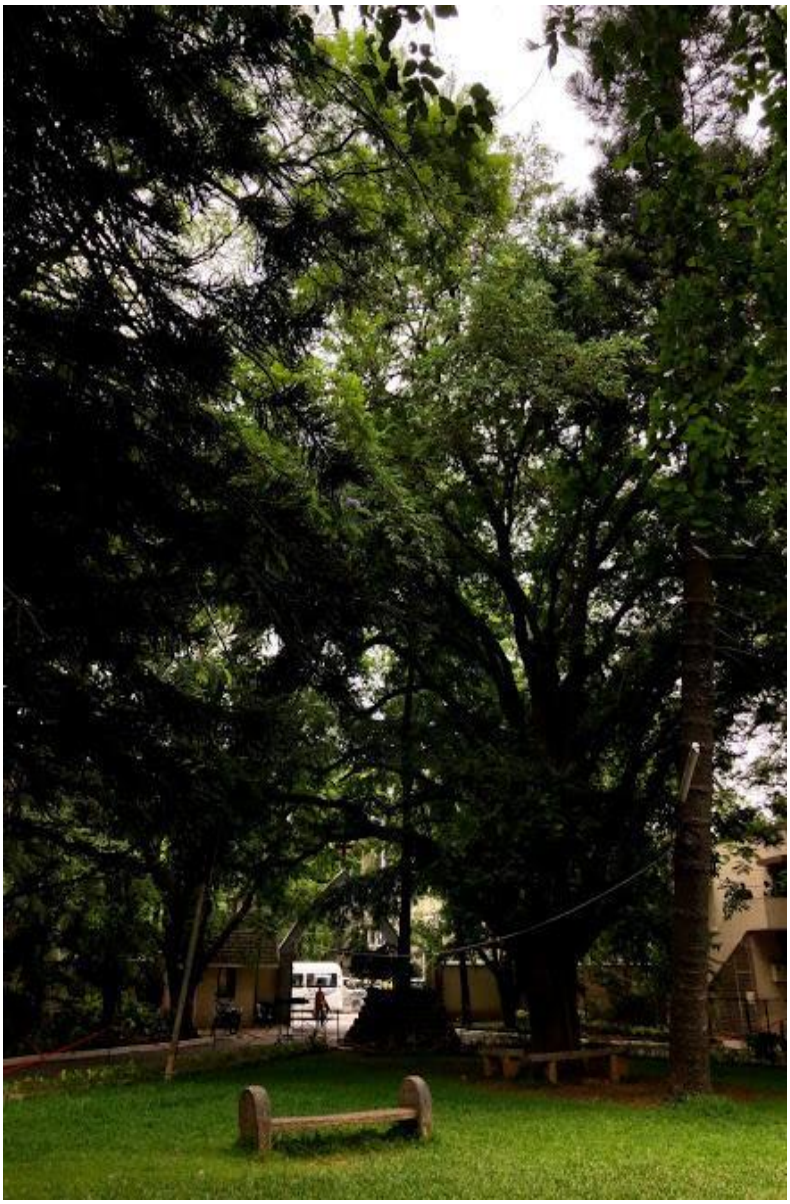

Entrance to All Saints Church, home to one of Bengaluru's oldest Sacred groves

Biodiversity Assessment of All Saints Church campus, Bengaluru

A report by Sheshadri Ramaswamy

prepared at the request of Environment Support Group, Bengaluru

September 2019

“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

Contents

1. Introduction

Why this report?

This report is an assessment of the biodiversity wealth in the All Saints Church premises in Bengaluru. The biodiversity that has been surveyed in this report are indicators of the status of the ecology and environment of the space, in particular, and the region, in general.

The biodiversity at All Saints Church is an integral part of the living heritage of Bengaluru. To those who frequent the church, the connection with the garden's biodiversity is sacred. For those who live around the church, the presence of such a thickly wooded grove significantly enhances the quality of their local environment.

This report offers an understanding of the crucial ecological services that the trees, shrubbery and soil play in maintaining ecological vitality of space. Additionally, the biodiversity surveyed in this report draws attention to the loss of community commons that will take place if the trees are felled, and the place trasnsformed into a concretised platform, as is proposed by Bangalore Metro in installing a station box in the sacred grove..

What does the report contain?

