The Environmental Impact of Tender SURE Project

A Study by R. Sheshadri & Jahnavi G Pai

By nature, we are a plant based intelligence — not just our exhale, which plants inhale, but they are my food chain, they are my medicine. I cannot live without plants. They are my life support. And this is why plant species need to be preserved.

 - Horst Rechelbacher

ROAD PROPOSED FOR TENDER SURE.
WILL THE "TREE TUNNEL" SURVIVE?

CONTENTS

1 Urban Ecology of Bangalore

The Bangalore metropolis has been a forerunner in developing urban greenery. In large part, this has been influenced by the city's legacy as a "garden city," evident in the centuries-old Lalbagh Botanical Gardens and Cubbon Park within the core of the city, and also private gardens and horticultural farms in the peri-urban area. Bangalore's boulevards formed its living heritage linking gardens with biodiversity-rich urban wildlife corridors. A people steeped in the tradition of raising trees, supported by nurseries, Horticulture and Forest Departments, and a host of other private suppliers, has influenced the greening of the metropolis over decades.

Due to a rich history of horticulture and various cultural and political influences, the trees species of Bangalore are very diverse and mostly introduced species. Bangalore trees are known to be planted such that a succession of species flowering across all season.

As observed by Nagendra & Gopal (2010), "older wooded streets and parks tend to have large-canopied, slow growing long lived tree species that provide greater shade, biodiversity support, pollution reduction and microclimatic buffering while recent planting has focused more on ornamental species and short-statured, small canopied, relatively short lived species that are easier to maintain but less likely to provide the same range of environmental and ecological services".

The consequences of these combined changes in ecosystems, land use and governance have been manifold, with deterioration of biodiversity and soil quality, aggravation of urban heat island effects, increased pollution, flooding, water scarcity and epidemics, and consequent impacts on human health and well-being.

In the past two decades, however, over half the city's greenery has disappeared. Large home gardens within the city have been converted into apartments and office blocks; widening streets to relieve unprecedented traffic congestion has destroyed boulevards, and land use policies have allowed for reckless conversion of farms into massive real estate projects. India's "garden city" known for its salubrious climate, is now suffering from the "heat island" effects. Energy and water use has been intensified to cool buildings, a task that trees performed eminently, gracefully and at no cost(Neginhal, 2006).

2 About Tender S.U.R.E.

Traffic jams and pollution have become synonymous with what was once known as the Garden City. Bangalore has the second highest number of vehicles plying on the road in the country(Ray, 2015). As of June 2016, there were about 57 lakh registered vehicles in the city (Commissioner for Transport and Road Safety, 2016).

This has been largely attributed to the lack of efficient public transport. CO_2 emissions from the road transport sector in Bangalore were estimated at 24 million tonnes (MT) in 2005–2006. Other greenhouse gases, CH_4 and N_2O, were estimated at 325 and 19 tonnes respectively. A study suggested that the total emissions projected for 2012 and 2017 would be 3.03 and 4.06 MT of CO_2 equivalents respectively (Sudhira & Nagendra, 2013).
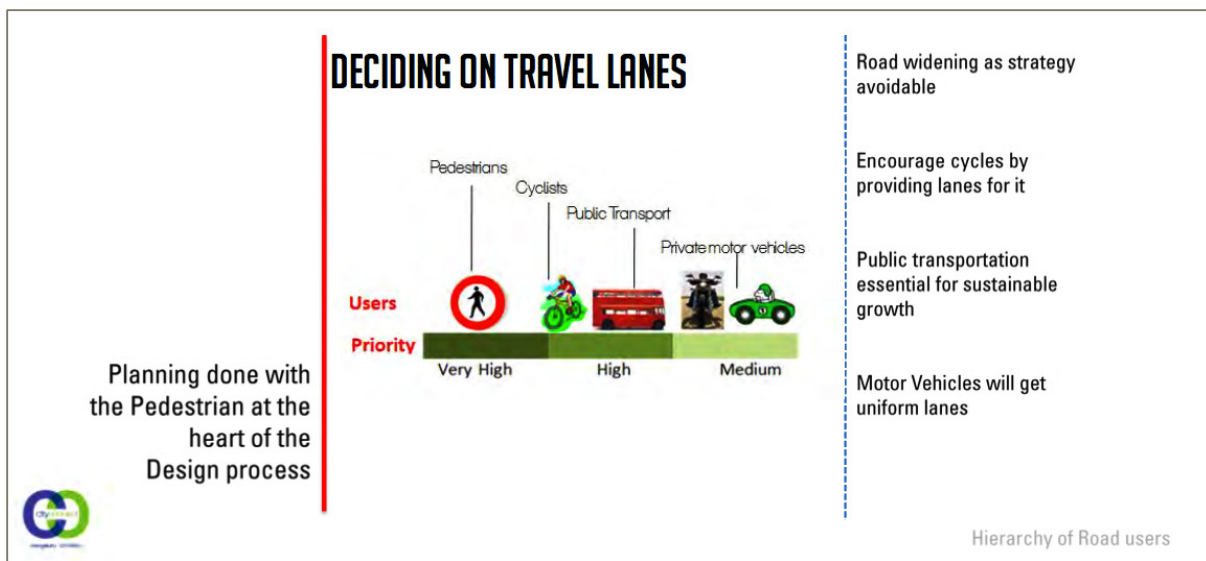

