IBDP EXTENDED ESSAY

Environmental Systems and Societies

Session: May 2019

TOPIC: An Evaluation of the Sustainability Of a Proposed Flyover Project in Hyderabad

RESEARCH QUESTION:

"To what extent does the 'Strategic Road Development Plan' (SRDP) Flyover Construction Project around the Kasu Brahmananda Reddy National Park (KBR Park, Hyderabad), incorporate the requirements of sustainable development in the environmental, social and economic context?"

Word Count: 3962

ACKNOWLEDGEMENTS:

I would like to thank my mentor, my parents and my school for giving me this opportunity to complete an Extended Essay in the Environmental Sciences and Societies and helping me along the way. I would also like to thank the GHMC officer and NGO member for letting me interview them despite their packed schedules. Lastly, I would like to the IBDP for presenting me with a chance to participate in active research and giving me this opportunity to extend my understanding of ESS.

TABLE OF CONTENTS:

INTRODUCTION:

SRDP Flyover around KBR Park

Hyderabad, in recent years, has seen a rapid increase in urbanization and development alongside a spurt in 'mega-projects.' One such mega-project planned in Hyderabad is the Strategic Road Development Plan (SRDP). The SRDP, a 240 billion rupees project, comprises of skyways, major corridors, roads, grade separators and flyovers and is projected to improve Hyderabad's connectivity and ease traffic congestions.[1] An important and controversial subset of the SRDP, however is the multi-level flyover planned around the Kasu Brahmananda Reddy (KBR) National Park.

The KBR Park, often dubbed "*a jungle amidst the concrete jungle",* is a national park situated at the heart of Hyderabad and is an integral part of Hyderabad's cultural heritage.[2] The nearly 400-acre park contains more than 600 species of plant life, 130 species of birds and 30 different varieties of reptiles and butterflies.[3] Given the wide variety of flora and fauna situated in the KBR Park, the proposed felling of 1394 trees in its buffer zone for the construction of a flyover, presents an apparent environmental cost.[4] Consequently, this project was met with bitter criticism in the local media and strong protests were staged by an NGO named "Citizens for Hyderabad".[5]

[1] "KTR Appeals to Centre to Share SRDP Cost," *Telangana Today*, May 5, 2018, accessed September 21, 2018, https://telanganatoday.com/ktr-appeals-to-centre-to-share-srdp-cost.
[2] Vijay Choudary, "Kasu Brahmananda Reddy National Park – Complete Detail," accessed September 13, 2018, http://natureconservation.in/kasu-brahmananda-reddy-national-park-complete-detail-updated/.
[3] "Kasu Brahmananda Reddy National Park," Travel Guide, JourneyFix, accessed November 18, 2018, http://www.journeyfix.com/indian-wildlife/kasu-brahmananda-reddy-national-park/overview-19-64.html.
[4] Application No.106 of 2016 (SZ) (National Green Tribunal May 24, 2017).
[5] Lalita Iyer, "Greens Fume as Flyovers around KBR Park Get Wildlife Nod," *The Week*, July 24, 2017, https://www.theweek.in/content/archival/news/india/greens-fume-as-flyovers-around-kbr-park-get-wildlife-nod.html.

Figure 1 – Citizens protesting against the proposed flyover project around KBR National Park.[6]

The National Green Tribunal, an environmental statutory body established by the Supreme Court [7] to oversee the legal dispute, ordered the state government to conduct an Environmental Impact Assessment (EIA) in order to evaluate the project from an environmental, socio-economic, cultural and health standpoint.[8] Based on the results of the EIA conducted, the case was ruled in the favour of the Telangana State Government and the SRDP was granted conditional approval.[9]

[6] "Hyderabadis from All Walks of Life Come Together to save KBR," *Times of India*, June 5, 2017, accessed August 28, 2018, https://timesofindia.indiatimes.com/city/hyderabad/hyderabadis-from-all-walks-of-life-come-together-to-save-kbr/articleshow/58987618.cms.
[7] "National Green Tribunal(NGT)," April 5, 2011 , accessed July 8, 2018, http://www.greentribunal.gov.in/history.aspx.
[8] "What Is Impact Assessment?," Convention on Biological Diversity, April 11, 2008, accessed December 1, 2018, https://www.cbd.int/impact/whatis.shtml.
[9] Application No.106 of 2016 (SZ).

Research Question

However, the data collected for the EIA was found to be limited to the LB Nagar Circle - Kamineni Circle flyover, and did not account for all areas within the scope of the SRDP.[10] In simple words, there was no EIA conducted for the KBR Park region. Given the ecological and historical significance of this park, it is worthwhile to investigate the short-term and long-term impacts of the proposed SRDP flyover around this region, to evaluate its impact on sustainability.

Therefore, the aim of this study was to investigate the following research question: **"To what extent does the 'Strategic Road Development Plan' (SRDP) Flyover Construction Project around the Kasu Brahmananda Reddy National Park (KBR Park, Hyderabad), incorporate the requirements of sustainable development in the environmental, economic and social context?"**

Roadmap

This investigation was approached via a short-term and long-term view of the project through the collection of various primary and secondary data, and focuses on the direct and indirect environmental, social and economic impacts. Primary data was collected via field surveys to identify trees in the area and calculate their carbon sequestration rates. Also population surveys and interviews of a Hyderabad municipal officer and a member of the NGO "Citizens for Hyderabad" were conducted to understand the social and economic implications. Secondary data was collected from credible sources such as Government websites, the court reading at the National Green Tribunal between NGOs and the State Government, the EIA conducted by the Environment Protection Training and Research

[10] Kaajal Maheshwari, Citizen of Hydeabad's view on the SRDP Project, April 4, 2018.

Institute (EPTRI) for the LB Nagar Circle - Kamineni Circle flyover as well as from multiple research articles and news reports which explore carbon sequestration and induced traffic. This study offers alternative perspectives on the issue of tree removal for flyover construction and underscores the importance of long-term view on sustainability and smart green solutions for urban planning.

SHORT-TERM IMPACTS

ENVIRONMENTAL IMPACT:

The KBR Park and its surroundings are abundantly packed with trees. These trees perform important ecological services such as maintaining the water table, controlling the temperature, and purifying the air.[11] Since, trees play an important role in maintaining the carbon balance in the environment, it was necessary to study Carbon sequestration rates of trees and vehicular emissions in the KBR Park region. The KBR flyover project does not involve axing of any trees inside the park, but rather of those in the buffer 'Ecosensitive' zone along the perimeter of the park.[12]

Therefore, the first step was to survey the location of the flyover and to identify the trees marked for removal. Owing to the vast numbers of trees present around the KBR Park, and the qualitative differences in terms of tree diversity between the various sections of the survey area, a stratified systematic sample was conducted in order to simplify the counting. Similar to the SRDP divisions proposed by the Government, the KBR Park area was divided into 4 different sectors: (A)KBR Park Entrance Junction, (B)Road No.45 Junction, (C)Film Nagar Junction and (D)Maharaja Agrasen Junction.

[11] Citizens for Hyderabad, "How Will Destroying the ESZ of KBR National Park Impact Us, the Hyderabadis," *Save KBR National Park* (blog), accessed December 29, 2018, https://www.savekbr.org/impact-of-esz-destruction-on-hydera.
[12] Bhaskar, Reddy, GHMC Officer on SRDP Project's KBR Park Segment, May 6, 2018.