This report contains a list of the species of trees found in the sacred grove of All Saints Church that would be directly effected by the Bangalore Metro's proposal. The girth, height, above ground biomass (AGB), below ground biomass (BGB), total biomass and total carbon content, of each tree has been measured in the 0.93 acre plot of land in the All Saints Church premises that constitutes its sacred grove. The report also contains a list of birds that were observed in the morning and evening of July 18th, 2019 over a period of 2 hours in each session. The amount of rain water percolation into the ground table has also been stated in this report.

The reason for stating the above in this report is to give an idea of the biodiversity that exists in All Saints Church. It must be noted that these observations are limited to a 0.93 acre of land in the All Saints Church premises which includes the area proposed for 'temporary acquisition' by M/s Bangalore Metro Rail Corporation Ltd..

Given the vast number of trees, birds, carbon content and rain water percolation in the measured plot of land, the All Saints Church premises can be considered as a critical conservation reserve. Had the entire premises been surveyed over seasons of a year, the researchers are certain that the richness of biodiversity would be much more than what has been stated in this report.

2. Literature Review

The following are some of the important concepts that are to be understood in the case of urban trees.

Urban tree diversity

The importance of trees in an urban environment can never be understated. Tree trunks occupy about one-unit area of space on the ground, yet their canopies occupy about 200 times or more of the unit area space and provide immeasurable benefits to all life forms.

Trees help in reducing the intensity of pollutants by purifying air of SO2 and Suspended Particulate Matter, sequestering carbon and acting as noise filters. Street trees are especially significant in this respect due to their proximity to the source of vehicular emission compared to other distant green spaces.

Trees 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, such as parks in residential and commercial areas. Thus, trees play 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 ecological benefits for people.

Street trees are also important habitats for the dwindling urban wildlife, especially birds, small mammals and insects pollinators. By acting as ‘corridors’, they provide crucial connectivity between urban parks, wooded areas, lakes and open spaces. 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. So acting as sinks for heat, they help reduce energy and water consumption for air conditioning systems.

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 and UN-Habitat, 2005)

Air Quality

The short-term and long-term impacts of a tree-less environment on the atmosphere is multifold. 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.

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 which compromise human health and comfort and impaired water quality (US Environment Protection Agency, 2011b).

Air Pollution and Carbon footprint mitigation

Urban trees help in mitigating the impacts of air pollution and increased carbon footprints 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- 25ºC.

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 3ºC cooler than new suburbs without trees (US Environmental Protection Agency, 2011a).

Unless the BBMP takes other measures to disincentive the use of private vehicles and take measures to improve appropriate and accessible public transport, vehicular density is only going to increase. Traffic jams will not only cause more pollution and heat. Bus based transit systems are the most effective public transport systems, while also causing least damage to urban open spaces and greenery, and yet are not promoted despite their high utility and low adverse impacts. As a city, Bangalore is heading towards a more polluted and congested future, the ill-effects of which would be further exacerbated by a tree-less environment, particularly those that are old and are of heritage value and found clustered in old parks and groves in the old built areas of the metropolis.

Noise and Health

Major sources of noise pollution are road, rail and air traffic; industries; construction and public work; and the particular activities of 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 daytime 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 Bengalureans.

Hydrology and Sustainability

On an average Bengaluru receives about 38,00,000 (Thirty eight lakh litres) of rain water in a one acre plot annually.

On open ground :

Percolation ~= 90%

Runoff ~= 10%

On hard paved surfaces :

Percolation ~= 10%

Runoff ~= 90%

Therefore, rainwater harvested in open ground space in All Saints Church is 0.938 acres * 3800000 = **3564400** litres of which 90% percolates into the underground aquifers. These numbers are significant because, with the changing climate, access to fresh water will be a major challenge in the coming decades. And cities like Bengaluru are heavily dependent on ground water to meet drinking water, domestic and commercial requirements and thus water conservation through percolation is critical for water security.

