Environmental and ecological impacts of tree-felling and road widening of Bengaluru's surrounding roads

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Executive Summary

In this report we present findings from a rapid environmental assessment conducted by us to assess the impacts of the proposed widening of peripheral roads around Bengaluru city, Karnataka. The project proposes widening of roads from 2-lane to 4-lane, and 4-lane to 6-lane, for six stretches: Budigere Cross (Hoskote) to Mylanahalli (near Kempegowda International Airport), Nelamangala to Madure, Madure to SMVIT Cross on Devanahalli Road, Kanchugaranahalli to Jigani, Bannerghatta to Besthamanahalli (near Anekal), and Besthamanahalli to Hoskote. While official numbers of trees that will be felled under the project are yet to be released, **newspaper reports estimate that 8,561 trees will be cut over a total distance of 152.03 km.**

Urban trees provide essential functions such as micro-climate regulation, carbon sequestration, pollution reduction, soil stabilisation, and prevention of groundwater run-off. Unplanned urbanisation and development in Bengaluru has led to the rapid decline in green cover over the last 20 years. This has severely compromised the overall health of the city and its inhabitants, as well as adversely impacted biodiversity. It is imperative that we protect the city's remaining green cover, to ensure that the city remains liveable, especially with climate change projections predicting even more increases in annual temperatures and unpredictable weather patterns.

Bengaluru city's deteriorating green cover needs to be protected for the environmental benefits as well as for the health and well-being of its residents. This is even more critical in these times, when India faces an impending climate emergency. **Thus, the cutting of trees on the outer road must be stopped immediately, and the heritage trees must especially remain untouched.**

The main finding of our rapid environmental assessment are:

1. The road widening project impacts will include a) health issues from increased air pollution and b) urban heat islands c) loss of heritage trees d) loss of urban biodiversity e) threat to forest ecosystems f) loss of religious spaces g) threat to lakes and h) reduction in carbon sequestration

2. The proposed stretches pass through **crucial biodiversity habitats** that include the **Junnasundra Mini Forest, and the Anekal Reserve Forest contiguous with the Bannerghatta National Park,** as well as scrubland, and agricultural fields. Disturbance of these stretches can negatively impact fauna including the endangered slender loris (*Loris tardigradus*), accorded protection under Schedule 1 of the Indian Wildlife (Protection) Act 1972. A slender loris was rescued recently by the residents of Sarjapur through which a large section of the proposed road passes. Residents also recorded other biodiversity such as the palm civet (*Paradoxurus hemaphroditus*) found all over India but not commonly seen, the Indian hare (*Lepus nigricollis nigricollis*) and the Indian jackal (*Canis aureus aureus*).

3. The total **number of trees that will be felled along the 152.03 km, are likely to be much higher than the estimated 8,561**. We found a systematic pattern of mismatch with tree numbers on our surveyed stretches being higher than those in reports. For instance, according to newspaper reports, 869 trees are to be cut in the 15 km Nelamangala to Madure stretch. We counted 929 trees in the same stretch, in our survey. On the Kanchugaranahalli to Jigani stretch covering 33.2 km, reports suggest that 184 trees are to be cut. From our field assessment, we counted around 1,000 trees already marked to be cut. In addition, several trees were unmarked but also likely to be cut during the road widening.

4. There are several **massive heritage trees on these stretches, the loss of which will be irreplaceable**. We recorded two massive banyan trees with a girth of 14.9 m and 17.7 m, an impressive 50 feet tall banyan, on the road from Nelamangala to Madure. One banyan tree on the Besthamanahalli to Hoskote stretch had a girth of 10 m. Other large heritage tree species that will be lost include peepul, Mysore fig, raintree, neem, teak, tamarind, and jamun.

5. We recorded **15 sacred *ashwathkattes* marked for removal.** *Ashwathkattes* are raised platforms with neem and peepul trees and snake shrines at their base that have immense religious and social significance for local residents. Three especially large peepul trees marked for removal on the *ashwathkattes* had girths of 5.8 m, 4.3 m and 3.5 m.

6. **Road work has already begun and several old and large trees have been cut or lopped** in three stretches: Bannerghatta to Besthamanahalli, Kanchugaranahalli to Jigani, and Budigere Cross to Mylanahalli. In the Kanchugaranahalli to Jigani stretch, we found 51 trees to have been already cut.

7. Along the six stretches of roads that we sampled, **we recorded 14 lakes.** This includes Varthur, the second largest lake in Bengaluru, and Madure kere, which extends over 568 acres. The road widening project will severely affect groundwater recharge, flood control and biodiversity in these lakes. The resulting environmental deterioration will also impact livelihoods of local grazers and fishers who use these lakes.

8. The lack of systematic planning for transportation infrastructure in cities like Bengaluru leaves us with no good choices or 'win-win' situations. Any proposal on construction of the proposed peripheral ring road can only move ahead after demonstration of need, and rigorous attention to specific details, to minimise and mitigate the ecological and social impacts. Unfortunately, we find the focus on minimisation and mitigation to be missing, along with a lack of transparency and insufficient attention to detail.

Introduction

"Mercury rising in Bengaluru, Friday was 'hottest January day ever'"
(The Indian Express, 2nd February 2020)

According to the India Meteorological Department, the temperature of 33.4 degrees Celsius recorded on 31st January 2020 in Bengaluru was the highest **ever** recorded in the month of January for the city. The city had almost no winter, and predictions point to a very harsh summer in the months to come. The pleasant climate and green cover that gave the city titles such as "Garden City" and "Pensioners Paradise", attracting investment and people, is a thing of the past.

Located in the semi-arid region of the Deccan Plateau, the green cover of Bengaluru was developed as far back as the 18th century when Hyder Ali and later his son, Tipu Sultan, laid parks such as Lal Bagh. Later, British and Indian administrators planted tree-lined avenues with a range of species, while plantation drives along roads carried out post-independence in the 1980s helped in greening the city's core areas. The climatic, ecological and aesthetic benefits the city continues to enjoy is the result of tree planting done in the past. For the city, these trees serve innumerable functions such as micro-climate regulation, carbon sequestration, pollution reduction, soil stabilisation, and prevention of ground water run-off. They are of aesthetic and religious value, and act as refuges for urban biodiversity.

Bengaluru, today, is the third fastest growing city in India, but unplanned urbanisation has paid little attention to retaining or improving green cover. Over the last few decades, trees have been felled for infrastructure development such as road widening or for laying new metro lines. Bengaluru is felling some of its oldest and largest trees for these development projects. In the few places where replanting is done, young trees predominantly belonging to small-sized species are used as replacement. The younger trees that replace the older, bigger trees have a lower capacity to absorb atmospheric pollutants, mitigate the effect of urban heat islands, stabilise soil and prevent groundwater run-off. Felling these trees, therefore, has serious repercussions for the health of the city's residents.

In recent years, the steel flyover project and the elevated corridor, as well as construction proposed in Cubbon Park have all threatened the already depleting green cover. Protests by civil society have been able to save green cover in road stretches and parks, but this has become an unending battle costing time and resources of all—and always creating the false divide between the pro-development and pro-environment groups. Undoubtedly, civil society protests, supported by media and progressive judgements of courts, have been able to protect the green cover in the city's core to some extent. But, as the city expands, the existing green cover in the peripheral areas is under severe threat.