FIG 1: HIERARCHY OF ROAD USERS ACCORDING TO TENDER SURE
SOURCE: BANGALORE CITY CONNECT FOUNDATION

In this light, a project that focuses on non-motorized and public transport is urgently needed in Bangalore. Tender S.U.R.E., an urban infrastructure project conceived by Bangalore City Connect Foundation (BCCF) and Jana Urban Space Foundation (JUSP) claims to address this issue. According to V. Ravichandar of BCCF, "Tender SURE is a futuristic project that is capital intensive and low on maintenance. We have to consider walking as the most basic form of transport. Unless we de-incentivize use of private transport, the city will never come out of the traffic mess" (Bharadwaj & Ramani, 2014). According to the proponents of Tender S.U.R.E., the project is designed around two specific goals of providing

(i) design specifications for various roads and intersections

(ii) guidelines to streamline procurement and maintenance of road contracts

Specifications are given in the form of meticulously designed replicable blueprints in two volumes (Ramanathan, 2011). From these documents, it seems that pedestrians, cyclists and public transport have remained central to the design. Wide footpaths and other pedestrian-friendly measures, dedicated cycling lanes, bus bays and well-designed bus stops are some of the key features of this project. However, the most important feature of the design is the integration of various public utilities such as electricity, water, sewage, storm water drains, etc., into the design process, thus eliminating the need to frequently dig and relay the roads for repairs and maintenance.

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2.1 Concerns and Criticism

The project has drawn much flak from various quarters for different reasons. The BBMP and some elected representatives complained about the shortcomings of design, for they feel that widening the footpath at the cost of the width of the carriageway resulted in more traffic jams (Joseph, 2015). They have also alleged that the project has overruled the Bangalore Development Authority's Master Plan 2015 and ignored the inputs of BBMP engineers (Bharadwaj & Ramani, 2014). The cost of laying a Tender SURE road is at least 10 times the cost of a regular road (K. Rao, 2015). An already cash-strapped BBMP is having to execute a plan without having a say in the matter("The Bengaluru footpath that's wider than the road has caught the CM's attention," 2015). Given the lack of parking spaces and narrow width of carriageway which is designed to discourage the use of private transport, shopkeepers feel that their business will be badly hit(Chaturvedi, 2014).

Activists have raised more serious concerns. The entire process of planning and execution of this multi-crore has neither been transparent, nor democratic in what has been described as an "elite capture of governance"("Activists Flay 'Elitist' Tendersure Projects for Bangalore," 2015). The Karnataka State Commission for Disabilities has said that the bollards on the footpath meant to discourage motorists from riding on the footpath are very unfriendly for the disabled (Rao, 2015). The rights of street vendors have also been severely compromised ("'Unilateral execution' of TenderSure project criticised," 2014). As on September 12th, 2016, the complete DPR was unavailable on the BCCF, JUSP or BBMP websites, thus making the entire planning process secretive and raising serious questions of accountability and transparency.

2.2 Environmental Concerns: What Lies Beneath?

Due to its focus on pedestrians, public and non-motorised transport, Tender SURE comes across as a project that endeavours for a cleaner environment. However, the complete absence of thought given to roadside tress, which are the most fundamental components of biodiversity and ecology, are of supreme concern.

2.2.1 Root of the Problem

The most alarming aspect of Tender SURE project is the lack of space given to the roots of the trees. Though the number of trees that have been felled remains undocumented, in the second phase of the project five trees fell on a single road in Jayanagar. After investigations, it was found that roots of these trees were severely damaged eventually leading to their fall(Kumar, 2016).
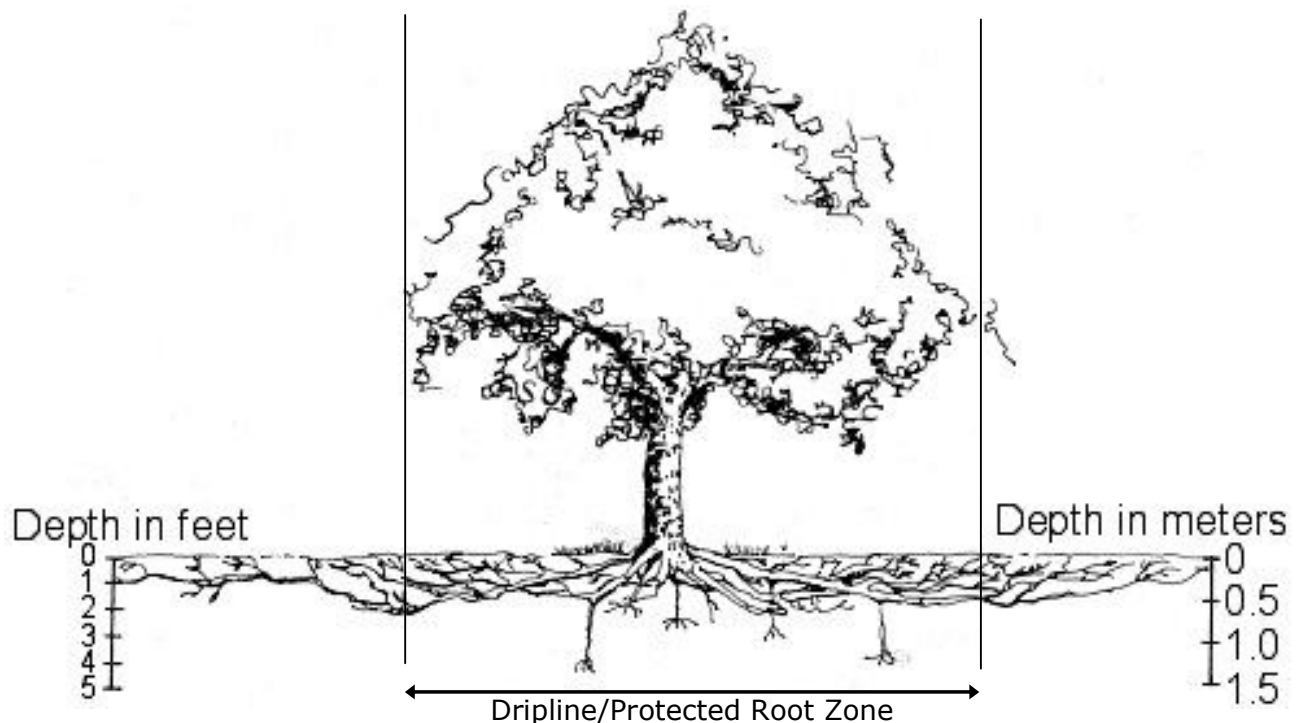
FIG 2: SCHEMATIC DIAGRAM OF A TREE ROOT SYSTEM. THE COMMON NOTION OF ROOTS BEING MIRROR IMAGES OF THE SHOOT SYSTEM IS WRONG AND MISLEADING.
SOURCE: TREE ASSOCIATES BLOG

