5 feet)		
<i>Agave</i> sp.	Agave	Grows in dry weather.
<i>Bambusa arundernacea</i>	Big bamboo	Thorny, multiple uses
<i>Caesalpinia pulcherrima</i>	Peacock tree	Low height, ornamental
<i>Cycas</i> spp.		Ornamental, mid-low height
<i>Dandrochelamus strictus</i>	Medri bamboo	Used commonly by the Medar community to make baskets, mats
<i>Dypsis lutescens</i>	Golden cane palm	Mid-low height, Bamboo-like screening plant, comparatively pest resistant.
<i>Fillicium decipiens</i>	Fern lead tree	Mid-low height, dense foliage
<i>Markhamia lutea</i>	Makhamia, Siala	Mid-low height, flowering
<i>Oxytenantara stocksi</i>	Marihal bamboo	Used in artistic work to make baskets, etc.
<i>Saribus rotundifolius</i>	Footstool palm	Short, ornamental

Category 2: MEDIUM SPACE AVAILABILITY

(No height or canopy restrictions.
Root may still have restrictions.)

Restrictions:

Height: Mid - tall (upto 40 feet)

Canopy: Spread out

Roots: Deep rooted - won't spread laterally on the surface

Category 1 species can also be used.

Applicable use cases:

Highways

City parks

Government schools and colleges

Temple and other religious campus grounds

Smaller cemeteries and crematoriums

Unused land - private vacant sites

Miyawaki mini-forest

Example photos of trees in Category 2 spaces:

Photo: Vijay Nishant. *African Tulip*.



Photo: Vijay Nishant. *Badminton Ball tree*.

Species	Common Name	Characteristics / Use cases
<i>Acacia catachu</i>	Kaggali mara	Native, non-invasive, thorny, fixes nitrogen in the soil
<i>Acacia ferruginea</i>	Banni	Mid height and canopy, religious use, native species.
<i>Adenathera microsperma</i>	Bead Tree	Ornamental
<i>Aegle marmelos</i>	Wood apple / Bael / Bela	Mid height and canopy, fruit bearing, medicinal, sacred, grows in arid weather.
<i>Alstonia macrophylla</i>	Batino	Mid-sized, medicinal.
<i>Amherstia nobilis</i>	Splendid/Noble Amherstia	Mid-tall, ornamental, sacred - native to Myanmar buddhist pagodas
<i>Bahunia racemosa</i>	Beedi tree	sacred, medicinal, flowering
<i>Bauhinia purpurea</i>	Bauhinia	All Bauhinia species have small height and canopy, and are good for planting on narrow roads (10 m width). Flower bearing, leaves are good fodder. Good for nitrogen fixation.
<i>Butea monosperma</i>	Flame of the forest	Small to mid sized tree, flowering/ornamental, leaves can be used to make plates (mutga ele) - this provides economic value, as such, suitable for low income rural areas, tribal areas.
<i>Cassia grandis</i>	Brazilian cassia / Coral shower tree /	Ornamental, suitable for avenue planting (10 m roads)
<i>Cassia javanica</i>	Java cassia	Ornamental, suitable for avenue planting (10 m roads)
<i>Casuarina equisetifolia</i>	She oak	Serve as good sound and air barriers for industrial areas. Suitable for small woodlots in the city, and as a pollution barrier for sites.
<i>Chloroxylan switinia</i>	East Indian Satinwood	Dryland species

Colvillea racemosa	Colville's glory/ Kilbili	Mid-tall, flowering
Dilbergia sisoo	Indian Rosewood/Sisoo	Fast growing, hardy, flowering
Erythrena indica	Indian Coral tree	Tall, ornamental
Jacaranda mimosifolia	Jacaranda / Nili gulmohar	Flowering, ornamental. Leguminous (nitrogen fixing). Suitable for avenues in parks, open areas. Not ideal for roadside planting.
Lagerstroemia flosreginae	Pride of India	Flowering, ornamental. Absorbs a lot of water, so, good for roadsides, parks, and low lying water logged areas, along canals, lake shores, and tank shores
Madhuka longifolia var. longifolia	Ippe Mara	
Melana arboria	Shivni	Great for carving - next best to sandal. Many local carving communities use this.
Millentonia hotensis	Akasha mallige, Indian cork tree / Akash Neem / Jasmine Tree	Flowering tree. Regular shedding flowers make it non-ideal for roads. Better suited for parks and private areas. Straight and tall, suitable for park peripheries and property borders to act as a barrier between traffic and interior space.
Mimusops elengi	Indian medlar / Bakul/ Maulsari	Short, dense canopy, fragrant flowers
Parkia biglandulosa	Badminton ball tree	Flowering, suitable for avenue planting on wide roads (20+ m).
Plumeria sp.	Pagoda tree	Short, fragrant, sacred
Polyalthia longifolia	Mast tree (Ashoka)	Narrow canopy, sturdy. Suitable for medians, roadside, sound/air pollution barriers. Height can be tall, so ensure no wires overhead.
Pterocarpus santalinus	Red sandal/Raktachan dana	Fast growing, can grow on degraded soil, medicinal. Classified as Near Threatened.
Reutealis trisperma	Philippine tung tree	Mid height, dense canopy, flowering
Santallum album	Sandlewood	Sacred, medicinal
Sapindis emarginatus	Antuvala/soapnut	Medicinal
Saraca asoca	Sita ashoka	Flowering
Schlichera oleosa	Kendale / Kusum tree	Used for biodiesel. Shade growing.
Senna spectabilis	Archibald's cassia	Mid-tall, dense canopy, flowering
Shorea talura	Jalari	Endemic to Bengaluru, threatened, provides lac used in making paints
Spondias	Amtekai	Edible fruit - used in making pickle