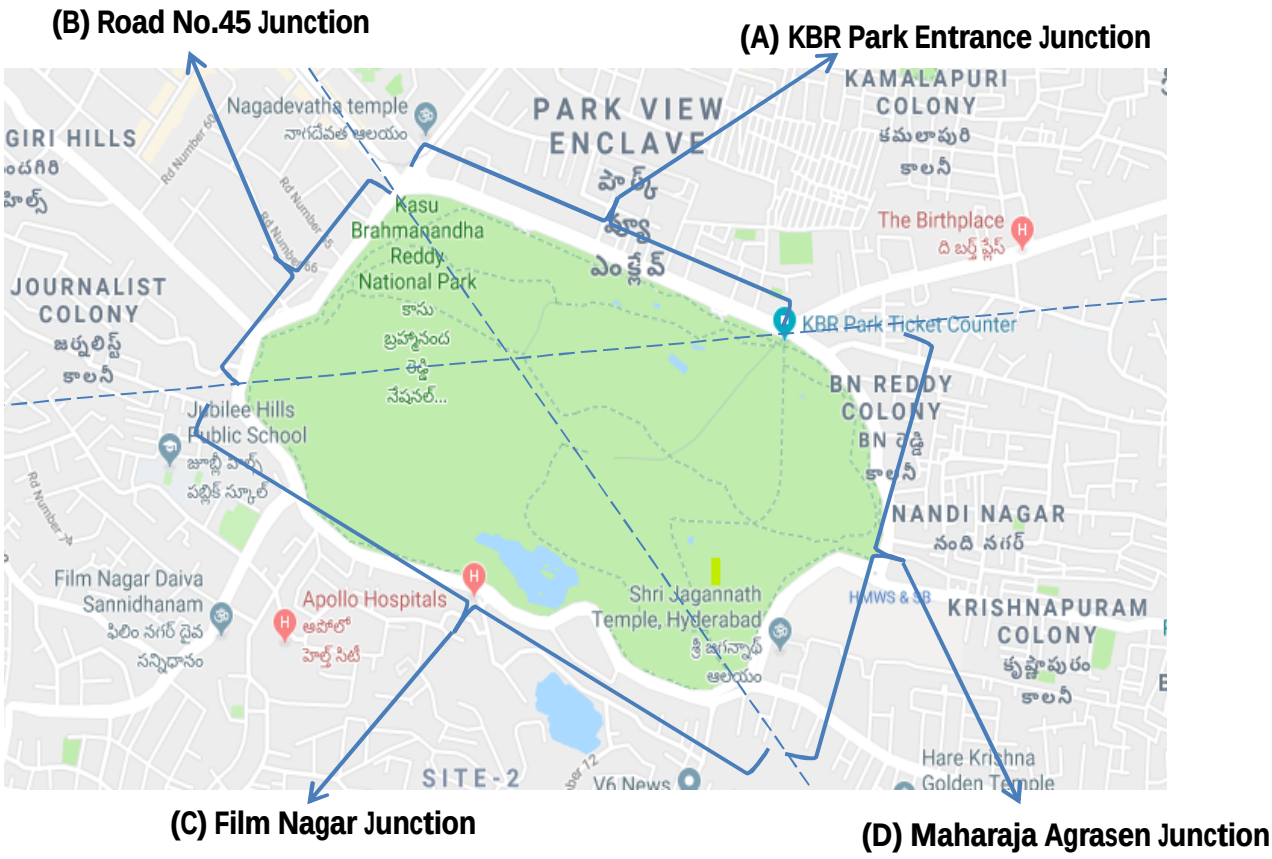
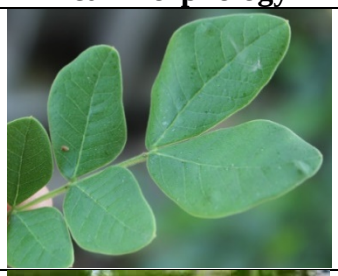
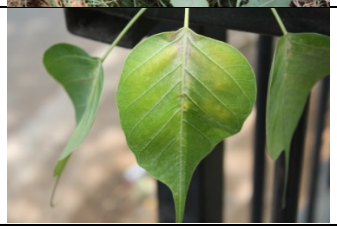


Figure 2 - Division of the KBR Park into 4 separate sectors for the stratified sample[13]

In each of the 4 areas, 15 random trees were systematically selected by counting every n^{th} tree (where $n_{3\text{-}7}$ depending on the length of the section) starting from one end of the road junction. The trees were identified by studying their leaf morphology and comparing it to an identification key and information in a field guide published by the Botanical Survey of India.[14]

[13] Google Maps, "Kasu Brahmananda Reddy Park," Google Maps, accessed June 6, 2018, maps.google.com.
[14] P. V. Prassana et al., "Trees of Hyderabad" (Botanical Survey of India, October 1, 2012), http://urbangreening.ap.gov.in/uploads/Publications/Trees_of_Hyderabad.pdf

Table 1 - Identification of Tree Species using Leaf morphology

Tree Species	Leaf Morphology	Distinguishing Features
1. **Red Cassia** *(Cassia roxburghii)*		- Pinnately compound leaf - elliptic and oblong leaflets - cylindrical fruit pods - Native species
2. **Gulmohar (***Delonix regia)*		- Rachis bearing 7-20 pairs of pinnae - Each branchlet bears 10-35 pairs of small, oblong and green leaflets - Introduced species. Ornamental.
3. **Neem** (*Azadirachta indica)*		- Pinnately compound leaf - Leaflets lanceolate, unequal at base. - Native species
4. **Peepal** *(Ficus religiosa)*		- Simple, ovate-round to cordate leaf - Shining, leathery, apex long tapering. - Native species
5. **Champa** *(Plumeria rubra)*		- Simple leaf, spirally aggregate at ends of branches - lanceolate-oblanceolate thick - Naturalized species
6. **Peela Gulmohar** *(Peltophorum pterocarpum)*		- Bipinnate leaf, 30-60 cm long, - 15-20 pinnae where each pinna has oval lealets. - Native species

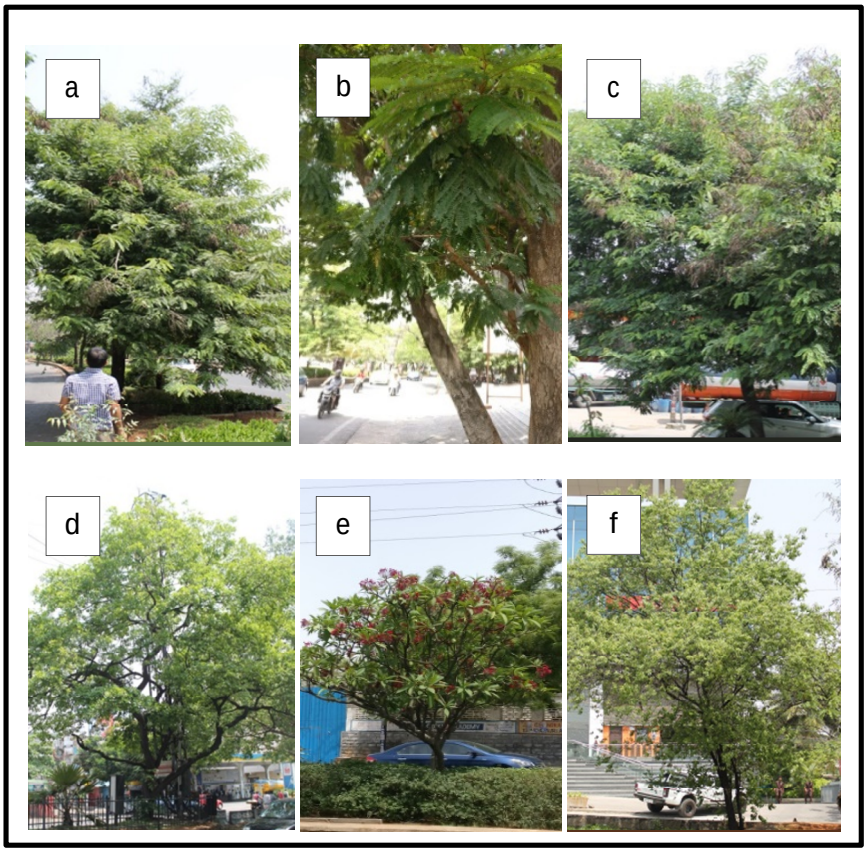


Figure 3 – Location and canopy structure of trees KBR park buffer zone. a) *Delonix regia, b) Peltophorum pterocarpum, c) Azadarichta indica, d) Ficus religiosa, e) Plumeria rubra* and *f) Casia roxburghii*

Out of the 60 trees surveyed, 57 trees comprised of six major (abundant) species. Three trees were omitted since they each represented minor (rare) species. The Percentage Distribution of each species within the total sampling area (Σ A,B,C,D) was calculated as follows:

Table 2 - Percentage Distribution of Abundant Species

S.No	Scientific Name	Number of trees within the total sample area (N)	Percentage of Sample (%) $P = \frac{N}{57} \times 100$
1	*Cassia roxburghii*	16	28.07
2	*Delonix regia*	14	24.56
3	*Azadirachta indica*	9	15.79
4	*Ficus religiosa*	6	10.53
5	*Plumeria rubra*	9	15.79
6	*Peltophorum pterocarpum*	3	5.26

Characterisation of trees in the KBR Park Buffer zone:

Methodology to calculate DBH:

Next, the Height and DBH(Diameter at Breast Height) of each tree species were calculated and the measurements were repeated for 4 trials each. The DBH was measured at the height of 1.3m as per general convention, by measuring the circumference and then dividing that by π. [15]

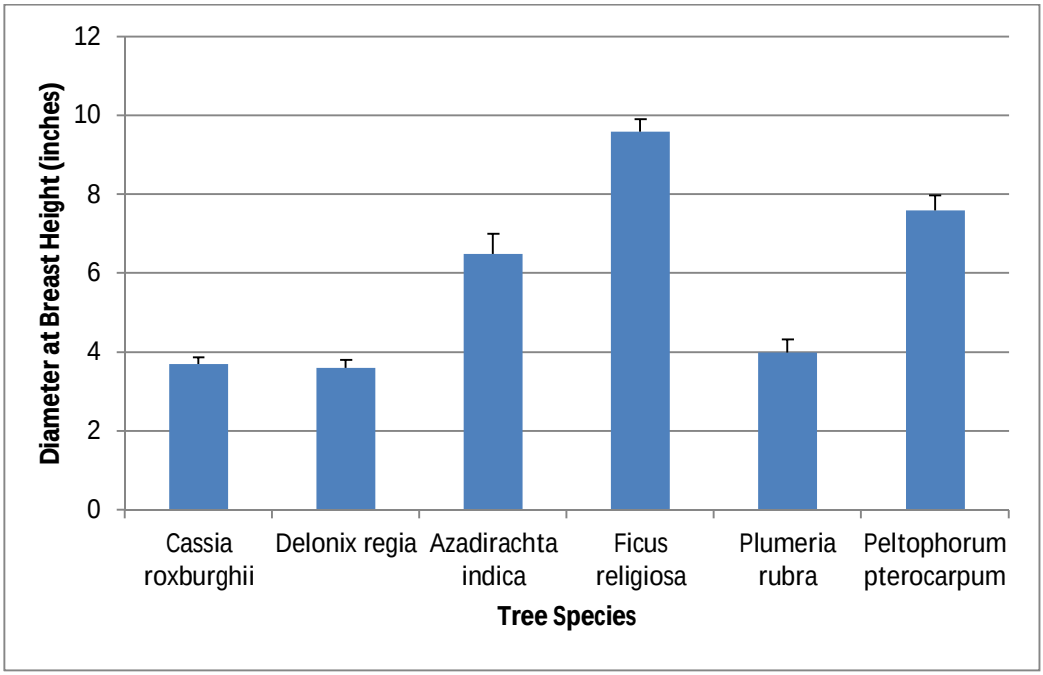
$$DBH(in\ inches) = \frac{Circumference}{\pi}$$

Results:

Table 3 – Diameter at Breast Height (DBH) of each Tree Species.