The Karnataka Road Development Corporation Limited (KRDCL), a company under the Public Works, Port and Inland Water Transport Department, has proposed a road-widening project in roads surrounding the city. The project proposes widening of roads from 2-lane to 4-lane and 4-lane to 6-lane. While no numbers have yet been released officially or environmental impact assessment carried out, newspaper reports estimate that 8,561 trees over a 152.03 km will be cut under this project (See Table 1 and Map 1 for details of project).

Table 1: Details of stretches and trees to be cut

Stretch	Road stretch details *	Length of stretch (km)**	No of trees to be cut**
1	Package 1: Development of road from Hoskote-Budigere cross(NH-4) to Mylanahalli (Kempegowda International Airport road) via Budigere-Singahalli in Bengaluru Urban/ Rural District	20.11	1,758
2	Package 2A: Development of road from Nelamangala from NH-4 to Madure on SH 74 via Chikkamadhure in Bengaluru Urban/Rural District	15.25	869
3	Package 2B: Development of road from Madure on SH 74 to Devanahalli Road (EMM VEE Solars on NH 7) via Rajanukunte and Thimmasandra in Bengaluru Urban/Rural District	23.99	1,593
4	Package 3A: Development of road from Kanchugaranahalli to Jigani via Harohalli and Urgandoddi and section of road from BM road junction to Coca cola factory of Bidadi-Harohalli road in Bengaluru	33.2	184
5	Package 3B: Development of road from Bannerghatta on SH-87 to Besthamanahalli (near Anekal) on SH-35 (including Anekal bypass, Grade separator across Chandapura road and ROB across railway line) via Jigani, Haragadde and Indalwadi in Bengaluru	20	520
6	Package 4A: Development of road from Besthamanahalli (near Anekal) on SH-35 to Hoskote road (NH-04) via Attibele-Sarjapura and Whitefield (excluding elevated corridor, Grade separator and ROB) in Bengaluru	39.48	3,637
	Total	**152.03**	**8,561**

Source:
*Website of the KRDCL. URL: http://www.krdcl.in/en/budgetworks-blraroundroads (retrieved on 12th March 2020)
**Letter written by A N Yellappa Reddy, Chairman, Bangalore Environment Trust to Chief Minister of Karnataka dated 12th February 2020

Map 1: Route of proposed road with stretches and trees marked for cutting

Stretches with trees marked for cutting:

- Budigere Cross (Hoskote) to Mylanahalli (KIAL)
- Nelamangala to Madure
- Madure to SMVIT Cross (Devanahalli Road)
- Kanchugaranahalli to Jigani
- Bannerghatta (SH 87) to Besthamanahalli (Anekal)
- Besthamanahalli (Anekal) to Hoskote

We conducted an independent rapid environmental impact assessment of the proposed stretches to be widened. The assessment was conducted between 29th February and 6th March. This report presents the results of the assessment. We counted all the trees from Nelamangala to Madure (stretch 2), while we intensively counted trees in the section from Besthamanahalli (near Anekal) to Attibele (coming within stretch 6) and a 5 km section from Bidadi to Jigani (coming within stretch 4). A member of Voice of Sarjapur, a civil society organisation, conducted an independent survey along a 13 km section of stretch 6, which they shared with us. We have also included this survey in the report.

Stretch 1: Budigere Cross (Hoskote) to Mylanahalli (Kempegowda International Airport)

Length of stretch: 20.11 kms
Number of trees to be cut (as per newspaper reports): 1,758

A canopy of jamun trees marked for felling

This stretch starts at Budigere Cross (Hoskote) NH4 and ends at Mylanahalli village near the Kempegowda International Airport (henceforth KIAL).

Some of the important species we observed in this stretch were jamun, cannonball tree, bahunia, neem, teak, peepul, banyan, and raintree, which were marked for felling. We also recorded a drumstick tree numbered for felling. In addition there were stretches containing species of eucalyptus and acacia, on both sides of the road. Close to KIAL was an *ashwathkatte* with *nagarkallus* (snake stones) at the base of two large peepul and one neem, of which one of the peepul close to the road was numbered for felling.

We observed that road work has started after the Budigere junction and numbered trees have already been cut , even before the project has been approved.

Roadwork in progress and trees already cut

Drumstick tree marked for felling

Ashwathkatte near Mylanahalli. The peepul to the right has been marked for cutting

Stretch 2: Nelamangala to Madure

Length of stretch: 15.25 kms
Number of trees to be cut (as per newspaper reports): 869
Number of trees to be cut (as per our survey): 929

A huge banyan tree with a canopy across the road marked for cutting

This stretch extends from Nelamangala to Madure, and in our survey we counted 929 trees (Annexure 1) which was higher than 869 trees reported in the newspapers. We identified 25 species numbering 784 trees, and in addition identified trees of the genus *Cassia*, and *Ficus* numbering 84. There was also one unidentified species in this stretch.

In this stretch we recorded an astonishingly high number of banyan trees which seemed to be decades old. There were 206 banyan trees, planted on both sides of the road, forming a beautiful canopy. We recorded two of the largest trees of the survey in this stretch which were two massive banyan trees, likely decades old, with a girth of 17.7 m and 14.9 m and towering over 50 feet. Among the other banyan species seven had a girth between 8 m and 9 m and 41 between 4 m and 7 m. The tallest banyans reached a height of an estimated 60 feet. There were 50 basari, another *Ficus* species and one of the largest trees was 40 feet with a girth of 2.7 m. There were 25 trees of Mysore fig, all around 40 feet in height, and one of the trees had a girth of 4 m. There were also 11 peepul trees, one of which was 50 feet tall with a girth of 3 m. There were also two cluster figs, one of which had a girth of 3.6 m.

We also recorded 51 honge and 49 jamun. We recorded fruit trees of mango, jackfruit, coconut, Singapore cherry, and tamarind, native tree species of ippe, neem, sissoo, and planted species were *Cassia sp*, acacia, copperpod, and eucalyptus. In addition we spotted trees with bright red flowers—one flame of the forest, three African tulip, and four gulmohar.

Stretch 3: Madure to SMVIT Cross (Devanahalli Road)

Length of stretch: 23.99 kms
Trees to be cut (as per newspaper report): 1,593

The banyan next to which there was a pond with water birds

This stretch begins at Madure and going via Rajankunte and Thimmasandra connects to the Devanahalli Road at SMVIT Cross bus stop. A large part of the stretch cuts across agricultural lands, and a small section of the road lies adjacent to the Junnasandra Mini Forest. During our rapid survey we spotted a mongoose (*Herpestes sp.*) crossing the road in this stretch. There were two important stretches with clumps of banyan, where we saw a group of bonnet macaques (*Macaca radiata*). We recorded a small pond at the side of the road beside a banyan, with a pond heron (*Ardeola grayii*) and stilt (*Himantopus himantopus*). This microhabitat, though dumped with garbage and with sewage inflow, was clearly important for these two bird species, and also a range for other invertebrates. Unfortunately, this is sure to be filled if the road widening project were to go ahead.