Roots are one of the most vital parts and play a crucial role in the life of a plant. They not only help in anchorage, but also in storing energy and uptake of water and nutrients. Even the finest roots are linked to corresponding portion of branches and leaves in a complex and elaborate plumbing system. Thus, if roots are damaged and killed, the corresponding portion of branches will die too.

Structure of Roots

Tree roots have a very wide variation in size ranging from woody roots of about 30 cm or more in diameter to fine, non-woody roots of less than 0.2 mm in diameter.

It is said that roots grow where life-sustaining resources are already available and not to or towards anything. They generally extend outward from the tree. Since soil surfaces contain the highest concentration of nutrients, nearly 99% of the woody roots are found within the top 30 cm of the soil and rapidly decrease with depth. They normally do not extend beyond 1 to 2 metres from the surface. The roots can occupy an area of up to four to seven times more than the canopy area(Perry, 1982).

Protecting the Roots

In a detailed paper on tree roots titled "The Ecology of Tree Roots and the Practical Significance Thereof", author Dr Thomas Perry says, "People must know where their roots are if trees are to be a gratifying part of the urban environment". There are barely any studies on the root systems of urban trees in India, perhaps an indication of our neglect towards this very important aspect of urban ecology. However, in the West, guidelines have been developed to protect trees during construction, which are relevant even here.

Typically, however, approximately 90-95 percent of a tree's root system is in the top three feet of soil, and more than half is in the top one foot. It is highly recommended in these guidelines that construction damage should be avoided in what is known as the "Protected Root Zone" (PRZ). The simplest method used to determine this is first to identify the 'dripline' i.e., the area directly below the branches. Roots that lie within this area are considered a tree's PRZ (See Fig 2). Since the canopy can be irregular, another more reliable way of estimating PRZ is to first measure the DBH (Diameter at Breast Height) of the tree in cm and then multiply it by 0.12 m(Trowbridge & Bassuk, 2004).

While each species has a different tolerance level to root damage, it is recommended that no more than 25% of roots in the PRZ be disturbed. Any damage in this area can lead to eventual killing of the tree.

Apart from direct damage, another major threat to urban street trees comes from soil compaction. Any project that aims to preserve trees should plan for steps to prevent excessive soil compaction that is known to be the single largest killer of urban trees(Johnson, 1999).

While TenderSURE meticulously details every single aspect of project execution, there is barely any mention of trees, let alone a detailed plan for future planting. Only two sections of one paragraph each deal with plants in the entire volume. In both these sections, trees are clubbed with "street furniture" such as utility boxes, street lighting, street bench, dustbins, and signages. A strip of 0.4 metre in local

roads to a maximum of 1 metre in higher order roads is allocated for this "landscaping strip", which is meant to serve as a divider between pedestrians and vehicles while also providing aesthetic features to the road.

Section 2.8.6 of this report even suggests that these "static elements" should be aligned properly so that mobility of pedestrians, cyclists and motor vehicles is not hindered(Ramanathan, 2011).

This comes as a rude shock considering that the TenderSURE project is being promoted as pedestrian-friendly. For instance, according to the drawings, in a 2.0-metre-wide footpath, a tree and a lamppost are treated similarly. The space allocated is 0.5 metre-wide and less than 0.4 – 0.8 metre-deep, which is completely concretised from all sides. As seen in Fig 2, this little space is nowhere sufficient for the majestic trees of Bangalore.

A study conducted on the density, diversity, composition and distribution of street trees of Bangalore showed that irrespective of road width, the average DBH of trees was found to range from 30 cm - 42 cm(Nagendra & Gopal, 2010). This means, the PRZ for these trees could range from 3.6 metre to 5 metre. Ironically, medium sized roads of 12 - 24 metre width also have the biggest trees. These trees have a PRZ of 5 metre but according to the Tender SURE drawings, only 0.25 metre - 0.5 metre has been allocated for trees on roads of this width! A time bomb seems to be ticking for the trees on Tender SURE footpaths.