mangifera		
Tabebuia spp.		Shrubs/small-mid trees, ornamental, suitable for avenue planting
Terminalia catappa	Desi badam / Jungle baadam / kaadu baadam	Ornamental avenue planting
Terminaria chebula	Myrobalan	Used in tanning
Thespesia populnea	Indian Tulip tree	Mid sized, flowering
Zizphus jujuba	Barehannu	Edible fruit, medicinal Suitable where height restrictions exist.

Category 3: HIGH SPACE AVAILABILITY (No height, canopy, or root restrictions)	
<p>Restrictions: Height: Medium to tall (30 - 80 feet) Canopy: Spread out Roots: Wide roots Category 1 & 2 species can also be used.</p> <p>Applicable use cases: Large campuses (with sufficient space around for outdoor planting) - residential, educational, corporate, hospitality, etc. Large public parks and playgrounds All Government of India land - Railways, Defense, Institutions, Department of Horticulture land, Cemeteries, etc. Buffer areas around lakes, rivers, rajakaluves, wetlands must be planted and increased, etc Contaminated land - previous dump sites</p> <p>Example photos of trees in Category 3 spaces:</p>	



Photo: Vijay Nishant. *Sausage tree*.



Photo: Vijay Nishant. *Yellow cassia*.

Species	Common Name	Characteristics / Use cases
Acacia spp.		Bioremediation of contaminated land/dump sites: Acacia should generally be avoided as it is invasive and water intensive, except in cases where bioremediation is needed, like previous dump sites. Acacia draws out dissolved soil pollutants along with the water, and cleans the soil. After soil quality is improved, Acacia can be removed and other diverse species can be planted on the same land. Arid weather, low maintenance.
Adansonia digitata	Baobab	Ornamental, drought resistant
Albizia lebbek	Siris	Mid height ad canopy. Timber and medicinal use.
Albizia saman	Rain tree	Shade providing. Suitable for wide open spaces. Roots and branches are very broad and fibrous - unsuitable for small parks, streets, and near buildings.
Albizzia	Bilwara	Fast growing, one of the best for nitrogen fixing, arid weather.

odoratissima		
Alstonia scholaris	Devil's tree	Mid-low height and canopy. Medicinal.
Arthocarpus hirsuta	Hebb-Halasu / Wild Jack	Edible fruit
Artocarpus heterophyllus	Jackfruit/Halasu	Fruit bearing - better suited for orchards, parks, residential areas.
Azadirachta indica	Neem	Shade providing, dense foliage for air and sound pollution absorption, dry weather. Medicinal. Low maintenance. Suitable for wide highways, cemeteries, crematoriums.
Canarium strictum	Dhoopa mara	Used in incense.
Castanospermum australe	Australian Chestnut	Tall, flowering
Coco nucifera	Coconut	Suitable for private lands only - nuisance in public spaces due to falling leaves and coconuts. Suitable for orchards, large open private spaces. They have fibrous root, which are unstable because height.
Couroupita guianensis	Cannonball tree / Shivalinga / Nagalinga	Tall, sacred
Dalbergia latifolia	Rosewood	Drought hardy, premium timber.
Dellenia indica	Elephant apple	Flowering, used in cooking
Delonix regia	Gulmohar	Flowering, tall tree with large canopy can be unstable in urban areas where roots don't have sufficient undisturbed space. Shallow, horizontally spreading, surface feeding roots can damage buildings, and tree can be easily broken in storms. Good for open spaces like institutional land, cemetery, crematoriums, etc.
Disoxylum malabaricum	White cedar/bili devadaru	Flowering, medicinal uses
Enterolobium contortisiliquum	Elephant Earpod tree	Tall, fast growing
Ficus benghalensis	Banyan	Suitable for all wide open areas (fibrous root can damage buildings-not suitable for small spaces near infrastructure), keystone species - critical to ecosystem balance. Low maintenance.
Ficus benjamina	Weeping fig	Suitable for all wide open areas (fibrous root can damage buildings-not suitable for small spaces near infrastructure), keystone species - critical to ecosystem balance. Low maintenance.
Ficus elastica	Indian rubber tree	Suitable for all wide open areas (fibrous root can damage buildings-not suitable for small spaces near infrastructure), keystone species - critical to ecosystem balance. Low maintenance.
Ficus racemosa	Country fig	Suitable for all wide open areas (fibrous root can damage buildings-not suitable for small spaces near infrastructure), keystone species -