Stretch 4: Kanchugaranahalli to Jigani

Length of stretch: 33.2 kms
Number of trees to be cut (as per newspaper reports): 184
Number of trees to be cut in 5 km section of stretch (as per our survey): 59

Trees numbered and already cut between Bidadi and Jigani

This stretch of road extends form Kanchugaranahalli (near Bidadi) to Jigani going via Harohalli and Urgandoddi. It is particularly important as in addition to agricultural land, the road cuts through a forest section—the Anekal Reserve Forest—that is contiguous with the Bannerghatta National Park. The habitat around the reserve forest is rocky, scrub jungle type. The total number of trees to be cut, from newspaper reports, are 184. However, when we counted just the trees that were marked to be cut, there were around a thousand which exceeded the reported number by almost ten times. In addition, there were many trees on this stretch that were unmarked, but could end up being cut as well. Trees in the Anekal Reserve Forest section were not marked to be cut, but trees right outside the Reserve Forest entrance, on both ends of the section were marked to be cut.

We did an intensive survey of a 5 km stretch documenting tree species and numbers. We counted 59 trees of which we could identify 14 species, including *Cassia sp* and *Eucalyptus sp* and one unidentified species (Annexure 2). There were 10 coconut trees, seven neem and raintrees, four honge, three tamarind, two each of Singapore cherry, teak, and black wattle, and one each of jackfruit, jamun and African tulip. Among *Ficus sp* there were two peepul, and one each of basari and banyan.

One of the trees numbered and lopped between Bidadi and Jigani

Among these were a number of massive trees, clearly decades, if not centuries old, that were marked for cutting. These are heritage trees, irreplaceable by saplings. They include a spectacular raintree, 70 feet tall and 4.5 m in girth, a peepul tree 4 m in girth, and two raintrees, a eucalyptus, and a banyan tree with girths between 3 m and 3.5 m. We also noted 26 trees with girths ranging from 2 m to 2.7 m, with species like honge, tamarind, teak, jackfruit, neem, eucalyptus, raintrees, black wattle and cassia.

Road work on this stretch has already started and marked trees had also been cut. We counted 51 trees that had already been cut throughout this stretch. From the species that we could identify that had been cut, there were peepul and raintree. This included one massive peepul tree with a girth more than 3 m. Some of the trees that were numbered had also been lopped.

The road cutting through Anekal Reserve Forest

Stretch 5: Bannerghatta to Besthamanhalli (near Anekal)

Length of stretch: 20 kms
Number of trees to be cut (as per newspaper reports): 520

This stretch extends from Bannerghatta to Besthamanhalli via Anekal by pass, Jigani, Haragadde and Indalwadi cross.

Trees had already been cut and roadwork started.

A tree trunk set on fire, still smouldering.

On this stretch as well, we noticed that road work has already started where the road was narrow. Tree felling was visible, with tree stumps set on fire and we saw one that was still smouldering. There were massive heritage trees from the Jigani to Bannerghatta stretch, including ones that had been trimmed.

Stretch 6: Besthamanahalli (near Anekal) to Hoskote

Length of stretch: 39.48 kms
Number of trees to be cut (as per newspaper reports): 3,637

This stretch extends from Besthamanahalli near Anekal and ends at Katamnallur near Hoskote. It passes through Attibele, Sarjapur, Dommasandra, Varthur and Whitefield. The stretch from Dommasandra to Varthur, has a number of banyan, jamun, ippe and cluster figs that are marked for cutting along the road.

Members of a civil society organisation, Voice of Sarjapur, had also undertaken a census of trees that would be cut in a 13 km section, on the stretch between Sarjapur and Attibele via Billapura, S Medihalli, and BEML Cooperative Society Layout. They had recorded 226 trees of a variety of species such as honge, jamun, banyan and other *Ficus* species. In this same stretch, during our survey, we marked species such as the flame of the forest, shivne and sissoo.

Peepul trees on an ashwathkatte market for felling between Besthamanahalli and Attibele

We conducted a detailed survey in the stretch between Besthamanahalli (near Anekal) and Attibele. We recorded 414 trees of which 309 trees were from 33 species, 37 were from six species (*Acacia sp.*, *Bauhinia sp.*, *Ficus sp.*, *Swietenia sp. Terminalia sp., and Ziziphus sp.*), and eight still require identification (Annexure 3). The stretch also included two *ashwathkattes* that are of religious importance, which had four peepul and two neem that were marked for cutting. Among native species, there were 65 honge, 21 neem, 15 *Ficus* trees which included two banyan, and three each of basari and cluster fig, 13 each of shivne and sissoo, nine bhendi, eight trees each of bauhinia, arjuna, jungli badam and teak, and six jamun. Among the large canopied trees were 22 copperpod and 15 raintrees. Among the non-native trees were 60 eucalyptus and 59 black wattle. Additional fruit trees that would be cut on this stretch include one tree each of mango, jackfruit and guava, four coconut trees as well, and 13 tamarind. A few specimens of babul, Singapore cherry, African tulip, cannonball tree, gulmohar, silver oak, elephant apple, buckthorn, gum Arabic tree and white-barked acacia would also be lost to road widening. This also indicates a considerable species diversity of trees that will be impacted.

A flowering sissoo marked for felling between Sarjapur and Attibele

In this stretch the biggest trees we recorded were two stunning species of *Ficus* with impressive girths of 10 m and 6.6 m. There peepul trees marked for cutting on the religiously important *ashwathkattes* had girths of 5.8 m, 4.3 m, and 3.5 m. Four other *Ficus* species including a banyan had a girth of more than 4 m. A jamun, cluster fig, a tamarind, and six raintrees had girths between 3.8 m and 3.2 m, towering at heights from 50 feet to 60 feet. Of the trees 133 had girths more than 2 m, which included five shivne with girths between 2 m and 2.5 m, and 115 trees of different species between 2 m and 3 m. These species included neem, sisso, gulmohar, eucalyptus, basri, babul, black wattle, copperpod, honge, raintree, tamarind, jamun, bhendi tree, jamun, African tulip, arjuna, and peepul. As mentioned above, many of these trees are probably decades old and cannot be replaced by saplings. There is also a rich species diversity, which is diluted as replanted saplings often have a far lesser species diversity.

An ippe tree marked to be cut between Dommasandra and Varthur

Other habitat types and lakes ecosystems

There were different kinds of habitats along the stretches from agricultural fields, to scrubland, to the Junnasundra Mini Forest and the Anekal Reserve Forest. Each of these habitats, along with trees are an ecosystem that support a variety of fauna, including the bonnet macaques, squirrels (*Funambulus palmarum*), and mongoose, which we recorded during our survey. The trees provide food and nesting habitat for a range of bird species from the common crow (*Corvus splendens*) and myna (*Acridotheres tristis*) to species such as drongos (*Dicrurus macrocercus*), Brahminy kite (*Haliastur indus*), black kites (*Milvus milvus*) oriental honey-buzzards (*Pernis ptilorhynchus*), black eagles (*Ictinaetus malayensis*), black-shouldered kites (*Elanus caeruleus*), green bee-eater (*Merops orientalis*), and yellow-billed babblers (*Turdoides afinis*). We spotted beautifully woven baya weaver bird nests too (*Ploceus philippinus*).

We saw two reptiles species, the south Indian rock agama (*Psammophilus dorsalis*) and *Calotes sp*, scurrying up the barks of *Ficus*. Many of the trees, especially with wide, spreading branches supported a number of large bee-hives.