2.2.2 No scope for future urban forestry planning

What is worse, is that in case of the eventual fall of a tree, from the drawings given in the DPR, it is evident that there is very little or no scope for future plantations. From the presentation about Tender SURE downloaded from BCCF website (Fig 3.), the space below the footpath seems completely concretised and occupied by underground ducts. It is reported that when the BBMP Forest Cell suggested to the engineering wing to retain or undertake fresh plantation on new Tender SURE roads, the request was turned down on the grounds that the infrastructure would get disturbed because of underground pipelines and cables(Khanna, 2016).

In August 2016, Bangalore Mirror, a newspaper, carried out a series of articles questioning the transparency and accountability of this multi-crore project. In response to this, JUSP chairperson Swati Ramanathan issued a clarification. Curiously, there is again no mention of pedestrians or trees. According to this article, Tender SURE seems more of a project to provide networked infrastructure. In other words, the single-most (and perhaps the only) aim of the project is to is to pave way for major utility lines of power, water, sewage, drainage, telecom, gas and security surveillance & traffic management are laid and maintained in an

organised manner(Ramanathan, 2016). The question that then arises is if trees and even pedestrians only incidental to this multi-crore project?
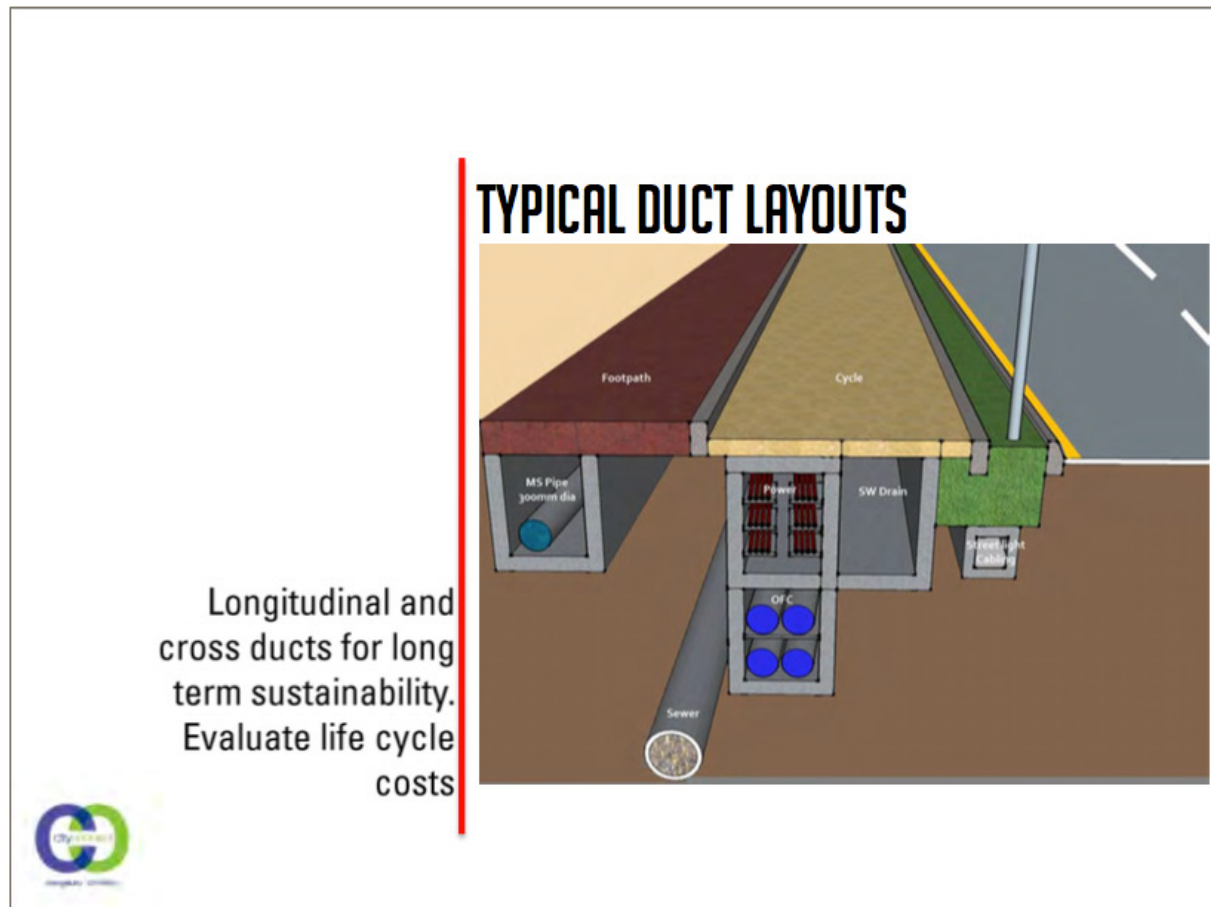

FIG 3: WHERE IS THE SPACE FOR TREES ON A TENDER SURE FOOTPATH?
(*Source:* Bangalore City Connect Foundation)

3   Environmental Risk and Impact of Tender SURE

Recently, a study published out by IISc has shown that Bangalore will be unliveable in five years! Already, unplanned urbanisation has taken a toll on the natural resources of the city. During 1973–2016, concretisation or paved surface increased 1005%; vegetation has decreased by 88% and wetlands by 79%. Currently there are only 1.5 million trees to support Bangalore's population of 9.5 million, indicating one tree for every seven persons in the city! This is insufficient even to sequester respiratory carbon, which ranges from 540 to 900 g per person per day. There has been an unprecedented increase in air pollutants and sharp decline in groundwater table. This study reveals "a calamitous picture of 93% of Bangalore's landscape being filled with paved surfaces (urban cover), and drastic reduction in open spaces and green cover. This would make the region GHG-rich, water-scarce, non-resilient and unliveable, depriving the city-dwellers of clean air, water and environment."(Ramachandra & Aithal, 2016) A crisis seems to be unfolding in Bangalore.