		critical to ecosystem balance. Low maintenance. Sacred
<i>Ficus religiosa</i>	Peepal	Suitable for all wide open areas (fibrous root can damage buildings- not suitable for small spaces near infrastructure), keystone species - critical to ecosystem balance. Low maintenance. Sacred
<i>Hardwickia binata</i>	Kammara	Native, flowering, ornamental, good for nitrogen fixing, provides very good fodder
<i>Hofia parviflora</i>	Malabar Ironwood	Used in construction, tanning
<i>Kigelia africana</i>	Sausage tree/ Mara Sowthae/Aanethor adu Kaayi	Tall, broad canopy
<i>Madhura longifolia</i> var <i>latifolia</i>	Mowra butter tree	Tall, flowering, medicinal
<i>Magnolia champaca</i> (prev. <i>Mycelia campaca</i>)	Sampige	Tall, broad canopy, flowering
<i>Mangifera indica</i>	Mango tree	Requires open spaces and light, dense foliage for air and sound absorption. Good for residential and low income areas as the local community can use the fruit for personal or economical use.
<i>Michelia champaca</i>	Champaca	Fragrant flowers, canopy shade, good for cemeteries, crematoriums
<i>Neolamarckia cadamba</i>	Kadamba tree	Ornamental, fragrant flowers
<i>Peltophorum pterocarpum</i>	Copper pod	Tall, ornamental
<i>Persea americana</i>	Avocado	Tall, edible fruit, suitable for private / residential areas or orchards.
<i>Pithecellobium dulce</i>	Manila tamarind, Seeme hunase	Tall, flowering
<i>Pterocarpus marsupium</i>	Honne mara	Native tree, flowering
<i>Pterospermum acerifolium</i>	Dinnerplate tree / Kanaka Champa	Tall, ornamental, shade tree, fragrant trees
<i>Roystonea regia</i>	Royal palm	Tall, ornamental palm
<i>Senna siamea</i>	Yellow cassia, Sima tangedu	Mid-height, wide canopy
<i>Spathodea campanulata</i>	African tulip	Mid-tall, flowering
<i>Swietenia macrophylla</i>	Large leaved mahogany	Tall, dense canopy
<i>Swietenia mahogany</i>	Spanish mahogany	Dense foliage for air and sound absorption

Syzgium cumini	Jamun	Edible, grafted varieties are mid height
Tamarindus indica	Tamarind	Suitable for wide highways
Tectona grandis	Teak	Requires good soil and moisture and more open spaces.
Terminalia arjuna	Arjun, Hole Matthi	Tall with wide canopy. Marshy species that can be planted along canals, lake shores, tank shores.
Terminaria alata / elliptica	Indian Laurel/Banappu/K arimaddi/Sadada/ Unapu mara	Dry weather tolerant
Terminaria paniculata	Kindal tree	Fruit bearing with multiple economic uses - timber, medicinal, silk.
Vitex altissima	Naviladi/baranige	Ornamental
Araucaria spp.	Christmas tree, and relates species	Tall, narrow canopy, deep tap roots. Trunk can grow wide. Suitable for ornamental use in parks, churches.
Holoptelea integrifolia	Tapasi	Threatened species, used for toy making in Channapatna.
Madhuka longifolia var. latifolia	Mowra, mahua	
Terminaria bellarica	Taare	Used as a dying and tanning compound. Has medicinal value. Tusser silk worms are reared on this tree.

Category 4: NO SPACE AVAILABILITY (No height, canopy, or root restrictions)	
Restrictions: No outdoor space	
Applicable use cases: Indoors or on terraces and balconies in pots	
Species: Species such as lemon, hibiscus, tapioca, tubers, leafy vegetables, etc. can be used.	

Species to generally avoid (due to reasons such as their invasive nature) - Eucalyptus, Silver Oak, Acacia areculiformis (other Acacia species can be used), Prosopis juliflora.

Who will create the urban forests?