S.No.	Scientific Name	Number of trees within the sample	Diameter at Breast Height (inches)					
			Trial 1	Trial 2	Trial 3	Trial 4	Average $\frac{T_1 + T_2 + T_3 + T_4}{4}$	Standard Deviation
1	*Cassia roxburghii*	16	3.8	3.9	3.5	3.6	3.7	0.2
2	*Delonix regia*	14	3.3	3.7	3.5	3.8	3.6	0.2
3	*Azadirachta indica*	9	7.1	6.0	6.7	5.9	6.5	0.5
4	*Ficus religiosa*	6	9.8	9.8	9.1	9.8	9.6	0.3
5	*Plumeria rubra*	9	4.3	4.2	4.1	3.5	4.0	0.3
6	*Peltophorum pterocarpum*	3	7.2	7.6	8.1	-	7.6	0.4

[15] Priyanka Bohre and O P Chaubey, "Biomass Production and Carbon Sequestration by Azadirachta Indica in Coal Mined Lands," *International Journal of Bio-Science and Bio-Technology* 8, no. 2 (April 2016), https://www.researchgate.net/publication/302948804_Biomass_Production_and_Carbon_Sequestration_by_Azadirachta_indica_in_Coal_Mined_Lands.



Graph 1- Average Diameter at Breast Height in inches for abundant Tree Species

Methodology to calculate Height of the trees:

The height of the tree was calculated with the help of a clinometer constructed using a protractor as shown in Fig. 3A, and with the help of simple trigonometry:[16]

$$H = h + b\tan(\alpha)$$

Where, h = height at which the clinometer was held,

b = distance between the clinometer and the tree, and

α = angle calculated using the clinometer.

[16] Obinna Ofoegbu and Ishaq Eneji, "Sequestration and Carbon Storage Potential of Tropical Forest Reserve and Tree Species Located within Benue State of Nigeria," April 2014, https://www.researchgate.net/publication/261699371_Sequestration_and_Carbon_Storage_Potential_of_Tropical_Forest_Reserve_and_Tree_Species_Located_within_Benue_State_of_Nigeria.

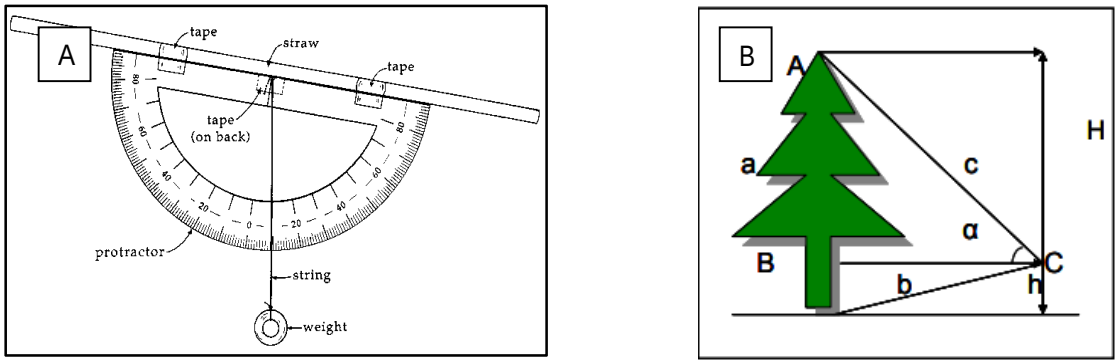


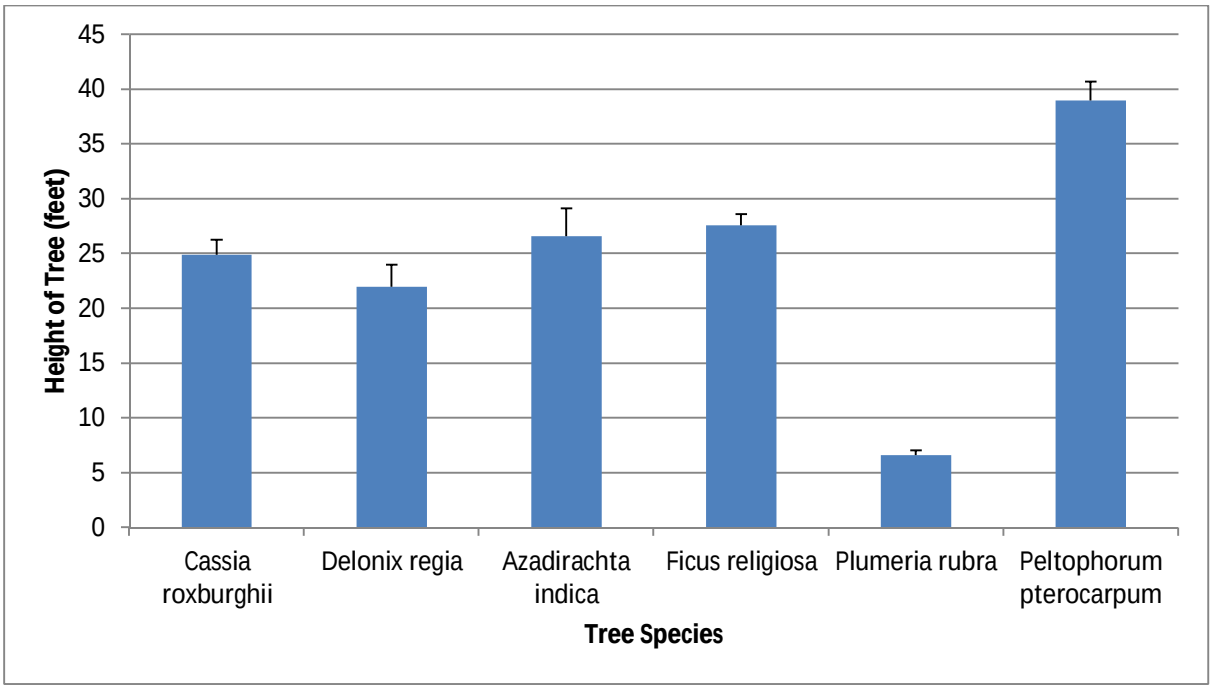
Figure 4: Calculation of the Tree Height using Trigonometry[17]. A) Construction of the clinometer. B) Measurements of the angle between the clinometer and the tree, the distance between the clinometer and the tree, height of the clinometer.

Results:

Table 4 – Height of each Tree Species.

S.No	Scientific Name	Number of trees within sample	Height of trees (feet)					
			Trial 1	Trial 2	Trial 3	Trial 4	Average Height $\frac{H_1 + H_2 + H_3 + H_4}{4}$	Standard Deviation
1	*Cassia roxburghii*	16	25.9	26.6	23.3	24.0	24.9	1.3
2	*Delonix regia*	14	20.0	22.6	20.3	24.9	22.0	2.0
3	*Azadirachta indica*	9	29.9	24.0	28.2	24.3	26.6	2.5
4	*Ficus religiosa*	6	27.6	29.2	26.9	26.6	27.6	1.0
5	*Plumeria rubra*	9	6.9	6.9	5.9	6.6	6.6	0.4
6	*Peltophorum pterocarpum*	3	36.7	39.7	40.7	-	39.0	1.7

[17] Ofoegbu and Eneji.



Graph 2 - Average Height in feet for abundant Tree Species

Calculating Carbon Sequestration Rates of Trees in the KBR Buffer zone:

Methodology:

Carbon sequestration rates of some trees are known, but not for all tropical species. Moreover, these rates depend on many factors such as the tree's density, its location, its age and also the fact that trees sequester the highest amounts of carbon in their younger age of 20 to 50 years. So, to calculate the CO_2 sequestered by an individual tree per year**(C)**, a general formula (approximation) discussed by an NGO called "We at Trees for the Future" was used.[18] This involves estimating each tree's total green weight**(W_G)**, dry weight**(W_D)**, weight of Carbon within the tree**(W_C)**.

a) Total Green Weight**(W_G)**: The Total Green Weight of a tree, with a diameter at breast height (DBH) smaller than 11inches, is equal to:

[18] Trees for the Future, "Calculating CO2 Sequestration by Trees," March 15, 2005, http://www.unm.edu/~jbrink/365/Documents/Calculating_tree_carbon.pdf.