It can thus be argued that a "futuristic" project such as Tender SURE should be nothing less than a model that would be resilient in the face of an alarming and despondent future.

3.1 Impacts of a Treeless Future

The biggest risk of Tender SURE is a treeless future for Bangalore streets. Justifying this, the BBMP Commissioner M Lakshminarayana had said, "The world over, there are no trees on footpaths. In Bangalore, there are some trees on footpaths and we are planting saplings but it's not an intensive exercise. Intensive plantation is being take up in parks and open spaces."(Khanna, 2016)

The importance of trees in an urban environment can never be understated. Tree trunks occupy about one-unit area of space on ground, yet their canopies occupy about 200 times or more, the unit area space in air and providing immeasurable benefits to all life forms too. In a paper on street trees of Bangalore titled 'Street trees in Bangalore: Density, diversity, composition and distribution,' the authors discuss the various benefits of street trees:

- Trees help in reducing the intensity of pollutants by purifying air of SO_2 and Suspended Particulate Matter, sequestering carbon and acting as noise filters. Street trees are especially significant in this respect due to their proximity the source of vehicular emission compared to other distant green spaces.

- They provide shade and shelter from sun and rain for pedestrians. They also provide critical spaces and shelter for street vendors.

- While street trees may constitute only a small fraction of green cover in most cities, wooded streets constitute the most accessible green spaces for the vast majority of low to medium income city dwellers who lack access to other green

spaces in residential and commercial areas thus playing an extremely significant and irreplaceable role in urban lives.

- In dull, dusty and grey concretised urban settings, trees give visual relief by lending aesthetic beauty. This is known to provide a range of psychological, social and economic benefits for people including reductions in domestic violence, lowering of obesity, higher property values, reductions in asthma levels, traffic speeds, and auto accidents, and overall improvements in human well-being and community vitality.

- Street trees are also important habitats for the dwindling urban wildlife, especially birds. By acting as "corridors," they provide crucial connectivity between urban parks.

- Urban trees play a significant role in lowering urban temperatures and mitigating the intensity of urban heat island effects, especially in tropical climates. In Bangalore particularly, it is recorded that they decrease ambient air temperatures in the summer by 3–5 °C, and road asphalt surface temperatures by as much as 23 °C.

- Trees help in reducing storm water runoff, thus reducing the likelihood of flooding and damage to urban properties(Nagendra & Gopal, 2010; Sudhira & Nagendra, 2013).

The importance of street trees for the city, its health and risks and impacts of decreased vegetation on various aspects of the environment are discussed in detail.

3.1.1 Air Quality

The short-term and long-term impacts of a tree-less environment on the atmosphere is multi-fold. Trees in an urban environment are extremely useful to alleviate the effects of air pollution by the following means:

Phytoremediation

Air pollutants include RSPM (Respirable suspended particulate matter) caused by vehicular movement, automotive emissions, and contaminants from wearing out of tyres, etc. Trees help people in coping with the pollutants in the atmosphere by means of phytoremediation. Studies have shown that trees help in removing air pollutants, especially suspended particulate matter(SECON, 2006). Leaves remove various pollutants from the air by means of "dry deposition". Shade trees reduce evaporative emissions from parked vehicles. Trees and vegetation remove and store carbon(US Environment Protection Agency, 2011a).

Phytoremediation using trees to clean up air pollution is low cost and low maintenance. Trees also help in increasing oxygen levels. Phytoremediation is the

best tool for controlling pollutants, as compared to other technological methods of remediation. Additionally, phytoremediation by trees is also aesthetically pleasing than other methods.

Providing relief in urban heat islands

Urban and suburban areas are usually warmer compared to the surrounding rural area. This difference in temperature is what constitutes an *urban heat island*. According to a report by the US Environmental Protection Agency, "the annual mean air temperature of a city with one million or more people can be 1 to 3°C warmer than its surroundings, and on a clear, calm night, this temperature difference can be as much as 12°C. Even smaller cities and towns will produce heat islands, though the effect often decreases as city size decreases." These heat islands are influenced by decreased vegetation; properties of urban materials such as solar reflectance, thermal emissivity, and heat capacity and dimensions; spacing of buildings (Urban geometry) influence; and weather and geographic location. Bangalore has seen an increase of ~ 2 – 2.5°C in the past three decades.

The impacts of urban heat islands include:

- increased energy consumption

- elevated emissions of air pollutants and greenhouse gases

- compromised human health and comfort

- Impaired water quality(US Environment Protection Agency, 2011b).

Urban trees help in mitigating these impacts by means of *shading* and *evapotranspiration*. Trees in full foliage allow only 10 - 30% of the sun's energy to reach the ground below. The rest is either absorbed by the foliage or reflected back into the atmosphere thus significantly reducing the heating of the surface below. This in turn reduces the heat transmitted to buildings and to the atmosphere. Studies have shown that temperatures of walls and roofs can reduce by up to 11-25°C.