In the vicinity of the Sarjapur-Attibele section of the road we recorded a *gunda thope* (wooded grove) that provided shelter to a breeding population of Indian grey hornbills (*Ocyceros birostris*). The scrub jungle was also a habitat for the grey francolin (*Francolinus pondicerianus*) and shikra (*Accipiter badius*), both of which we spotted during our field survey.

The slender loris rescued at Sarjapur (Photo shared by Voice of Sarjapur)

Our conversations with locals also indicated the presence of the Indian hare (*Lepus nigricollis nigricollis*) and Indian jackal (*Canis aureus aureus*). Local residents, near Sarjapur, rescued a slender loris (*Loris tardigradus*), an endangered primate species accorded protection under Schedule 1 of the Indian Wildlife (Protection) Act 1972. Local residents have also sighted the palm civet (*Paradoxurus hemaphroditus*) which is found across India, but not so commonly seen.

We recorded a total of 14 lakes along these stretches. The lakes we recorded in our rapid survey included a 21 acre lake in Jyothipura (stretch 1), Madure kere extending to an area of 568 acres and a smaller lake close to Nelamangala town covering an area of 0.51 acres (stretch 2). There was one lake in stretch 4, and three in stretch 5 that included the Doddakere extending for 210

acres, Haragadde to around 59 acres and Kumbaranahalli lake covering an area of 9.8 acres. There were seven lakes in stretch 6 including, Varthur the second largest lake in the Bengaluru city limits (See Map 2 for habitats and lake ecosystems).

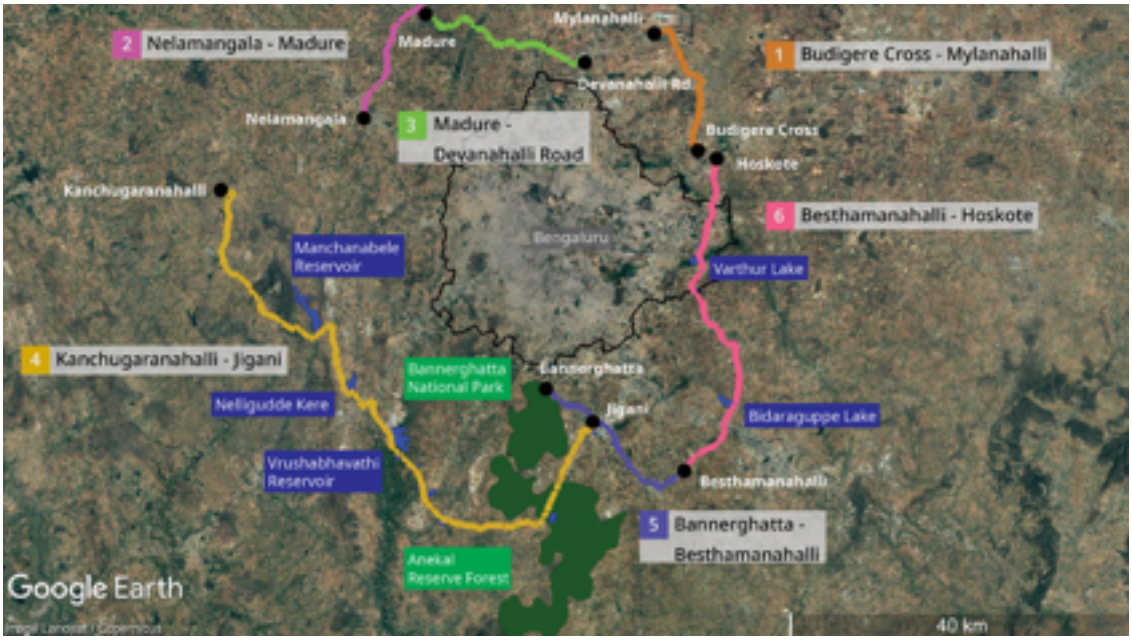
Fishing in lake adjacent to the road between Sarjapur and Attibele

These lakes support a host of biodiversity from water birds, to amphibians, to reptiles, to fish, and invertebrates. In the lakes that we surveyed, we observed chicks and nesting birds. In the Madure kere, we recorded woolly necked stork (*Ciconia episcopus*), spot-billed pelicans (*Pelecanus philippensis*), northern pintails (*Anas acuta*), coots (*Fulica atra*), purple moorhens (*Porphyrio porphyrio*), and a marsh harrier (*Circus aeruginosus*). The coots had nests and several chicks were observed swimming behind the parents.

Lake ecosystems in and around Bengaluru are not only a habitat for bird life, snakes and frogs, but are also a source of livelihood and subsistence for local communities. We saw a few people fishing and grazing livestock in and around the lakes.

A lake in the vicinity of the Sarjapur-Attibele road with a grove of arjuna trees

Map 2: Lakes and vegetation patches along the proposed road expansion



Lakes

Vegetation

Stretches on proposed route :

- Budigere Cross (Hoskote) to Mylanahalli (KIAL)
- Nelamangala to Madure
- Madure to SMVIT Cross (Devanahalli Road)
- Kanchugaranahalli to Jigani
- Bannerghatta (SH 87) to Besthamanahalli (Anekal)
- Besthamanahalli (Anekal) to Hoskote

Environmental impacts from loss of trees and surrounding ecosystems

1. Health hazard from increased air pollution

Air pollution is the third biggest cause of death in India, killing approximately 1.2 million people per year (Health Effects Institute 2019). Quality of air has serious implications for the health of vulnerable populations such as the elderly and children. Further, according to the Global Burden of Disease Study 2017, life expectancy in India is reduced by 1.7 years as a result of air pollution (India State-Level Disease Burden Initiative Air Pollution Collaborators 2019). There are economic impacts as well, with air pollution causing a loss of 3 percent in GDP for the country (Dahiya et al 2017).

Air pollution in Bengaluru is already of serious concern. The air quality index is around 141,[1] which is considered unhealthy for sensitive groups. Particulate matter (PM) are minute particles in the air that are a mixture of soot, dust, smoke, metals and other harmful substance. The concentration of PM_{10} for Bengaluru was 120 mg/m^3 which was double that of the National Ambient Air Quality Standard's annual average at 60 mg/m^3. The major contribution to the PM_{10} load was transport and road dust resuspension, while for $PM_{2.5}$ which are much finer suspended particles, the main source was transport. Transport was also the highest source of NOx (nitrogen oxides) that are irritant gases causing inflammation of airways (Dahiya et al 2017).
Trees play a very important role in controlling air pollution by absorbing toxic gases such as NOx and sulphur dioxide. Trees also settle particulate matter and mitigate the impact of dust pollution. They act as the lungs for the city producing oxygen and removing carbon dioxide. Our own research in Bengaluru, has found that street trees have a significant impact on air pollution, reducing Suspended Particulate Matter levels by as much as 75 percent and keeping sulphur dioxide levels within permissible limits (Vailshery et al 2013).

The construction of the Bengaluru outer road will increase vehicular traffic and incessant construction activity will also increase pollution. The cutting down of the trees, many of them with large canopies will compromise the health and life expectancy of Bengaluru's residents which is already a cause for concern.