$W_G = 0.25D^2H$ .....[19]

On the other hand, if the diameter at breast height is greater than 11 inches,

$W_G = 0.15D^2H$.....[20]

Where, D = DBH of the tree (inches) and H = height of the tree (feet).

From Graph 1, it can be seen that the average DBH of the trees under consideration has a value smaller than 11 inches. Hence, only the first formula was used to calculate DBH.

b) Dry Weight of a tree**(W_D)** calculated as follows

$W_D = 0.725W_G$.....[21]

c) Weight of Carbon in the Tree**(W_C)**: calculated as follows:

$W_C = 3.66W_D$.....[22]

d) Annual Carbon Dioxide Sequestered in the Tree: Measured by dividing the carbon sequestered**(W_C)** by the age of the tree**(A).**

$C = \frac{W_C}{A}$.....[23]

This entire procedure implies that:

$$C = \frac{W_C}{A}$$

$$\Rightarrow C = \frac{3.66W_D}{A}$$

$$\Rightarrow C = \frac{3.66(0.725W_G)}{A}$$

[19] ibid
[20] ibid
[21] ibid
[22] ibid
[23] ibid

$$\Longrightarrow C = \frac{2.6535(0.25D^2H)}{A} = \frac{0.663375D^2H}{A} \; for\; D < 11$$

To calculate annual sequestration rates, it was essential to find the age of the trees. However, it is nearly impossible to do this without destructive sampling to count the annual rings of wood growths. Consequently, an estimate of 15 years had to be used, according to the time of planting by the GHMC(Greater Hyderabad Municipal Corporation).[24]

Results:

Table 4 - Carbon Sequestered by Species in kg/year.

S.No	Scientific Name	Number of trees within the sample ***(N)***	Average Age (year) ***(A)***	Total Carbon Sequestered (kg) $(W_C = 0.663375D^2H)$	Carbon Sequestered (Per Tree) (kg/year) $(C_{Tree} = W_C/A)$
1	*Cassia roxburghii*	16	15	226.13	15.08
2	*Delonix regia*	14	15	189.14	12.61
3	*Azadirachta indica*	9	15	745.53	49.70
4	*Ficus religiosa*	6	15	1687.37	112.49
5	*Plumeria rubra*	9	15	70.05	4.67
6	*Peltophorum pterocarpum*	3	15	1494.35	99.62

Sample Calculations:

Carbon Sequestered kg/year - *Cassia roxburghii*:

$DBH = D = 3.7 inches$

$Height = H = 24.9 feet$

$Age = 15\ years$

$$Carbon\ Sequestered = C = \frac{0.663375D^2H}{A} = 15.10\ kg\ year^{-1}$$

[24] Application No.106 of 2016 (SZ).

The last step was to use this data from the random sample to find the carbon sequestered by all the 1394 trees that were marked for removal.

Table 5 – Telangana Government data regarding the Number of Trees that would have to be cut for the SRDP Flyover[25]

S. No.	Junction	No. of Trees
1.	KBR Entrance Junction 1st level flyover	225
2.	KBR Entrance Junction 2nd level flyover	181
3.	Road No.45 Junction 1st level flyover	164
4.	Road No.45 Junction 2nd level flyover	98
5.	Film Nagar Junction 1st level flyover	167
6.	Film Nagar Junction 2nd level flyover	139
7.	Maharaja Agrasen Junction 1st level flyover	248
8.	Maharaja Agrasen Junction 2nd level flyover	172
	Total	1394

Since, a total of 1394 trees are being cut, the total carbon sequestration by all trees was calculated using relative distribution of the species within the sample**(N)**.

Table 6 – Estimating the Carbon Sequestered by the 1394 Trees marked for removal

S.No	**Scientific Name**	**Number of trees within the sample (N)**	**Percentage of Sample (%)** $P = \frac{N}{57} \times 100\%$	**Total Estimated Count** $E = P \times 1394$	**Total Carbon Sequestered by Species (tonnes/year)** $C_{Species} = \frac{C_{Tree} \times E}{1000}$
1	*Cassia roxburghii*	16	28.07	391	5.895
2	*Delonix regia*	14	24.56	342	4.312
3	*Azadirachta indica*	9	15.79	220	10.934
4	*Ficus religiosa*	6	10.53	147	16.536
5	*Plumeria rubra*	9	15.79	220	1.027
6	*Peltophorum pterocarpum*	3	5.26	73	7.272
				Total	**45.978**

[25] Application No.106 of 2016 (SZ).

Sample Calculation *(P. pterocarpum)*:

$$Number\ of\ P.pterocarpum\ Trees = 3$$

$$Percentage\ of\ Sample = P = \frac{3}{57} * 100\% = 5.26\%$$

$$Thus, Total\ Estimated\ Count = P * 3194 = 0.0526 * 1394 = 73.3244 \simeq 73$$

$$Carbon\ Sequestered\ by\ one\ P.pterocarpum\ Tree\ Annually = C_{Tree}$$

$$= 99.62\ tonnes\ year^{-1}$$

$$Carbon\ Sequestered\ by\ P.pterocapum\ Species\ in\ the\ KBR\ Park\ Buffer\ zone, Annually$$

$$= \frac{C_{Tree} \times E}{1000} = \frac{73 \times 99.62}{1000} = 7.272\ tonnes\ year^{-1}$$

Thus, the CO_2 sequestered by the 1394 trees marked for removal amounts to a value of 45.978 tonnes per year.

Carbon Emitted by Vehicles around the KBR Park

According to a Comprehensive Traffic Study (CTS) conducted by the Hyderabad Metropolitan Development Authority (HMDA), nearly 2.5 lakh cars travel around the KBR Park junctions every day.[26] Because of the idling and slower speeds at these junctions the government has calculated that nearly 32,096 litres of fuel is lost every day.

[26] Application No.106 of 2016 (SZ).

Table 7- Estimated CO_2 produced by Vehicles using specific Fuels in India

Fuel Type	Estimated Amount of Vehicles[27]
Petrol	61%
Diesel	39%

Fuel Type	Kg of CO_2 per unit of consumption[28]
Petrol	2.31
Diesel	2.68

Petrol consumed by KBR commuters = (0.61)(32096) = 19578.56 l

Thus, CO2 released by Petrol vehicles = (19578.56)(2.31) = 45.226 tonnes/day

Diesel consumed by KBR commuters = (0.39)(32096) = 12517.44 l

Thus, CO2 released by Diesel vehicles = (12517.44)(2.68) = 33.547 tonnes/day

According to this calculation, the total CO_2 released on a daily basis due to traffic equals 78.773 tonnes per day. Furthermore, the government has estimated that the flyover will reduce pollutant load by 55.85%, therefore bringing the carbon emissions down to **43.995 tonnes per day**. [29]

However, the credibility of this source is unknown because the original document, a Comprehensive Traffic Study, was not published to the public.

[27] volkman10, "Model-Wise Petrol vs Diesel Sales Figures (Jan - June 2018)," *Team-BHP*, September 12, 2018, https://www.team-bhp.com/forum/indian-car-scene/201743-model-wise-petrol-vs-diesel-sales-figures-jan-june-2018-a.html.

[28] University of Exeter, "Calculation of CO2 Emissions," Economic Effects of Money Laundering, April 8, 2009, , accessed February 01, 2019, https://people.exeter.ac.uk/TWDavies/energy_conversion/Calculation of CO2 emissions from fuels.htm.

[29] Application No.106 of 2016 (SZ).

Carbon balance between sequestration and emissions in the KBR Park region.

From the above calculations, the trees marked for felling sequester an annual amount of 45.978 tonnes, while the proposed flyover is expected to reduce carbon emission by 43.995 tonnes per day. Hence, in contrast to public opinion, annually the flyover would reduce carbon emissions that amount to almost 344 times the amount of CO_2 sequestered by the tree, making the flyover, in terms of carbon footprint, a very efficient solution for the short-term.

SOCIAL IMPACT:

Along with environmental criteria, the goal of Sustainable Development also includes consideration of social sustainability where it becomes crucial to understand the society's requirements.[30] Society, in this case, was defined as the people residing around the KBR Park, the people who use the roads for travel purposes and the people who own businesses around the KBR Park. Thus, a random survey of 40 people was conducted around the KBR Park, in which information on their demographics, awareness and attitudes towards impacts of the flyover on health and comfort, was collected. (See Appendix C)

Demographics of Survey Respondents

The average age of the respondents was 32.03 years, while the majority of the respondents were male – 73.1%. The average annual earnings of the participants summed up to INR 14.77 lakhs. These respondents were left anonymous and their consent was taken before asking them questions.

[30] György Enyedi, "Social Sustainability of Large Cities," Ekistics 69 (2002): , www.jstor.org/stable/43619551.

The respondents were connected to the KBR Park and its surrounding roads for a variety of reasons:

Table 8 - Association with KBR Park for the 40 respondents.