Evapotranspiration refers to the *evaporation* of water from soil around vegetation and *transpiration,* which is the movement of water from the roots of plants to the atmosphere through their leaves. Evapotranspiration cools the air by using heat from the air to evaporate water.

Studies have shown that suburban areas with mature trees are 2 to 3°C cooler than new suburbs without trees(US Environment Protection Agency, 2011a).

Unless the BBMP takes other measures to disincentive the use of private vehicles and take measures to improve public transport, vehicular density is only going increase. Further, with the decrease in the width of the carriageway on Tender SURE roads, traffic jams will not only cause more pollution but will also dissuade

people from using buses, which are the worst affected by jams. Are we then heading towards a more polluted and congested future, the ill-effects of which would be further exacerbated by a tree-less environment?

3.1.2 Noise and Health

Major sources of noise pollution are road, rail and air traffic; industries; construction and public work; and the neighbourhood. According to World Health Organisation, the adverse effects of Noise pollution include "noise-induced hearing impairment; interference with speech communication; disturbance of rest and sleep; psychophysiological, mental-health and performance effects; effects on residential behaviour and annoyance; and interference with intended activities."(Berglund, Lindvall, & Schwela, 1999)

Plants and soil are known to attenuate noise pollution through absorption, deviation, reflection, and refraction of sound waves. Sound energy is dispersed through branches and trees by means of reflection and refraction of sound waves. Research has also shown that vegetation factors important for noise reduction include density, width, height and length of the tree belts as well as leaf size and branching characteristics(Gómez-baggethun et al., 2015).

A study conducted in Varanasi has shown that areas without vegetation had significantly higher noise pollution compared to areas with vegetation(Pathak, Tripathi, & Mishra, 2008). From the Karnataka State Pollution Control Board data on monthly average values of Noise levels measured at ten 'Continuous Noise Monitoring Stations' in Bangalore city from April-2015 to Mar-2016, it is evident that the city's noise levels are much above the permissible limits. This is true for both day time and night time noise levels and in both commercial and residential areas(Karnataka State Pollution Control Board, n.d.). Without trees, this situation will only worsen affecting the health and wellbeing of Bangaloreans.

3.1.3 Urban Biodiversity

Cities occupy only 2% of the Earth's surface. Yet, they use 75% of the planet's natural resources. Cities draw on their surrounding ecosystems for goods and services, and their products and emissions can affect regional and even global ecosystems. Healthy ecosystems and biological diversity are vital for cities to function properly.

Urban interests have had a detrimental effect on the ecosystems around the cities, damaging the biodiversity of the surrounding areas, and in turn threatening the viability of the cities themselves. While damaged ecosystems negatively affect urban residents, healthy ecosystems provide cities with a range of services which

are essential for their economic, social and environmental sustainability(UNEP & UN-Habitat, 2005).

Bangalore's biodiversity has been well-documented, thanks to the expertise and very proactive citizen groups. A checklist of birds compiled in 1994 and that of fauna compiled in 1999 documented the presence of 40 species of mammals, over 340 species of birds, 38 species of reptiles, 16 species of amphibians, 41 species of fishes and 160 species of butterflies within a 40 km radius from the city centre(George et al., 1994; Karthikeyan, 1999). From this, it is evident that Bangalore's urban environment has supported a wide variety of biodiversity. Trees, especially older ones, are crucial for several forms of wildlife. Large parks and gardens connected by tree-lined avenues help in creating a mosaic of habitats for a variety of species to thrive. Several species use this tree / vegetation cover to disperse to newer areas that could be conducive for their survival(Karthikeyan, 2015).A booklet titled 'Trees of Bangalore' published by an eminent naturalist, Mr Karthikeyan S is given in the Appendix. Ecological functions of some of the species are also given in the booklet.

Use of Roadside Trees by the Birds of Bangalore by Krishna M B

(The Text of this section is reproduced from a note published by a distinguished Bangalore-based ecologist, Dr Krishna M. B. The note can be accessed at: http://www.krishnamb.com/use-of-roadside-trees-by-the-birds-of-bangalore/)

There are many birds and animals which live on and make use of roadside trees. They may be using the trees for shelter, for getting their food or, even using it as a travel corridor to move from place to place. If one considers birds of Bangalore for example, there might be birds of quite different lifestyles living in or using these trees. They might come to these trees just for roosting, or come to these trees to catch insects or eat fruit, or do both. They could even build their nests on roadside trees and feed their young there. There are even water birds like Night Herons which build their nests and raise their young on large trees in Bangalore.

Roadside avenues play a very important role in connecting the various green spaces still surviving in the city. The green spaces could not only be the parks and public gardens that we have, but could also be the various other gardens distributed in other private areas. The following lists the lifestyles of birds that could be using roadside trees (both large and small) in our city. It should be noted that in many cases, though certainly not all, roadside trees take more importance in conjunction with appropriate other greenery, including gardens.