2. Urban heat islands: Health and economic impacts

Heat can be debilitating. Working in the heat can cause low productivity, but worse can lead to exhaustion, dehydration and even death. Across India, cities are experiencing very high temperatures, and climate change will further exacerbate the impacts of heat stress. The increased temperatures means that people will not be able to work and the loss in daylight

[1] As on 11th March 2020 from https://aqicn.org/map/bangalore/

working hours will have health and social impacts especially for the poor who work out in the open. Working fewer hours means lesser pay for the poor, and rising temperatures mean the middle and upper class buy air conditioners and coolers further contributing to the rise in temperatures. Rising temperatures also means that the country will lose 1.8 percent of its GDP by 2050—an economic loss a developing country like India can ill afford (UNDP 2016).

Trees reduce temperatures on road surfaces and surrounding areas considerably. Our previous research in Bengaluru has shown that trees reduce the ambient air temperature on roads by as much as 5.6 degrees C and they reduce surface asphalt temperature by as much as 27.5 degrees C (Vailshery et al 2013). Temperatures in Bengaluru are on the rise, and the city recorded a temperature of 33.4 degrees C on 30th January 2020, the hottest day in the month ever recorded (The Indian Express 2020).

Street trees are a natural means of microclimate regulation, which is crucial today and is going to be of even more relevance in the years to come, as the world gets hotter. It is imperative that we protect trees, that regulate the city temperature at no cost, so that the city continues to be liveable.

3. Irreversible loss of heritage trees

Heritage trees are trees that are significant in terms of age, size or species. These also include trees of cultural and religious significance and trees that provide a habitat for birds, bats and honeybees. Heritage trees are those that have thrived for many years, even across generations, and cutting them would be an irreplaceable loss for not only us but also for our future generations (Thiruvady no date).

Heritage trees mainly species of *Ficus* such as banyan and peepul have been marked for felling in all stretches. In a 15 km stretch between Nelamangala and Madure which we had intensely surveyed there were 206 banyan trees, the majority of them concentrated in a 5 km stretch. These were stunningly large trees, and two of the largest banyans had girths of 17.7 m and 14.9 m and both towered at a height of 50 feet. The canopy of these trees extends across the road providing shade.

The *Ficus* species provide important refuges for urban biodiversity—and are keystone species whose presence in the ecosystem is critical for other biodiversity. They are capable of supporting a range of animal species such as fruit-eating birds (Annexure 4) and bat species, mammal species like the bonnet macaques, squirrels, reptiles, and innumerable invertebrates. Especially when they are connected to one another it becomes more important for biodiversity, as they improve connectivity. Cutting these trees that are keystone species providing a habitat and food for different kinds of biodiversity will lead to the destruction of a very critical ecosystem.

4. Loss of urban biodiversity including the endangered slender loris

Trees in cities are crucial habitats for biodiversity ranging from birds, to reptiles, to mammals, and to invertebrates. *Ficus* species, such as banyan, basari, peepul, cluster fig, and others are keystone species providing food and nesting spaces. In our survey in stretches with trees, especially *Ficus*, we recorded several fruit eating birds such as barbets, jungle mynas, mynas, and bulbuls. Among mammal species we recorded bonnet macaques and squirrels, while the Indian rock agama a species of reptile was also recorded. Bees are critical for pollination, and the several trees we surveyed also supported a number of large hives. Locals we spoke to reported sightings of the Indian hare and Indian jackal around Sarjapur.

Bengaluru is home to the slender loris, an indicator[2] species in an urban environment whose presence has been reported from several parts in the city. But we know very little about the population of this primate species categorised as "Endangered" by the IUCN Red List (IUCN 2008), and listed under Schedule I of the Indian Wildlife (Protection) Act 1972. Local residents near Sarjapur had recently rescued a slender loris indicating the presence of this endangered primate in the vicinity of the road widening project. The loris requires dense, contiguous tree cover (Kar Gupta 2007), but the felling of trees for the road will result in fragmentation of the habitat of the loris and threaten the very survival of this endangered species, not to mention the disturbance from construction and associated noise, light, dust, and traffic movement .

5. Threat to forest ecosystem and resulting human-wildlife conflict

The proposed road will cut through the Anekal Reserve Forest that is contiguous to the Bannerghatta National Park. These forest ecosystems are the habitat for charismatic species such as elephant (*Elephas maximus*), gaur (*Bos gaurus*), sloth bear (*Melursus ursinus*), leopard (*Panthera pardus*), and our national animal, the tiger (*Panthera tigris*). The Bannerghatta National Park along with its buffer areas including the Anekal Reserve Forest, is already facing immense pressures from Bengaluru's growth, and the proposed road widening project, is going to further fragment the landscape. The habitat fragmentation of forest will negatively affect the elephant corridor resulting in increased incidence of human-wildlife conflict that can cause fatalities for both animals and people (Shekhar 2018). The road during its construction itself will adversely impact the wildlife, but vehicular traffic post construction will also lead to accidents and death of animals'. The trees that will be destroyed, will be a huge loss for the animal species depending on them. At a time when there is increasing alarm about human impacts resulting in extinction of species (IPBES 2019), a road project such as this that destroys trees and forest habitat would only be accelerating the process of destruction and extinction.

[2] A species whose presence or absence is indicative of the overall health of an ecosystem

6. Destruction trees that are of social and religious significance

In our survey we recorded at least 15 *ashwathkattes* marked for removal. *Ashwathkattes* are raised platforms with neem and peepul trees and snake shrines at their base have religious significance for local residents. They are also a place for local residents to meet, and passers-by to rest in the shade on hot afternoons. Some of the peepul trees on these *kattes* have grown to great heights with trunks of wide girths. Three peepul trees on the *ashwathkattes* marked for cutting had a girth of 5 m, 4.3 m and 3.5 m. There are also several other trees of religious significance such as the banyan, cannonball tree, and neem, also marked for cutting.

Trees along roads are also critical for supporting livelihoods of vendors who sell their goods under the shade of trees. Vendors selling perishable items such as fruits, flowers and vegetables seek the shade of trees to conduct their trade as the shade protects their goods from wilting and getting spoilt. Similarly, those who sell items such as clothing, that fade under the sun, also see trees as critical for the shade. The customers too prefer to buy from these vendors, rather than standing under the hot sun. Many vendors also use parts of the tree, for example neem twigs and leaves, and have developed connections with the trees under which they earn their income (Basu and Nagendra 2020)

7. Impacts on lakes

The Supreme Court of India has mandated that a buffer zone of at least 30 m needs to be maintained around lakes where no construction is allowed (Akshatha 2019). But from our survey we found that in the case of a few lakes the road expansion will be carried out within this 30 m boundary (Map 2). This would be in violation of the ruling of the Supreme Court.

A total of 14 lakes were recorded along the stretches where road construction is being proposed. These lakes support a host of biodiversity from water birds, to amphibians, to reptiles, to fish, and invertebrates. The lakes are also important nesting sites of birds, and many of the birds are migratory, coming in from Europe and Africa. Nearly 144 bird species have been recorded in e-Bird lists from lakes in Bengaluru (Annexure 5). Disturbing these lakes for road widening will disturb these crucial habitats of birds.

In addition to supporting biodiversity, lakes provide a number of ecological benefits. Lakes are essential for groundwater recharge, that is especially critical for Bengaluru whose groundwater is rapidly being depleted. Trees close to the road and the lake will help with functions such as increasing water retention, absorbing water and slowing down run-off thereby also enabling recharge of groundwater.