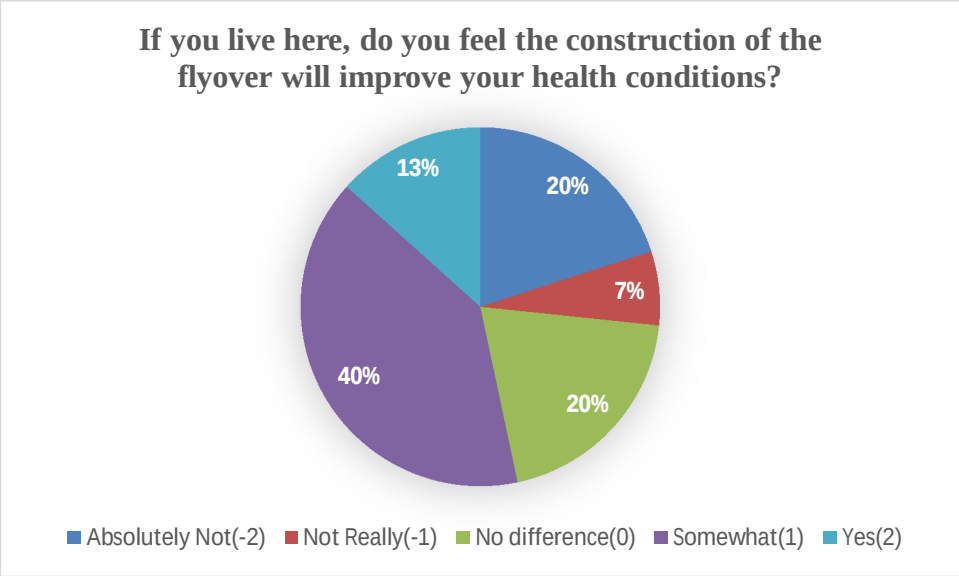
Association with KBR Park	Number of Respondents
Live in the vicinity	13
Use Solely for Travel Purposes	12
Own Businesses around the Park	12
Take Walks in the Park	3

Before being informed about the flyover, each respondent was asked to identify their ideal solution to the traffic around the KBR Park and explain their reasoning behind that choice. This reasoning was graded between 1 and 5 to establish an environmental awareness score for each respondent. Contradictory to the usual trend, this score remained fairly constant between 3 and 3.5 through each wage category, indicating the respondents' ecocentric environmental value systems. This could be due to the fact that the people working, living and travelling around the KBR Park have been sensitised to several environmental issues through various protests, conventions and strikes conducted around the park.

Health impacts

The flyover, by reducing car idling and traffic flow, decreases air pollution and carbon emissions, thereby providing significant health advantages such as lowered incidence of respiratory illnesses ranging from lung cancer to bronchitis, within residents around the KBR Park and in the city as well.

Unfortunately, these flyover projects impact on air and noise pollution is very minimal. Similar to the SRDP LB Nagar Circle flyover[31], built recently this year, this flyover would certainly provide health benefits, but given the project's small scale, these benefits will be trivial.



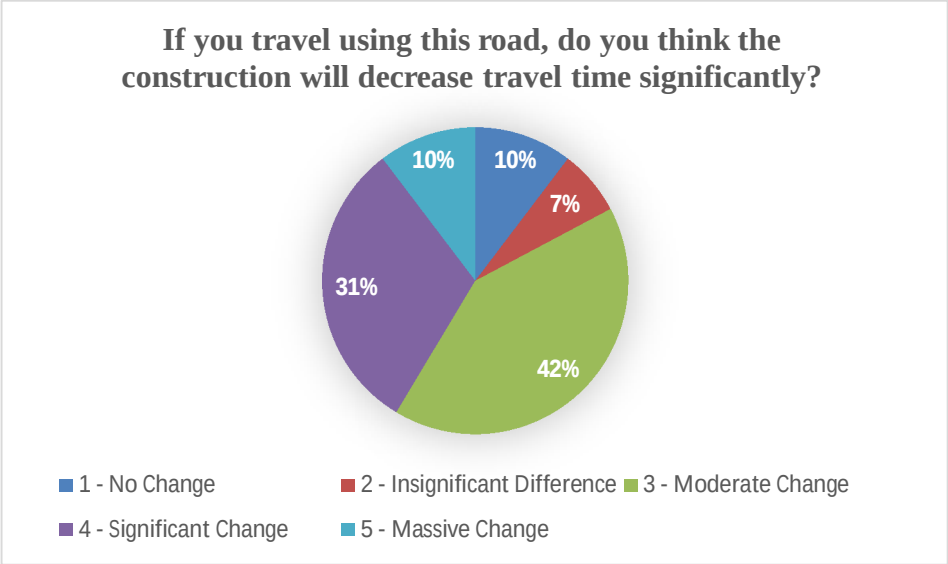
Graph 3 - Survey Results regarding Health Conditions

The survey provided similar results, with 40% of people stating that the flyover would be 'somewhat' beneficial in improving living and health conditions. To quantitate this, the respondents were asked to answer their questions with five different options, each with a corresponding score. The most positive answer added 2 points to the overall score, while the most negative answer provided a score of -2. The scores were multiplied with the number of responses and the weighted average score was calculated to be +0.2 (See Appendix C), agreeing with the idea that the flyover would only provide 'trivial benefits'.

[31] "Under Strategic Road Development Project (SRDP) for Proposed Road Widening for Multilevel Flyover at LB Nagar Circle to Kamineni Circle, Saroonagar Mandal of Rangareddy District.," Social Impact Assessment (Environment Protection Training & Research Institute, March 2017), http://www.rangareddy.telangana.gov.in/rangareddy/notifications.apo?mode=downLoadDetails&fileName=889.pdf

Travelling Ease

This flyover, by increasing the quantity of lanes that can be used, reduces the congestion that the KBR Park roads see at a daily basis and provides a quicker roadway that reduces travel time. Furthermore, by providing more open space to drivers, there is limited scope for accidents.

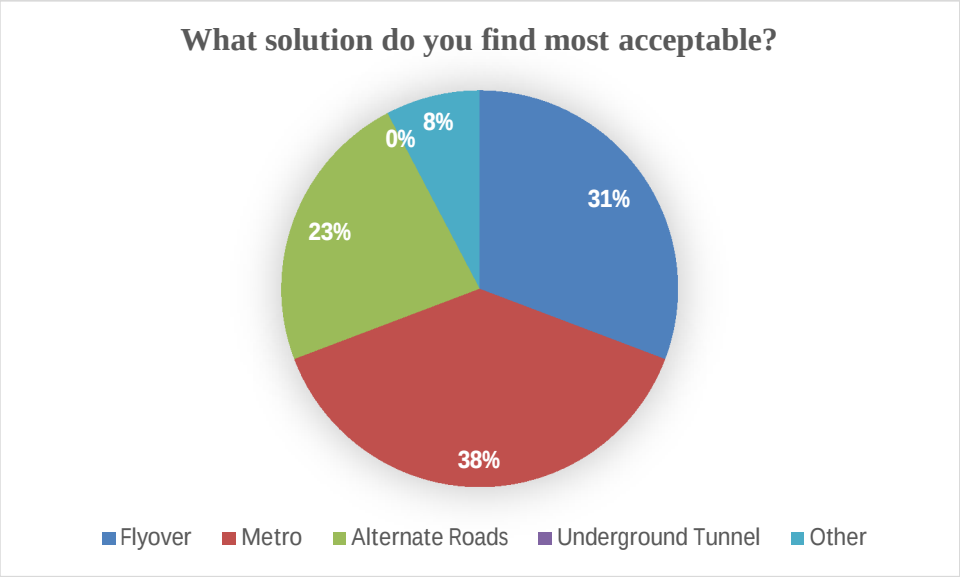


Graph 4 - Survey Results Regarding Travel Time

The participants were asked to answer the question by giving the flyover a score from 1(no effect in decreasing travel time) to 5(significant effect in reducing travel time). The average score received was 3.24, showing a general acceptance in the flyover's effect in reducing travel time. (See Appendix C) A majority of the surveyed citizens came to the consensus that there was a large amount of traffic at certain 'choke-points', and a flyover would be an efficient solution to ease the traffic flow.

Alternate Solutions

Due to the previously established ecocentric value systems of the respondents, many respondents were in favour of the trees over the proposed flyover.



Graph 5 - Survey Results Regarding Respondents' most acceptable Solution

While 76.9% of the survey respondents believed that the government needed to provide a solution to decongest the KBR Park Road, a majority of the respondents felt that instead of a flyover, the Metro-Rail was a more desirable solution since it is a public form of transport that would be better at reducing pollution. This signifies that the felling of trees for the flyover is not necessarily the most 'socially acceptable' solution.