- Fruit eating birds

- Nectar feeding birds

- Sallying insectivores

- Foliage gleaning insectivores

- Bark gleaning insectivores

- Far ranging roosting birds

- Birds of prey

- Scavenging birds

- Singing birds

- Birds using it as a corridor for movement and dispersal

- Birds which use buildings

- Water birds nesting or roosting in roadside trees

Even though birds can fly, they very often keep close to shelter and are loath to cross large open spaces away from cover. Quiet residential areas with closed canopies could even have the spill over from neighbouring gardens and harbour the more woodland kind of birds. There is a common misconception that roadside trees serve no use for wildlife in urban areas. Nothing could be farther than the truth. All the examples considered herein could come under the preview of the Wildlife Protection Act, 1972 and revisions and perhaps under the treaties for the conservation of migratory birds. These are some of the birds found in each category mentioned above:

Fruit Eating Birds

There are many fruit eating birds which come to take fruit from roadside trees. Many of these are even part of our folklore and culture like the Koel. Small Green Barbet and the Coppersmith Barbet are two of the more prominent species. In addition, both Redwhiskered and Redvented Bulbuls can come to roadside trees in appropriate habitats. Roseringed Parakeets and the colourful Blossomheaded Parakeets come to roadside trees. The two myna species and the starlings, namely Jungle and Common Mynas; the Grey-headed, Black-headed and Rose-coloured Starlings come to roadside trees to take fruit. At the other end of the size spectrum, we have the almost thumb sized Tickell's Flowerpecker visiting the mistletoe on roadside trees.

Nectar Feeding Birds

Many nectar feeding birds like the Purplerumped Sunbird and the Purple Sunbird come to roadside trees. The much rarer Maroon-breasted Sunbird also comes to roadside trees.

Sallying Insectivores

A large number of sallying insectivorous birds also use roadside trees. Various flycatchers could make use of the under-canopy space to carry on their food gathering activities. Many of these are migratory. The Grey Drongo which is again a migratory species, makes use of the air space over the canopy using the upper branches as perching sites.

Foliage Gleaning Insectivores

There are quite a number of birds in this category. There are warblers which are abundantly found here. They search leaves at different levels depending on the species. The migratory Greenish Leaf Warblers are quite prominent. Tailor-birds, and occasionally Ashy Long-tailed Warblers make use of the lower branches, and in the wooded outskirts, the Franklin's Long-tailed Warbler.

Bark Gleaning Insectivores

Grey Tit is a prominent member of this guild. On the outskirts, woodpeckers are found too.

Ground Feeding Birds

Many birds which feed on the ground or near to the ground fly up into trees on disturbance, and roost there. They could be both insect eating birds like the various species of babblers or seed eating birds like the Spotted Dove. The many babblers include, depending on the part of the city and time, the most common of them all, the White-headed Babbler. In addition, we have a class of birds which perch on low trees but swoop on insects on the ground like the Roller, though this is essentially on the outskirts. The Roller is known to breed on roadside trees.

Far Ranging Roosting Birds

There are long flying birds like the crows and mynas which commute long distances from their feeding to roosting places. Depending on the season, even Roseringed Parakeets are found abundantly on Roadside trees.

Birds of Prey

Most birds of prey make use of the large roadside trees for roosting, feeding and nesting. Shikra, Brahminy and Common Kites are all found on roadside trees. In addition, many species of owls like the Spotted Owl, the Collared Scops Owl, the Barn Owl and the Mottled Wood Owl could come to or roost in roadside trees.

Scavenging Birds

Crows are one of the main users of roadside trees. Common Kites are another species found abundantly on this substrate.

Singing Birds

Quiet roadside trees are places where our proverbial cuckoos, the Koels roost and sing from. Many warblers and flycatchers, thrushes and the Magpie-Robin sing from the shelter of roadside trees.

Birds Using it as a Corridor For Movement And Dispersal

The critical function of the roadside avenue to provide a corridor for movement of our avifauna cannot be underestimated. Many species are loath to leave their sheltered places and fly across open ground. For all such species and others in general, avenues provide the corridor.

Birds Which Use Buildings

Birds which sit on building like Blue Rock Pigeons also perch on trees. Often they land on to trees before settling down on the ledges of buildings. Another bird which shows a similar behaviour is the Barn Owl.

Water Birds Nesting or Roosting in Roadside Trees

This is a classic example of the unexpected happening. Many species of shoreline water birds like Night Herons, Egrets and other herons roost and breed on roadside trees, often within Bangalore.

And Then, There Are Endemic Birds

Many of the species which occur on these roadside trees are endemic to this part of the world, and found nowhere else. They include the Small Green Barbet, the Purple-rumped Sunbird and the Mottled Wood Owl.

3.1.4 Quality of Life

Gopal & Nagendra(2014)elucidate the importance of greenery for the wellbeing of urbanites, especially the urban poor. According to them, "Greenery near residential areas promotes walking, thereby improving people's cardiovascular systems and reducing obesity. Green surroundings and home gardens reduce morbidity, increasing mental peace"

A study on the psychological effects of "Natural versus Urban Scenes" has shown that individuals who viewed urban scenes with vegetation had slower heartbeats, lower blood pressure, and more relaxed brain wave patterns than individuals who viewed scenes without vegetation(Ulrich, 1981). Another study has shown that people "living in buildings without nearby trees and grass reported more procrastination in facing their major issues and assessed their issues as more severe, less soluble, and more longstanding than did their counterparts living in greener surroundings" indicating that green space enhances residents' effectiveness by reducing mental fatigue(Kuo, 2001).

The most important benefits of trees in an urban environment perhaps cannot be justified by numbers and statistics. As Dwyer et al. point out, "There are deep

emotional ties between people and trees that are not conveyed by a high correlation between "tree size" and "preference" in the equations we have developed to predict perceptions of urban forest environments. Likewise, the strong ties between people and trees cannot be explained by increased property values, reductions in air pollutants, and moderations in temperature. The psychological ties between people and trees defy easy quantification, yet few would deny their existence or their profound implications for urban forest management"(Dwyer, Schroeder, & Gobster, 1991).