In Bangalore most of the lakes have been encroached for illegal buildings and almost all are sewage-fed. Lake catchments are being used as dumping yards for either municipal solid waste or building debris, thus rendering the immediate source of fresh water non-potable. Piped water connection (which has exhausted its capacity) serves only 8 lakh of the 22 lakh households, and nearly 40% of the population depend on groundwater. Bangalore's hope therefore lies in harvesting rainwater. However, due to a heavy dependence on groundwater, water table has declined to 300 meters from 28 metres over a period of 20 years (Ramachandra….; Aithal, 2016; Ranganath, 2016). Rainwater harvesting is thus the immediate need of the hour, and this is performed in abundance by the trees in All Saints Church.

Trees in All Saints Church making a multi canopy cover

3. Methodology and Techniques used in survey report

Tree Survey - In order to conduct this survey of the biodiversity and ecological services of the plant diversity in the premises of All Saints Church, standard scientific techniques of inquiry were adopted. The list of trees surveyed in the 0.93 acre plot of land in the All Saints Church premises have been compiled and identified with the common name and the scientific name.

In order to do the tree survey, the girth of all the trees were calculated at breast height, that is, 4.5 feet from the ground level. This was measured using flexible tape. The height of the trees was measured using an app by the name *Tree-H*. The above ground biomass (AGB), the below ground biomass (BGB), the total biomass and the carbon of the trees were measured using scientific formulae.

To calculate the above ground biomass (AGB) the following formula (Chave, J., Andalo, C., Brown, S. et al, 2005) was used:

$$\boldsymbol{AGB} = 0.112 * (rho * D\hat{}2 * H\ )\ \hat{}\ 0{:}916,$$

where *rho* is the wood density, *D* is the diameter at breast height and *H* is the height of trunk. This is the formula for dry forest trees, which are the type of trees present in the Bangalore region.

For the purpose of this report, the BGB was calculated as 30% of the AGB (Martin AR, SC Thomas. 2011).

To calculate the total AGB carbon content, 47% of the AGB was taken as the AGB carbon content (Martin AR, SC Thomas. 2011).

To calculate the BGB carbon, 47% of the BGB was taken as the BGB carbon content. The total carbon content was the sum of the AGB carbon and BGB carbon.

Bird Survey - In order to conduct a survey of the birds in the All Saints Church premises, 2 hours of bird sighting was done in the morning, from 6:30 am to 8:30 am, and in the evening, from 4:30 pm to 6:30 pm.

Hydrology - To calculate the rain water percolation into the groundwater table, the average rainfall over the year over 40856 sq ft was calculated and open ground percolation was calculated.

Trees providing shade to the main church building

4. Results

Tree density

The tree diversity is quite high in the All Saints Church premises with 41 species in the 0.93 acres plot. There are also several heritage trees that have been existing for centuries. The green cover helps in rendering an aesthetic ambience, cooling the air, absorption and adsorption of dust and particulate matter and noise mitigation.

Tree diversity

Table 1 shows the diversity of trees that were identified in the 0.93 acre plot that was surveyed. The scientific name and the common name have been compiled.

Sl.no	Scientific name	Common name	No. of individuals
1	*Annona reticulata*	Ramaphala	1
2	*Areca lutescens*	Golden Palm	4
3	*Artocarpus heterophyllus*	Jackfruit	3
4	*Auracaria columnaries*	Christmas tree	5
5	*Azadirachta indica*	Neem	1
6	*Bamboosa vulgaris*	Golden Bamboo	1
7	*Bauhinia variegata*	Basavapada	1
8	*Brassia actinophylla*	Umbrella tree	1
9	*Caesalpinia pulcherrima*	Peacock flower	1
10	*Cassia javanica*	Pink Cassia	1
11	*Delonix regia*	Gulmohar	4
12	*Ficus racemosa*	Atthi	4
13	*Filicium decipiens*	Indian Fern Tree	2
14	*Ziziphus mauritiana*	Ber / Elchi Hannu	1
15	*Grevillea robusta*	Silver oak	7
16	*Jacaranda mimosifolia*	Jacaranda	5
17	*Kigelia pineta*	Sausage Tree	4
18	*Aleuritis moluccanus*	Indian Walnut / Candle Nut	6
19	*Lagerstroemia speciosa*	Pride of India	3
20	*Limonia acidissima*	Wood Apple	1
21	*Mangifera indica*	Mango	2
22	*Millingtonia hortensis*	Aakasha Mallige	1
23	*Parkia biglandulosa*	Badminton Ball Tree	10
24	*Peltophorum pterocarpum*	Copper Pod	1
25	*Phyllanthus acidus*	Kirunelli	1
26	*Phyllanthus emblica*	Nelli	1