However, this segment of the survey was subject to strong social desirability biases. When people were asked to choose between flyovers and trees, the socially acceptable answer is 'trees' and there could be tendencies for participants to respond inaccurately. Also, a sample size of only 40 people could be inadequate and lead to inaccuracies

ECONOMIC IMPACT:

While, flyovers are often built with an economic goal in mind like connecting two complimentary locations, in this case the flyover is being built to ease the traffic flow and not for specific economic benefits.[32] Yet, the following economic impacts may be considered:

Impact on Employment

By 2030, the construction sector in India is expected to be the third largest globally, contributing to 15% of the Indian GDP. The construction sector employed 40 million people in 2013, 52 million in 2017 and is expected to employ 67 million by 2022.[33]

This flyover would provide employment opportunities to workers not only during the construction phase, but for maintenance activities. The employed workers would earn a salary from either the government itself or a contracted private firm, and would spend that salary on goods and services mostly in the local economy. This process repeats itself, and the overall economic activity in the area increases, effectively creating a multiplier effect. According to various experts, this multiplier is equal to 1.5, indicating that every Rs.1 invested into the salary of a worker produces Rs.1.5 in economic welfare.[34]

[32] Bridge Masters, "The Positive Economic Impacts of Bridges," Bridge Masters Inc., March 16, 2018, https://bridgemastersinc.com/positive-economic-impacts-bridges/.
[33] "Realty, Construction to Generate 15 Million Jobs by 2022: Economic Survey," *The Economic Times*, January 29, 2018, https://economictimes.indiatimes.com/jobs/realty-construction-to-generate-15-million-jobs-by-2022-economic-survey/articleshow/62696169.cms.
[34] Masters, "The Positive Economic Impacts of Bridges."

Impact on Non-Renewable Resources

Fossil fuels, goods with an incredibly high demand, are often the difference between a developing and developed countries. Fuel shortages have the capability to shake an entire economy and cause massive inflations.

This flyover plays an important role in reducing the usage of an important economic resource – fuel. According to calculations conducted by the Telangana State Government, this flyover will be responsible in saving a staggering 40.59 crore litres between 2015 to 2035.[35]

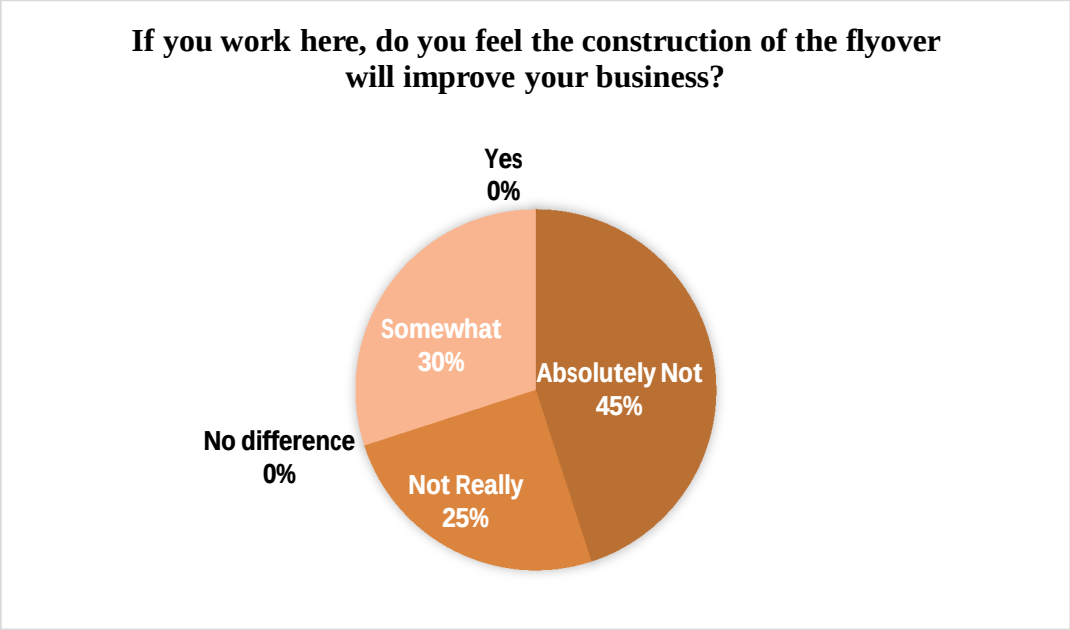
With this development, there will be more efficient movement for commuters, increasing the speed at which trades and commerce services can be conducted. Furthermore, this will cause a reduction in commuter travel time, providing the economy's workforce additional time to become a resourceful asset to the country.

Impact on Local Businesses

Over 60 different shops, restaurants and hotels are placed around the KBR Park. The construction of a flyover would reduce the customers who would visit these shops and restaurants, as being above the ground on the flyover would limit any traveller to stop at these stores – effectively bypassing them. For example, the flyover built outside Livingston in Merced County, California provided few interesting revelations about the association of economic activity and flyovers, as it led to an economically significant loss of "36 jobs per square kilometre, 33% of the average 1990 grid cell employment level."[36]

[35] Application No.106 of 2016 (SZ).
[36] Richard Funderburg, "New Highways and Land Use Change: Results from a Quasi-Experimental Research Design," *ELSEVIER*, February 2010, https://www.sciencedirect.com/science/article/pii/S0965856409001232.

A survey was conducted to understand the views of business owners around the KBR Park.



Graph 6 - Survey Question Regarding the Flyover's Effect on Businesses.

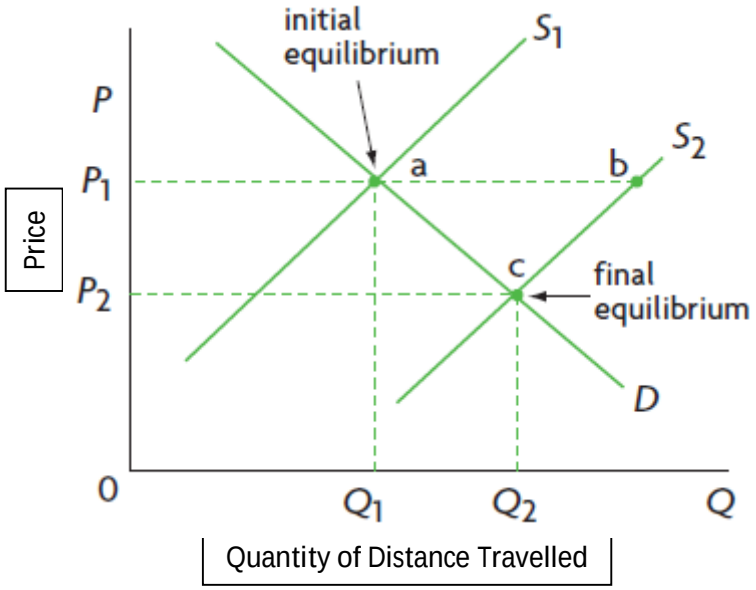
The bulk of these businesses were restaurants and shops which used visual cues to attract their customers. Consequently, 14 out of the 20 businesses felt that would get bypassed and lose a majority of their consumers. The rest 6 businesses, mostly hotels and well-known shops (Starbucks) with large customer bases, were unafraid of the flyover, and even felt that the flyover would provide their customers with a more peaceful and efficient travel network.

LONG-TERM CONCERNS:

The short-term scenario discussed above mostly shows significant advantages to the flyover, in the environmental, social and economic sectors. However, the long run presents an entirely different story.

Induced Traffic Model

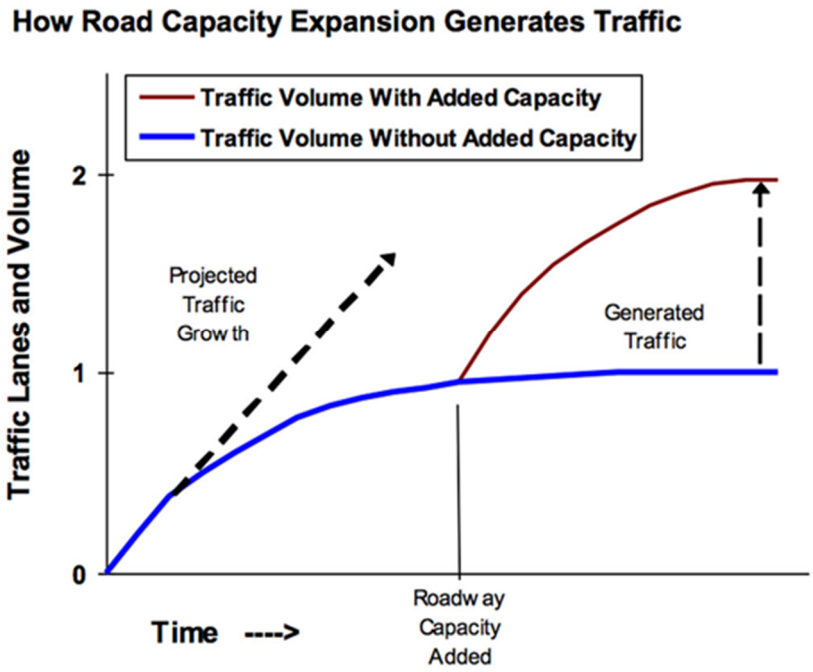
Traveling by roads can be thought of in the economic concepts of demand and supply. “Demand, in economics, is defined as consumers' willingness and ability to consume a given good.”[37] “Supply, on the other hand, is the producer's willingness and ability to supply a given good at various price points, holding all else constant.”[38] Supply in this context can be thought of the roadways and flyovers provided to the consumers (the people who use the roads and flyovers).