The words of Dwyer et al. sum up the importance of trees: "There is often synergism among these attributes that complicates our attempts to understand the ties between people and trees and forests. The task is similar to describing what attracts us to a loved one, a home, or a profession. We can come up with endless lists of reasons, but are seldom satisfied that we have included all the dimensions, or that they collectively come anywhere near capturing the totality of what we are evaluating!" They add, "In sum, urban trees are living, breathing organisms with which people feel a strong relationship, and in our planning and management we should not think of them just as air conditioners, providers of shade, and ornaments in the urban system. Failure to recognise the deep significance of trees to urbanites most likely result in less effort being given to tree planting, care and protection than the public desires".

3.2   Water Woes

With the changing climate, access to fresh water will be a major challenge in the coming decades. In Bangalore, 98% of the lakes have been encroached for illegal buildings and 90% of the lakes are sewage-fed. Lake catchments are being used as dumping yards for either municipal solid waste or building debris and lakes have been polluted by indiscriminate disposal of solid and liquid waste. Thus, by rendering the immediate source of fresh water non-potable and piped water connection (which has exhausted its capacity) serving only 8 lakh of the 22 lakh households; and nearly 40% of the population depending on groundwater, Bangalore's hope lies in harvesting rainwater. However, due to a heavy dependence on ground water, water table has declined to 300 metre from 28 metre over a period of 20 years(Ramachandra & Aithal, 2016; Ranganath, 2016). Rainwater harvesting is thus the immediate need of the hour.

3.2.1   A Missed Opportunity to Harvest Road Runoff

Based on Bangalore Rainwater Harvesting Regulations, 2009, the Bangalore Water Supply and Sewage Board made installation of rainwater harvesting structures compulsory for all residential, commercial and industrial premises. However, what has not been explored by the State is the potential to harvest run off from roads. It has been estimated that a 7.0 m wide road has seven times more water harvesting potential than a roof top of 1000 sq. m area. In India, urban areas have a total of 0.25

million km of roads and constitute about 30% area of any city(Sachdeva & Sharma, 2008).

Tender SURE roads are poorly designed to exploit this potential. There are provisions to channel rainwater to lakes through storm water drains and without the mixing of sewage. There is also a mention of a proper design of the inlet "after detailed hydraulic design for the road". This inlet directs water to the storm water drain. It is unclear if this detailed design has been undertaken and implemented yet.

There is also a mention of "swales". i.e., linear depression of channels for collection and conveyance of storm water but these have been recommended only for roads above 48 metre width. These swales are, however, missing in the designs and thus perhaps even in execution. The need for recharge groundwater locally has been completely neglected.

Karnataka State Council for Science and Technology has recommendations on road and footpath design to harvest rainwater from roads: "To increase ground water recharge by percolation and decrease the flooding of storm water drains, an infiltration trench could be built by the side of the drain all along the road, wherever possible. The infiltration trench can be 2 feet wide and 2 feet deep and filled with pebbles or aggregates with a top layer of coarse river sand".

"As the rainwater from the road flows into the infiltration trench, water percolates into the ground. During heavy rainfall, excess water spills over to the storm water drains. The infiltration trenches store water temporarily during rainfall and later for infiltration. These infiltration trenches may be exposed as walk ways or paved with inter-locking pavers, specially designed with gaps in between for water to flow into the infiltration trenches" (Shivakumar, 2005).

This cannot be implemented on Tender SURE roads because there is no soil beneath for water to percolate.

In Chennai, storm water drains have proven to be inefficient flood mitigation measure. Experts recommend that they should be given up and replaced with rainwater harvesting measures(Gopalakrishnan, 2012).

Road Rainwater Harvesting: Coimbatore Shows the Way

After experiencing the worst water crisis in 2003, an NGO called Siruthuli, water harvesting structures to capture runoff from roads and open spaces were constructed. These structures consist of a deep bore well, recharge pit percolation/filter chamber filled with filter materials and concrete slabs. This has resulted in dramatic increase of ground water levels. In 2003 the average static water level of Coimbatore City during the year 2003 was about 90′ with a yield of 1.5″. Following a monsoon failure in 2004, the average static yield went down to

122′ – 131′ and the average yield reduced to 1.3″. Within a year of implementing the project, the average static level has rose to 63′ with an average yield of 2″. As of 2009, water levels in all zones were 10′ - 40′ deep. Failed bore wells and open wells started yielding enough water even in summer, which has been a boon for farmers and urban dwellers alike(UN-Water, n.d.).

3.2.2 Water-Intensive Landscaping

Apart from being ineffective in capturing rainwater, the landscape strips on Tender SURE roads are water-intensive! Maintainingthe plants on these strips will require watering on a regular basis. It is unclear how much water is required and from where this will be supplied.

4 Conclusion

Bangalore's trees and natural resources have been neglected and sacrificed at the altar of development for far too long. While the developed world is introspecting on their failed development models, we seem to be following the same path to destruction.

Tender SURE has shown what pedestrian and public-transport friendly roads can feel and look like. It is important to take these positive aspects while also incorporating the natural resources, identity and culture of the city into any further planning of roads. Any futuristic project must take into account the inevitable impacts of a changing climate and plan for a resilient city. The city's natural resources cannot be neglected, especially with glaring scientific evidence that the city will be unliveable in the next five years!

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