Ownership, commitments, and engagement

Ultimately, the success of any project depends on the community's ownership. After the tree planting activity is concluded, a community needs maintain the area and ensure that any disturbances are checked. A few strategies can be employed to obtain a community's ongoing support for a project -

- Advocate for an urban forestry master plan at the city level - involving the government and all relevant stakeholders. Creating ward level urban forestry microplans can also create sustainable and accountable urban greening. See below for a city or ward level master planning framework.
- Include the relevant communities from the beginning of the planning phase
- Ensure roles and responsibilities are delegated, and that there is a general formal or informal protocol for transfer of roles and responsibilities.
- Ensure that the community has access to information and guidance on how to care for the area, how to maximize the benefit of the area without disturbing the space, and where to lodge complaints of violations.
- Ensure that the space is planned with accessibility in mind - especially to the community who is expected to take ownership of the project.
- Include signage, art, media coverage, etc. to give the planting and maintenance community a sense of pride in transforming the place.
- Ensure a mechanism for periodic check in by a third party, if required, to ensure that the area is maintained to acceptable standards.

City/ ward level urban forestry planning framework

This draft framework can be utilized to develop a ward level microplan and a city level masterplan to increase urban forestry in Bengaluru:

- Assess the current scenario
 - Carry out a land-use assessment and tree census (this can be at varying levels of comprehensiveness based on the community's capacity).
 - Determine the following metrics:
 - What percent of land is currently planted?
 - What is the number of trees per capita?
 - What percent of land has a public park within a 300 m walking distance?
- Understand challenges and opportunities
 - Conduct workshops and citizen surveys to understand people's perceptions of current green space and their vision for urban greenery. Understand key challenges and opportunities.
- Set a target
 - With the goal of establishing minimum 33% green space in the ward or minimum 1 tree per person, assess where your community stands and determine a suitable metric. If the ward is far below the minimum, then assess challenges and develop an innovative

plan to increase green space. If the ward far exceeds the minimum requirements, they can still assess any, maintenance, accessibility, and tree health needs in the ward, as well as any scope for increasing green space further. They can also share best practices and support to other wards that do not meet the minimum.

- Create an accountable and suitable mechanism to increase green space
 - Once a target has been determined, the community must clearly define roles and responsibilities and an accountability mechanism to achieve the set goal by the set deadline.
 - On an ongoing basis, any challenges and lessons learned must be reviewed and the plan can be adapted accordingly to suit the local context.

We invite all Bengalureans to join us in a conversation about improving land use, increasing green space, and enhancing the quality of life in Bengaluru. Let us work together so that each effort adds to the next, and a thriving and sustainable urban ecosystem can be created for the benefit of generations to come.

References and Recommended Reading

Salbitano, F., Borelli, S., Conigliaro, N., Chen, Y., (2016). *Guidelines on Urban and Peri-urban Forestry*. United Nations Food and Agriculture Organization.
<http://www.fao.org/3/i6210e/I6210E.pdf>

Food and Agriculture Organization (2018). *Forests and Sustainable Cities: Inspiring Stories from Around the World*. United Nations.
<http://www.fao.org/3/i8838en/i8838en.pdf>

Town and Country Planning Organization (2014). *Urban Greening Guidelines 2014*. Government of India: Ministry of Urban Development.
<http://www.indiaenvironmentportal.org.in/files/file/urban%20green%20guidelines%202014.pdf>

Karnataka Working Plan for Bangalore Urban Forest Division: 2002-2012 (Published 2003).
<https://aranya.gov.in/downloads/FWP-Bengaluru-Urban.pdf>

BDA Revised Master Plan 2031 (2017)
<http://opencity.in/pages/bda-revised-master-plan-2031-all-documents>

T.V.Ramachandra, Bharath H Aithal, Gouri Kulkarni, Vinay S, (2017). Green Spaces in Bengaluru: Quantification through Geospatial Techniques. *Indian Forester*, 143(4) : 307-320, 2017,
http://wgbis.ces.iisc.ernet.in/energy/water/paper/Green_Space_in_Bengaluru/index.html

Ramachandra , T. V., et. al., (2014). *Trees of Bengaluru*. ENVIS, CES, IISc. Bangalore.
http://wgbis.ces.iisc.ernet.in/energy/water/paper/ETR75/CES_TV_RTR75_TREES_24may2014.pdf

Neginhal, S. G., (2002). *A Handbook on City Trees and Urban Planting (Urban Forestry)*. Bengaluru 560020.

Arun Kumar A. N., Geeta Joshi, G. Selvakumar, Manojkumar. *Compendium of promising native tree species for different agroclimatic zones of Karnataka*. Government of Karnataka Forest Department Research Wing. Bengaluru 560076.