27	*Plumeria rubra*	Temple Tree	1
28	*Polyalthia longifolia*	False Ashoka	9
29	*Pongamia pinnata*	Honge	8
30	*Psidium gujava*	Guava	2
31	*Punica granatum*	Pomegranate	1
32	*Roystonia regia*	Bottle Palm	1
33	*Samanea saman*	Rain Tree	1
34	*Swietenia macrophylla*	Mahogany	2
35	*Syzigium cumini*	Nerle	2
36	*Tabebuia aurea*	Tree of Gold	1
37	*Tamarindus indica*	Tamarind	3
38	*Terminalia catappa*	Kaadu Badami	3

Table 1: List of trees surveyed and observed in the 0.93 acres plot in the All Saints Church premises
Total no. of Trees in the 0.93 acre plot = 111 nos.

Av. Girth

The average girth of all the trees surveyed is: **1.467 metres**

Av. Height

The average height of the trees surveyed is: **19.815 metres**

Above ground biomass

The total above ground biomass (AGB) is: **39699.3874 Kgs**

Below ground biomass

The total below ground biomass (BGB) is: **11909.81622 Kgs**

Total Carbon Content (AGB+BGB of all trees surveyed) and Carbon Sequestered

Total Carbon Content (AGB+BGB of all trees surveyed) is: **24462.76252 Kgs.**

The ratio of Carbon Sequestered by the Church in one acre to the Carbon Emissions of Namma Metro is 1 : 500,000. We arrived at this ratio by calculating the carbon sequestered by the vegetation in the church, which came up to 1243.9141 kgs of CO2 and

calculating the Carbon emitted by the Namma metro, which comes to 586000000 kg of CO2.[1] This is a massively disproportionate carbon dynamics equation.

Birds Diversity

Table 2 shows the bird diversity that was observed on 18th July, 2018, for 2 hours of bird sighting was done in the morning, from 6:30 am to 8:30 am, and in the evening, from 4:30 pm to 6:30 pm.

Sl no.	**Scientific name**	**Common name**
1	*Eudynamys scolopaceus*	Asian Koel
2	*Dicrurus macrocercus*	Black Drongo
3	*Milvus migrans*	Black Kite
4	*Haliastur indus*	Brahminy Kite
5	*Parus cinereus*	Cinereous Tit
6	*Acridotheres tristis*	Common Myna
7	*Orthotomus sutorius*	Common Tailorbird
8	*Megalaima haemacephala*	Coppersmith Barbet
9	*Centropus sinensis*	Greater Coucal Green
10	*Merops orientalis*	Bee-eater
11	*Corvus splendens*	House Crow
12	*Terpsiphone paradisi*	Indian Paradise-Flycatcher
13	*Acridotheres fuscus*	Jungle Myna
14	*Corvus macrorhynchos*	Large-billed Crow
15	*Apus affinis*	Little Swift

[1] This calculation was arrived at by calculating the electricity consumed per year by the Namma Metro which is 4549500000 kWh. Therefore, the carbon emissions per year (Kg of CO2) IS 586000000 as the average operating time of Namma Metro is 16.85 hours a day.

16	*Copsychus saularis*	Oriental Magpie-Robin
17	*Dicaeum erythrorhynchos*	Pale-billed Flowerpecker
18	*Leptocoma zeylonica*	Purple-rumped Sunbird
19	*Pycnonotus cafer*	Red-vented Bulbul
20	*Vanellus indicus*	Red-wattled Lapwing
21	*Pycnonotus jocosus*	Red-whiskered Bulbul
22	*Columba livia*	Rock pigeon
23	*Psittacula krameri*	Rose-ringed Parakeet
24	*Megalaima viridis*	White-cheeked Barbet
25	*Halcyon smyrnensis*	White-throated Kingfisher

Bird Corridors

The green space in All Saints Church is an integral part of a bird corridor stretching from Bannerughatta to Cubbon Park to North Bengaluru. The birds use the trees for shelter, for getting their food or, even using it as a travel corridor to move from place to place (MB, Krishna, 2016). This function of trees in the city cannot be underestimated. Many species of birds loath using the open skies and ground for flying and prefer their sheltered places (MB, Krishna, 2016). For such species, the green canopies, similar to the ones present inside All Saints Church are important in providing corridors to travel (MB, Krishna, 2016).