Graph 7 - The quantity of 'Travel' demanded and supplied by the KBR Park Flyover[39]

[37] Ellie Tragakes, *Economics for the IB Diploma* (Brantford, Ontario: W. Ross MacDonald School Resource Services Library, 2017).
[38] Ellie Tragakes, *Economics for the IB Diploma* (Cambridge University Press, n.d.).
[39] Tragakes.

As additional flyovers are built, the supply for “traveling” is increased from S1 to S2. This additional capacity helps in decreasing travel time, which effectively reduces the ‘price’ of traveling. As a result the economy shifts from equilibrium point 'a' in the graph to equilibrium point 'c', where demand has increased from a quantity of Q1 to Q2. This effect of demand increasing is called 'induced travel'. This means that instead of succeeding in reducing the traffic around the KBR Park, these flyovers would attract more vehicles along the roads, and thus more carbon emissions. Graph 9 shows the effect of increasing roadway on traffic volume, as calculated by California’s government:



Graph 8 - The relationship between Traffic Volume and Roadway Capacity as calculated by the California State Government[40]

[40] Todd Litman, “Generated Traffic and Induced Travel Implications for Transport Planning,” April 24, 2018, http://www.vtpi.org/gentraf.pdf.

Urban Heat Island Effect

A study by the Indian meteorological department showed that the seasonal average temperature in Andhra Pradesh has increased by 0.01 degrees every year since 1950.[41] Furthermore, "the average March-to-May summertime heat index for Hyderabad had grown by 0.69 degrees per decade between 1951 and 2010."[42] One of the factors to these changes in temperature is the UHI (Urban Heat Island) effect.

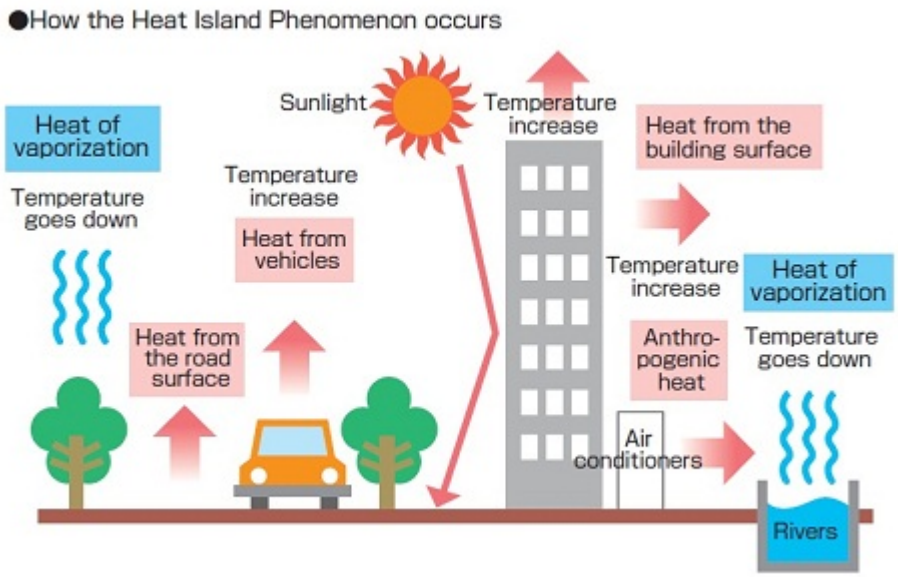


Figure 5 – Potential Causes of the Urban Heat Island Phenomenon[43]

Due to the high thermal bulk properties and surface radiative properties, construction material like asphalt and concrete absorb a large amount of heat.[44] As urban and suburban areas lose land surface and vegetation to such construction projects, this warming effect, the UHI effect, significantly increases day temperatures as heat no longer has a pathway to escape.[45]

---

[41] L S Rathore, S D Attri, and A K Jaswal, "STATE LEVEL CLIMATE CHANGE TRENDS IN INDIA," December 2013, http://www.imd.gov.in/section/climate/StateLevelClimateChangeMonoFinal.pdf.
[42] Somini Sengupta, "In India, Summer Heat May Soon Be Literally Unbearable," *The New York Times*, July 17, 2018, https://www.nytimes.com/2018/07/17/climate/india-heat-wave-summer.html.
[43] Casandra, "What Is the Heat Island Effect?," Green Ribbon, January 14, 2014, http://www.gardinergreenribbon.com/heat-island-effect/.
[44] Casandra.
[45] Casandra.

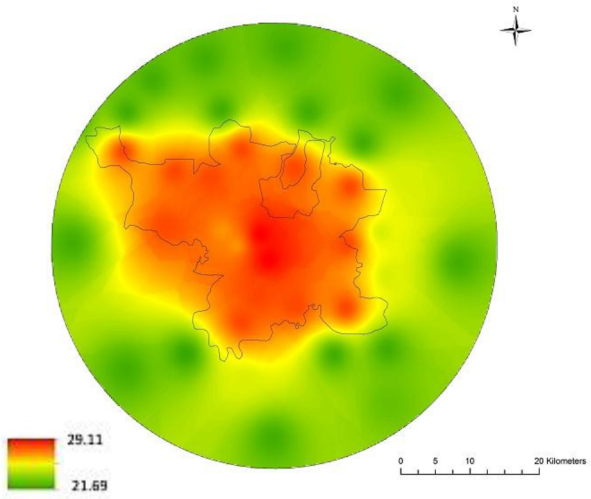


Figure 6 - Summer Temperatures around Greater Hyderabad[46]

As seen in Figure 6, Hyderabad's temperatures vary by almost 8 degrees Celsius[47], compared to the surrounding rural areas. This proposed SRDP flyover, situated at a higher elevation, will magnify the heat and temperatures causing widespread man made climate disaster. For these reasons, it becomes essential to maintain a strong green cover and provide alternatives to constructions like flyovers.

In conclusion, the flyover poses potential disadvantages in the long run: It does not provide an incentive to commuters to switch to a more eco-friendly transportation, instead it unintentionally influences commuters to use their vehicles more often, increasing the threats of the urban heat island effect and severe climate change.

[46] N Sridhar and Vijaya Bhole, "Seasonal Analysis of Urban Heat Island of Greater Hyderabad Using Thermal Remote Sensing," *STM Journals* 9, no. 1, accessed June 7, 2018, https://www.omicsonline.org/proceedings/estimation-of-urban-heat-island-intensity-in-the-megacity-of-hyderabad-23818.html.
[47] Sridhar and Bhole.

DISCUSSION:

Hyderabad has been in a race to becoming a world-class city, and in the process mercilessly massacred its lung spaces, and axed its decades-old trees and gardens. The green cover has fallen to a paltry 3%, and is expected to drop further to 2.5% in the next decade.[48] Furthermore, the 'built-up' landscape is also expected to double from 35.18% to 64.60% in the following decade.[49] While urbanization is important and even good for economies, it is important to maintain urbanization at a sustainable level in the long-term, whereby the needs of the future generations are not compromised. Hyderabad needs efficient and holistic plans that will involve: economics, society and environment.

Smart Cities: Transportation

Despite living in the 21st century, we look to conventional expansion approaches like interlinking roads, flyovers or introducing high-speed vehicles. One of the most important criteria of the Smart Cities Mission is to ensure smart transportation, however, "only 20 Indian cities with populations of over 500,000 have organised public transport systems."[50]

Smart cities are expected to integrate technology with transportation to produce eco-friendly, comfortable, safe and sustainable solutions to cope against mobility challenges. Unfortunately, Hyderabad, with an incomplete Metro Rail system and outdated buses, is far from fulfilling this criteria.

[48] Sudipta Sengupta, "City of Gardens Rapidly Losing Lung Spaces, Fighting for Its Last Breath," *Times of India*, October 25, 2017, https://timesofindia.indiatimes.com/city/hyderabad/city-of-gardens-rapidly-losing-lung-spaces-fighting-for-its-last-breath/articleshow/61213044.cms.
[49] Sengupta.
[50] Mohit Kochar, "Smart Transportation: A Key Building Block for a Smart City," *Forbes India*, July 6, 2018, http://www.forbesindia.com/blog/infrastructure/smart-transportation-a-key-building-block-for-a-smart-city/.

It has become a convention for Hyderabad to deal with traffic problems by building more roads and networks: the Outer Ring Road, a network of 158km long roads[51], in 2014, and now the SRDP in 2017. It is time for Hyderabad to move towards more technology-based transport systems:

- MaaS(Mobility-as-a-Service)[52] – MaaS refers to moving different types of transport options – cabs, metro rails and buses – to one platform to successfully integrate the first and last mile connectivity.
- Underground Tunnels – If we have to go back to choosing flyovers and roads, we can potentially build underground roads so that the limited green cover above-ground is not disturbed, although doing this in a cost-effective manner would require tremendous effort.

Equal Development in Urban and Rural Areas

The state, Telangana, has a population of 3.2 crores, making it more populated than Australia itself. The population of Telangana can be divided into two categories: 38.67% urban population[53] and 61.33% rural population. However, out of the 1.35 crore urban population, more than 1cr reside in Hyderabad.[54] Telangana is missing any kind of rural development and lacks any urban development other than Hyderabad.