8. Carbon sequestration

Projections point to a 1.2 degree C increase in temperature of the planet in just 10 years. This global warming will have devastating impacts at a local, regional and global level. Trees act as reservoirs that sequester carbon and play a crucial role in addressing global warming and impact of climate change. Carbon is stored in what is referred to as biomass in all parts of the trees: above and below ground. Young trees absorb carbon while growing, but research has shown that older trees fix large amounts of carbon as well (Stephenson et al 2014). The outer road project will result in the cutting down of some very old and large trees thereby reducing drastically the carbon absorbed and contributing to climate change.

In the steel flyover project it was estimated that the 2,176 trees that would have been cut stored an average of 985 metric tonnes of carbon (Nagendra et al 2017). The 8,561 trees, which according to our rapid survey is a conservative estimate, would sequester so much more carbon. The outer road project passes through a reserve forest, and the losses in terms of carbon sequestration alone will be incalculable. We are currently in a global climate emergency and it is imperative to stress the importance of protecting trees to prepare for the climate emergency that is projected.

What the feasibility reports say with regard to the environment

At present, no environmental impact assessment has been done with regard to the project that gives details of ecological impacts and mitigation as a result of the road widening project. In the absence of any assessment, we looked at the feasibility reports to understand what kind of measures are proposed to mitigate the adverse environmental impacts as a result of the project.

In the context of greening, the feasibility reports for the stretches between Budigere Cross (Hoskote) and Mylanahalli (near KIAL) and the stretches between Nelamangala and Madure to SMVIT Cross on Devanahalli Road talk of “highway landscaping” but only mention in passing that this would include protecting any man-made or natural features such as ponds along the route. There is also a mention of trees being planted at a distance of 14 m from the center line to provide recovery area for vehicles that run off the road. In order to allow for visibility of traffic the feasibility report says that tree will be lopped/thinned, but there is no mention of cutting even as trees along the stretch have been marked and are already being cut. Immediately contradicting this, the feasibility report also says to reduce impacts of a large number of trees being cut for the project, replantation will be done along the highway. But there are no details of how many trees or where these trees will be planted. Considering the previous record of the government with regard to replanting, it is unlikely that any planting will be done for the trees cut.

The feasibility report, with regard to water for construction work also says that, *"It is assumed that suitable water for construction work will be available within economical leads and hence separate rates for water required for construction has not been included in the adopted rates"*. This is not only indicative of a wrong pricing of the project, but also of concern in a city that has depleting water resources. The construction of the road will require massive quantities of water. Bengaluru already faces a water crises, especially in the summer months, and it is not clear where the water will be procured from—and whether local water sources used will further deplete the groundwater table (Infrastructure Support Engineering Consultants Pvt Ltd, no date a and b).

For the stretches from Kanchugaranahalli to Jigani, Bannerghatta to Besthamanahalli (Anekal) and Besthamanahalli to Hoskote the feasibility reports mention landscaping for aesthetic purposes and the focus is on shrubs and grass. It mentions in passing that tree plantation will be done by private sponsorship as this will have favourable impacts on environment such as reducing noise and air pollution, but gives no further information (Apt Consulting Engineering Services, 2017a and b). There is no mention of trees that will be lost or planted.

Conclusion and recommendations

An official environmental impact assessment is yet to be conducted for the outer road project, even as work on road widening has begun and trees have already been felled. Newspaper reports list that 8,561 trees will be cut for the project, but from our rapid environmental assessment this seems to be a conservative estimate. The impact on the forest ecosystems and wider environment would be even more with many more trees being cut.

The Supreme Court of India in January 2020 had expressed concern on the cutting of trees for infrastructure projects, and had especially drawn attention to the destruction of heritage trees that are a source of the oxygen we breathe (Kumar 2020). The outer road project will result in numerous heritage trees being cut—in a 15 km stretch we counted 206 banyan trees many of which were old and large. We would like to strongly emphasise that no kind of planting or transplanting can replace the loss of these huge trees that provide an invaluable ecological service. Young saplings will take decades to grow, and also take a lot of time before they can provide the benefits that full-grown trees can in terms of reducing pollution, supporting biodiversity or mitigating heat stress. Further, the species that are replanted are much lesser in diversity, often non-native, and fast growing that offer little shade. Currently, the massive trees with connecting canopies, especially the *Ficus*, provide contiguous habitats for biodiversity. This has taken centuries to grow, and cannot be replicated over a few years.

Bengaluru is set to expand into the peripheral areas, and instead of thinking ahead to ensure that there is enough greenery for the health and well-being of the residents, projects like the outer road will destroy what little greenery there is—without considering the long term impacts on the people and the city.

Trees provide a number of tangible and intangible services to a city and its residents:

- Trees in Bengaluru act as the lungs, cleaning air of harmful pollutants such as NOx and sulphur dioxide, and also dust that are causes for debilitation and death in Indian cities. They are essential for keeping the air healthy and breathable in high-traffic cities like Bengaluru.

- With temperatures in Bengaluru rising, winters becoming non-existent and summers harsher than before, the health, economic and social impacts owing to heat stress will be felt increasingly by all, but more so by pedestrians, vendors and those who have to work in the open such as daily wage labourers. Street trees help to reduce the temperature of concrete and asphalted surfaces by 20 degrees C and air temperature by at least 3-5 degrees C.

- Heritage trees are an integral part of the history of a city. The felling of these trees means there will be an irreversible loss of not only the ecological benefits but also contribute to erasing the historical and social links between the city and its residents.

- With species extinction staring us in the face like never before, the loss of trees that provide a habitat for species such as the endangered slender loris would further push these species to extinction in Bengaluru. Other biodiversity such as birds, butterflies, reptiles, bats, and many other fauna found on the trees in these roads would be endangered too.

- Linear projects like the outer road that cut through forests, in this case the Anekal Forest Reserve and Bannerghatta National Park, will fragment habitat used by animals such as elephants, making them vulnerable to accidents owing to the vehicular traffic. Moreover, it will result in increased incidence of human-wildlife conflict with mortality on both sides.

- The benefit of trees goes beyond the ecological—with people valuing trees for cultural and religious purposes. *Ashwathkattes* with huge peepul trees are already marked for cutting, and their destruction would be an irreplaceable loss to the local residents as they are both sacred and social spaces where people come together as a community at different points in the day.

- Several lakes will be affected by the outer road project, compromising the groundwater in Bengaluru which is already severely depleted. Trees help to absorb and retain water, slowing down the rate of run-off and enabling effective groundwater recharge. The peripheral areas are already water stressed and the road widening will only exacerbate the issue of water scarcity.

- We are living through a time of climate emergency, and it is imperative that we do everything possible to mitigate the impacts of carbon emissions. Trees sequester carbon above and below the ground. Cutting trees that mitigate the impacts of climate change will mean that we are moving closer to the destruction of the planet.

- The project feasibility report provides no information on the adverse ecological impacts of the project with regard to trees or water bodies, or any clarity on how these will be addressed. There are insufficient details on impact on tree cover. The report further proposes that private organisations will be invited to sponsor greening. Trees are a common pool resource that cannot be handed over to private entities who have profit as their primary motive as this can lead to exclusion of people.