Birds hotspots

Some bird hotspots that are located nearby are:

1. Ulsoor lake
2. Cubbon park
3. Lalbagh Botanical Gardens
4. Defense lands like ASC, Parade ground, etc
5. Government lands and other greenspaces

It is important to conserve trees because birds are highly dependent on them. Conserving trees in turn helps in conserving birds. Bird communities are highly sensitive to habitat change and hence they play an important role in indicating the health of the environment and the danger it is in. Some of them are important pollinators and help in seed dispersal that propagate their host species in symbiosis.

5. Conclusions

Human survival is directly tied to our relationship with the natural environment (Schultz, 2002). This holds true in the case of All Saints Church as well. The proposed construction of a station box below the sacred grove of the Church will result in comprehensive destruction of a biodiversity rich ecosystem. It must not be missed that the community revers this space as a sacred grove, not only because it is part of the Church, but also because it has been carefully nurtured into a biodiversity rich space.

Indications

The study indicates that the All Saints Church is home to one of core Benguluru's largest biodiversity hotspots, in terms of flora and fauna and the Heritage trees it hosts. It is also a living heritage space and should not be compromised by infrastructure development. The All Saints Church campus acts as a nature resort for the Arpana school which is housed abutting the sacred grove and for the communities who frequent the church and live nearby. Additionally, it acts as a major lung space mitigating the high automotive emissions at the Vellara junction. The area of All Saints Church acts as a critical carbon sink in a heavilty built region of the metropolis. The ratio of Carbon Sequestered by the Church in one acre to the Carbon Emissions of Namma Metro is 1 : 500,000. This means 500,000 sacred groves equivalent to the All Saints Churches area of vegetation are needed to offset carbon emissions of M/s BMRCL. We arrived at this ratio by calculating the carbon sequestered by the vegetation in the church, which came up to 1243.9141 kg of CO2 and calculating the Carbon emitted by the Namma metro, which comes to 586000000 kg of CO2[2].

The leaf litter biomass per year was not taken into account for this report, which has a sizeable contribution to carbon footprint mitigation. The grasses and shrubs in the area also account for a sizeable carbon footprint mitigation. The All Saints Church area also acts at a rainwater sink and provides as an Oxygen enriching fresh phyto cooled air source. The trees in the area also help in traffic noise absorbency, and this verdancy serves as a relief from the noise of the street just outsides the church campus. It may also be said that were we to imagine the space without trees, the Church will be directly exposed to street noise,

[2] Ibid

as well as the smoke and dust that blows from the street. There is, thereby, an critical need to conserve existing trees and raise more such verdancy in urban spaces, instead of taking up compensatory afforestation in far away areas such as Dandeli (500 kms. away), as is proposed by Bangalore Metro or anywhere else outside the city. Such afforestation is no compensation whatsoever for the loss of this verdant and sacred space – the disastrous consequences of which are irreversible and irreplaceable.

Implications

Therefore, from the results of the survey, there is clear evidence of the critical importance of conserving such verdant urban spaces no matter what other public interest it is compared with. This is particularly the case with the need to protect and conserve tree assemblages of All Saints Church premises. The 111 number of trees that have been identified in the 0.93 acre plot of land provide multiple ecological services to the entirety of Bengaluru anf from the very core of the metropolis. Had the entire All Saints Church premises been surveyed, the number of trees would certainly be more, and would help us estimate the larger contribution of ecological services of the campus to the city. Felling the trees in the area will not only disturb the ecology and sanctity of the place, but will cause repercussions for other ecological systems, such as the water cycle, carbon sequestration, destruction of bird and other urban wildlife habitats, and a loss of specific gene pools of trees that have been nurtured by generations and over centuries. A critical loss of the ecosystem foundations will affect birds, mammals and insects that abound this space now. Needless to state, there will be a irreplaceable and irreversible loss of ecological security and sustainability.

A Big Banyan tree in the church premises

"Human survival is directly tied to our relationship with the natural environment. Achieving a sustainable lifestyle depends on establishing a balance between the consumption of individuals, and the capacity of the natural environment for renewal."

-George Monbiot

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