- Article 21 of the Indian Constitution guarantees a fundamental right to life that includes the right to a healthy environment, while Articles 49-A and 51-A (clause g) lays down the responsibility of the state and that of the citizen to protect the environment (Vardhan 2014). But the felling of trees severely compromises the health of both the environment and the people and is in contravention of the Constitution of India

The core of Bengaluru is greener when compared to the peripheral areas where the outer road is being proposed (Nagendra et al 2012). And where there is tree cover, the impacts of air pollution and, rising temperatures are felt to a lesser degree. Biodiversity too thrives in these green pockets. The ecological and environmental benefits of trees in the city core was the result of greening of the city taken up even before colonial times and continued post-Independence by dedicated officials and civil society members. But with the expansion of the city into the peripheral areas, which lack green cover and have not been a part of city greening plans, we need to take up aggressive and careful tree planting drives, and not projects that destroy even the existing limited greenery. We need to stop the cutting of trees immediately, and specifically designate large trees as heritage trees to ensure that they remain untouched. Not doing so will mean that we have extinguished the history of the city through cutting of heritage trees, and compromised the health of Bengaluru's residents with irreversible consequences.

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Annexures

Annexure 1: Tree numbers and species in the Nelamangala to Madure stretch (Stretch 2)

Common name	Species scientific name	Number
African tulip	*Spathodea campanulata*	3
Babul	*Acacia nilotica*	4
Banyan	*Ficus benghalensis*	206
Basari	*Ficus amplissima*	50
Black wattle	*Acacia mearnsii*	322
Buckthorn	*Rhamnus cathartica*	1
Cassia	*Cassia sp.*	58
Cluster fig	*Ficus racemosa*	2
Coconut	*Cocos nucifera*	1
Copperpod	*Peltophorum pterocarpum*	1
Eucalyptus	*Eucalyptus globulus*	77
Ficus sp.	*Ficus sp.*	26
Flame of the forest	*Beutea monosperma*	1
Gulmohar	*Delonix regia*	4
Honge	*Pongamia pinnata*	51
Indian jujube	*Ziziphus mauritiana*	1
Ippe	*Madhuca longifolia var longifolia* (*var latifolia*)	3
Jackfruit	*Artocarpus heterophyllus*	1
Jamun	*Syzygium cumini*	49
Mango	*Mangifera indica*	7
Mysore fig	*Ficus mysorensis*	25
Neem	*Azadirachta indica*	8
Peepul	*Ficus religiosa*	11
Singapore cherry	*Muntingia calabura*	3
Sissoo	*Dalbergia sissoo*	10
Tamarind	*Tamarindus indicus*	2
Unidentified	Unidentified	1
White-barked acacia	*Acacia leucophloea*	1
TOTAL		**929**

Annexure 2: Tree numbers and species in the Kanchugarana-halli (near Bidadi) to Jigani stretch (Stretch 4)

Common name	Species scientific name	Number
African tulip	*Spathodea campanulata*	1
Banyan	*Ficus benghalensis*	1
Basari	*Ficus amplissima*	1
Black wattle	*Acacia mearnsii*	2
Cassia	*Cassia sp.*	3
Coconut	*Cocos nucifera*	10
Eucalyptus	*Euclyptus sp.*	8
Honge	*Pongamia pinnata*	4
Jackfruit	*Artocarpus heterophyllus*	1
Jamun	*Syzygium cumini*	1
Neem	*Azadirachta indica*	7
Peepul	*Ficus religiosa*	2
Raintree	*Albizia saman*	7
Singapore cherry	*Muntingia calabura*	2
Tamarind	*Tamarindus indicus*	3
Teak	*Tectona grandis*	2
Unidentified	Unidentified	4
TOTAL		**9**

Annexure 3: Tree numbers and species in the Attibele to Anekal stretch (Stretch 6)

Common name	Species scientific name	Number
Acacia sp.	*Acacia sp.*	9
African tulip	*Spathodea campanulata*	3
Arjuna	*Terminalia arjuna*	8
Babul	*Acacia nilotica*	4
Banyan	*Ficus benghalensis*	2
Basari	*Ficus amplissima*	3
Bauhinia sp.	*Bauhinia sp.*	7
Behndi tree	*Thespesia populnea*	9

Common name	Species scientific name	Number
Bidi leaf tree	*Bauhinia racemosa*	1
Black wattle	*Acacia mearnsii*	59
Buckthorn	*Rhamnus cathartica*	4
Cannonball tree	*Couroupita guianensis*	1
Cluster fig	*Ficus racemosa*	3
Coconut	*Cocos nucifera*	4
Copperpod	*Peltophorum pterocarpum*	22
Elephant apple	*Limonia acidissima*	1
Eucalyptus	*Eucalyptus globulus*	60
Ficus sp.	*Ficus sp.*	15
Guava	*Psidium guajava*	1
Gulmohar	*Delonix regia*	3
Gum Arabic tree	*Vachellia nilotica*	1
Honge	*Pongamia pinnata*	65
Indian jujube	*Ziziphus sp.*	1
Jackfruit	*Artocarpus heterophyllus*	1
Jamun	*Syzygium cumini*	6
Jangli badam	*Terminalia catappa*	8
Mahogany	*Swietenia sp*	2
Mango	*Mangifera indica*	1
Neem	*Azadirachta indica*	23
Peepul	*Ficus religiosa*	4
Raintree	*Albizia saman*	15
Shivne	*Gmelina arborea*	13
Silver oak	*Grevillea robusta*	2
Singapore cherry	*Muntingia calabura*	7
Sissoo	*Dalbergia sissoo*	13
Tamarind	*Tamarindus indicus*	13
Teak	*Tectona grandis*	8
Terminalia sp.	*Terminalia sp.*	3
Unidentified	Unidentified	8
White bark acacia	*Vachellia leucophloea*	1
TOTAL		**414**

Annexure 4: Peepul and banyan: Heritage trees that are a habitat for bird species

Common name	Species scientific name
Alexandrine parakeet	*Psittacula eupatria*
Asian koel	*Eudynamys scolopaceus*
Brahminy starling	*Sturnia pagodarum*
Chestnut-tailed starling	*Sturnia malabarica*
Common myna	*Acridotheres tristis*
Common tailorbird	*Orthotomus sutorius*
Coppersmith barbet	*Psilopogon haemacephalus*
Greater coucal	*Centropus sinensis*
House sparrow	Passer domesticus
Jungle myna	*Acridotheres fuscus*
Large-billed crow	*Corvus macrorhynchos*
Malabar parakeet	*Psittacula columboides*
Oriental white-eye	*Zosterops palpebrosus*
Pale-billed flowerpecker	*Dicaeum erythrorhynchos*
Purple sunbird	*Cinnyris asiaticus*
Red-vented bulbul	*Pycnonotus cafer*
Red-whiskered bulbul	*Pycnonotus jocosus*
Rose-ringed parakeet	*Psittacula krameri*
Rosy starling	*Pastor roseus*
White-browed bulbul	*Pycnonotus luteolus*
White-cheeked barbet	*Psilopogon viridis*

Annexure 5: Bird species found around lakes in Bengaluru

Common name	Scientific name
Alexandrine parakeet	*Psittacula eupatria*
Ashy drongo	*Dicrurus leucophaeus*
Ashy prinia	*Prinia socialis*
Ashy woodswallow	*Artamus fuscus*
Asian koel	*Eudynamys scolopaceus*
Asian openbill	*Anastomus oscitans*
Baillon's crake	*Zapornia pusilla*
Bank swallow	*Riparia riparia*
Barn owl	*Tyto alba*
Barn swallow	*Hirundo rustica*
Bay-backed shrike	*Lanius vittatus*
Black-bellied tern	*Sterna acuticauda*
Black-headed ibis	*Threskiornis melanocephalus*
Black-winged kite	*Elanus caeruleus*
Black-winged stilt	*Himantopus himantopus*
Black bittern	*Ixobrychus flavicollis*
Black drongo	*Dicrurus macrocercus*
Black eagle	*Ictinaetus malaiensis*
Black kite	*Milvus migrans*
Black stork	*Ciconia nigra*
Blyth's reed warbler	*Acrocephalus dumetorum*
Booted eagle	*Hieraaetus pennatus*
Booted warbler	*Iduna caligata*
Brahminy kite	*Haliastur indus*
Brahminy starling	*Sturnia pagodarum*
Bronze-winged jacana	*Metopidius indicus*
Brown fish-owl	*Ketupa zeylonensis*
Cattle egret	*Bubulcus ibis*
Chestnut-tailed starling	*Sturnia malabarica*
Chestnut-winged cuckoo	*Clamator coromandus*
Cinnamon bittern	*Ixobrychus cinnamomeus*
Citrine wagtail	*Motacilla citreola*
Collared pratincole	*Glareola pratincola*
Common cuckoo	*Cuculus canorus*
Common greenshank	*Tringa nebularia*
Common hawk cuckoo	*Hierococcyx varius*

Common name	Scientific name
Common kingfisher	*Alcedo atthis*
Common myna	*Acridotheres tristis*
Common pochard	*Aythya ferina*
Common redshank	*Tringa totanus*
Common sandpiper	*Actitis hypoleucos*
Common snipe	*Gallinago gallinago*
Common tailorbird	*Orthotomus sutorius*
Common tern	*Sterna hirundo*
Coppersmith barbet	*Psilopogon haemacephalus*
Cotton pygmy goose	*Nettapus coromandelianus*
Crested treeswift	*Hemiprocne coronata*
Curlew sandpiper	*Calidris ferruginea*
Egyptian vulture	*Neophron percnopterus*
Eurasian collared dove	*Streptopelia decaocto*
Eurasian coot	*Fulica atra*
Eurasian hoopoe	*Upupa epops*
Eurasian marsh harrier	*Circus aeruginosus*
Eurasian moorhen	*Gallinula chloropus*
Eurasian spoonbill	*Platalea leucorodia*
Eurasian wigeon	*Mareca penelope*
Gadwall	*Mareca strepera*
Garganey	*Spatula querquedula*
Glossy ibis	*Plegadis falcinellus*
Golden-fronted leafbird	*Chloropsis aurifrons*
Grey-headed swamphen	*Porphyrio poliocephalus*
Grey heron	*Ardea cinerea*
Grey wagtail	*Motacilla cinerea*
Great cormorant	*Phalacrocorax carbo*
Great egret	*Ardea alba*
Great snipe	*Gallinago media*
Greater coucal	*Centropus sinensis*
Green-winged teal	*Anas crecca*
Green bee-eater	*Merops orientalis*
Green sandpiper	*Tringa ochropus*
Greenish warbler	*Phylloscopus trochiloides*
Gull-billed tern	*Gelochelidon nilotica*

Common name	Scientific name
House crow	*Corvus splendens*
House sparrow	*Passer domesticus*
Indian cormorant	*Phalacrocorax fuscicollis*
Indian golden oriole	*Oriolus kundoo*
Indian grey hornbill	*Ocyceros birostris*
Indian paradise flycatcher	*Terpsiphone paradisi*
Indian peafowl	*Pavo cristatus*
Indian pond heron	*Ardeola grayii*
Indian roller	*Coracias benghalensis*
Indian silverbill	*Euodice malabarica*
Indian spot-billed duck	*Anas poecilorhyncha*
Intermediate egret	*Ardea intermedia*
Jack snipe	*Lymnocryptes minimus*
Jungle myna	*Acridotheres fuscus*
Knob-billed duck	*Sarkidiornis melanotos*
Large-billed crow	*Corvus macrorhynchos*
Laughing dove	*Streptopelia senegalensis*
Lesser sand plover	*Charadrius mongolus*
Lesser whistling duck	*Dendrocygna javanica*
Little cormorant	*Microcarbo niger*
Little egret	*Egretta garzetta*
Little grebe	*Tachybaptus ruficollis*
Little-ringed plover	*Charadrius dubius*
Little stint	*Calidris minuta*
Malabar parakeet	*Psittacula columboides*
Mallard	NA
Marsh sandpiper	*Tringa stagnatilis*
Northern pintail	*Anas acuta*
Northern shoveler	*Spatula clypeata*
Olive-backed pipit	*Anthus hodgsoni*
Oriental darter	*Anhinga melanogaster*
Oriental honey-buzzard	*Pernis ptilorhynchus*
Oriental white-eye	*Zosterops palpebrosus*
Osprey	*Pandion haliaetus*
Paddyfield pipit	*Anthus rufulus*
Painted stork	*Mycteria leucocephala*
Pale-billed flowerpecker	*Dicaeum erythrorhynchos*
Pheasant-tailed jacana	*Hydrophasianus chirurgus*

Common name	Scientific name
Pied bushchat	*Saxicola caprata*
Pied kingfisher	*Ceryle rudis*
Pied thrush	*Geokichla wardii*
Pin-tailed snipe	*Gallinago stenura*
Plum-headed parakeet	*Psittacula cyanocephala*
Purple-rumped sunbird	*Leptocoma zeylonica*
Purple heron	*Ardea purpurea*
Purple sunbird	*Cinnyris asiaticus*
Red-vented bulbul	*Pycnonotus cafer*
Red-wattled lapwing	*Vanellus indicus*
Red-whiskered bulbul	*Pycnonotus jocosus*
Rock pigeon	*Columba livia*
Rose-ringed parakeet	*Psittacula krameri*
Rosy starling	*Pastor roseus*
Ruddy-breasted crake	*Zapornia fusca*
Ruddy shelduck	*Tadorna ferruginea*
Scaly-breasted munia	*Lonchura punctulata*
Shikra	*Accipiter badius*
Short-toed snake eagle	*Circaetus gallicus*
Spot-billed pelican	*Pelecanus philippensis*
Spotted dove	*Streptopelia chinensis*
Spotted owlet	*Athene brama*
Watercock	*Gallicrex cinerea*
Western reef heron	*Egretta gularis*
White-breasted waterhen	*Amaurornis phoenicurus*
White-browed bulbul	*Pycnonotus luteolus*
White-browed wagtail	*Motacilla maderaspatensis*
White-cheeked barbet	*Psilopogon viridis*
White-eyed buzzard	*Butastur teesa*
White-throated kingfisher	*Halcyon smyrnensis*
Woolly-necked stork	*Ciconia episcopus*
Yellow-billed babbler	*Turdoides affinis*
Yellow-wattled lapwing	*Vanellus malabaricus*
Yellow bittern	*Ixobrychus sinensis*