Hyderabad, Telangana's development and economic hub, has been attracting rural populations from all corners of the state. This large migration rate has added to the already large population growth rate. Consequently, to support this humongous population, the only possible solution is to expand the limited infrastructure through mega projects, large flyovers

[51] Diganta Das, "Hyderabad: Visioning, Restructuring and Making of a High-Tech City," *ELSEVIER*, December 9, 2014, http://blog.hawaii.edu/durp/files/2014/03/Das-15_city-profl-Hyderabad.pdf.
[52] Kochar, "Smart Transportation: A Key Building Block for a Smart City."
[53] Pradeep Vallupu, "ISSUES TO BE CONCERNED FOR URBANIZATION IN TELANGANA," *Ijcrt*, November 4, 2017, http://ijcrt.org/papers/IJCRT1704107.pdf.
[54] Vallupu.

and housing facilities. At the root level, the difference in rural development and urban development has led to large-scale migrations, and consequently, overpopulation. The State government could possibly conduct a program similar to the Central Government's Smart Cities Mission - "an urban renewal and retrofitting program" which aims to develop 100 cities in a sustainable manner.[55]

CONCLUSION:

This essay has critically evaluated the sustainability of the KBR Park flyover by considering its impact on the environmental, economic and social factors in the short and long run. Interestingly, this proposed flyover shows largely positive benefits in the short run by improving traffic flow, health in the nearby vicinity and employment, and reducing carbon emissions. However, in the long run as this solution does not provide commuters with an incentive to move towards more eco-sensitive transportation means, instead it motivates more people to purchase vehicles and use these improved roadways through a phenomenon called 'induced traffic', displaying that the proposed solution is indeed 'unsustainable'.

This investigation highlights the importance of moving towards smart, simple, green and most importantly sustainable solutions in the long run. While the SRDP flyover is indeed a powerful solution to the impending crisis that the traffic presents, perhaps the government should have encouraged a more sustainable solution like equally developing rural areas or promoting public transport. As Chief Seattle once said, "We do not inherit the Earth from our ancestors; we borrow it from our children," we must ensure that the future generations have access to resources necessary for their sustenance.[56]

[55] "Smart Cities Mission," February 18, 2017, accessed November 21, 2018, http://smartcities.gov.in/content/.
[56] Joseph Coohill, "Chief Seattle "We Do Not Inherit the Earth from Our Ancestors; We Borrow It from Our Children." Quote or No Quote?" Professor Buzzkill – History's Myths Debunked (blog), September 21, 2017, accessed January 28, 2019, http://professorbuzzkill.com/qnq-32/.

BIBLIOGRAPHY:

Books:

Tragakes, Ellie. *Economics for the IB Diploma*. Brantford, Ontario: W. Ross MacDonald School Resource Services Library, 2017.

Blog Articles:

Choudary, Vijay. "Kasu Brahmananda Reddy National Park – Complete Detail." Accessed September 13, 2018. http://natureconservation.in/kasu-brahmananda-reddy-national-park-complete-detail-updated/.

Citizens for Hyderabad. "How Will Destroying the ESZ of KBR National Park Impact Us, the Hyderabadis." *Save KBR National Park* (blog). Accessed December 29, 2018. https://www.savekbr.org/impact-of-esz-destruction-on-hydera.

Joseph Coohill, "Chief Seattle "We Do Not Inherit the Earth from Our Ancestors; We Borrow It from Our Children." Quote or No Quote?" *Professor Buzzkill – History's Myths Debunked* (blog), September 21, 2017, accessed January 28, 2019, http://professorbuzzkill.com/qnq-32/.

Court Cases:

Application No.106 of 2016 (SZ) (National Green Tribunal May 24, 2017).

Documents:

Prassana, P. V., Chandra Reddy, Venkat Ramana, and P Venu. "Trees of Hyderabad." Botanical Survey of India, October 1, 2012, http://urbangreening.ap.gov.in/uploads/Publications/Trees_of_Hyderabad.pdf

Trees for the Future. "Calculating CO2 Sequestration by Trees," March 15, 2005. http://www.unm.edu/~jbrink/365/Documents/Calculating_tree_carbon.pdf.

"Under Strategic Road Development Project (SRDP) for Proposed Road Widening for Multilevel Flyover at LB Nagar Circle to Kamineni Circle, Saroonagar Mandal of Rangareddy District." SOCIAL IMPACT ASSESSMENT. ENVIRONMENT PROTECTION TRAINING & RESEARCH INSTITUTE, March 2017, http://www.rangareddy.telangana.gov.in/rangareddy/notifications.apo?mode=downLoadDetails&fileName=889.pdf

Interviews:

Bhaskar, Reddy. GHMC Officer on SRDP Project's KBR Park Segment, May 6, 2018.

Maheshwari, Kaajal. Citizen of Hydeabad's view on the SRDP Project, April 4, 2018.

Forum Posts:

volkman10. "Model-Wise Petrol vs Diesel Sales Figures (Jan - June 2018)." *Team-BHP*, September 12, 2018. https://www.team-bhp.com/forum/indian-car-scene/201743-model-wise-petrol-vs-diesel-sales-figures-jan-june-2018-a.html.

Journal Papers:

Bohre, Priyanka, and O P Chaubey. "Biomass Production and Carbon Sequestration by Azadirachta Indica in Coal Mined Lands." *International Journal of Bio-Science and Bio-Technology* 8, no. 2 (April 2016): 1-111 https://www.researchgate.net/publication/302948804_Biomass_Production_and_Carbon_Sequestration_by_Azadirachta_indica_in_Coal_Mined_Lands.

Das, Diganta. "Hyderabad: Visioning, Restructuring and Making of a High-Tech City." *ELSEVIER*, December 9, 2014. http://blog.hawaii.edu/durp/files/2014/03/Das-15_city-profl-Hyderabad.pdf.

Funderburg, Richard. "New Highways and Land Use Change: Results from a Quasi-Experimental Research Design." *ELSEVIER*, February 2010. https://www.sciencedirect.com/science/article/pii/S0965856409001232.

Enyedi, György. "Social Sustainability of Large Cities." *Ekistics 69* (2002). www.jstor.org/stable/43619551.

Litman, Todd. "Generated Traffic and Induced Travel Implications for Transport Planning," April 24, 2018. http://www.vtpi.org/gentraf.pdf.

Ofoegbu, Obinna, and Ishaq Eneji. "Sequestration and Carbon Storage Potential of Tropical Forest Reserve and Tree Species Located within Benue State of Nigeria," April 2014. https://www.researchgate.net/publication/261699371_Sequestration_and_Carbon_Storage_Potential_of_Tropical_Forest_Reserve_and_Tree_Species_Located_within_Benue_State_of_Nigeria.

Rathore, L S, S D Attri, and A K Jaswal. "STATE LEVEL CLIMATE CHANGE TRENDS IN INDIA," December 2013. http://www.imd.gov.in/section/climate/StateLevelClimateChangeMonoFinal.pdf.

Sridhar, N, and Vijaya Bhole. "Seasonal Analysis of Urban Heat Island of Greater Hyderabad Using Thermal Remote Sensing." *STM Journals* 9, no. 1. Accessed June 7, 2018. https://www.omicsonline.org/proceedings/estimation-of-urban-heat-island-intensity-in-the-megacity-of-hyderabad-23818.html.

Vallupu, Pradeep. "ISSUES TO BE CONCERNED FOR URBANIZATION IN TELANGANA." *Ijcrt*, November 4, 2017. http://ijcrt.org/papers/IJCRT1704107.pdf.

Magazine Article:

Casandra. “What Is the Heat Island Effect?” Green Ribbon, January 14, 2014. http://www.gardinergreenribbon.com/heat-island-effect/.

Newspaper Articles:

"Hyderabadis from All Walks of Life Come Together to save KBR.” *Times of India*, June 5, Accessed August 28, 2018. https://timesofindia.indiatimes.com/city/hyderabad/hyderabadis-from-all-walks-of-life-come-together-to-save-kbr/articleshow/58987618.cms.

Kochar, Mohit. “Smart Transportation: A Key Building Block for a Smart City.” *Forbes India*, July 6, 2018. http://www.forbesindia.com/blog/infrastructure/smart-transportation-a-key-building-block-for-a-smart-city/.

“Realty, Construction to Generate 15 Million Jobs by 2022: Economic Survey.” *The Economic Times*, January 29, 2018. https://economictimes.indiatimes.com/jobs/realty-construction-to-generate-15-million-jobs-by-2022-economic-survey/articleshow/62696169.cms.

Sengupta, Somini. “In India, Summer Heat May Soon Be Literally Unbearable.” *The New York Times*, July 17, 2018. https://www.nytimes.com/2018/07/17/climate/india-heat-wave-summer.html.

Sengupta, Sudipta. “City of Gardens Rapidly Losing Lung Spaces, Fighting for Its Last Breath.” *Times of India*, October 25, 2017. https://timesofindia.indiatimes.com/city/hyderabad/city-of-gardens-rapidly-losing-lung-spaces-fighting-for-its-last-breath/articleshow/61213044.cms.

Tadepalli, Siddharth. “Open Spaces Form Less than 4% of Hyderabad’s Area, Disappearing Fast.” *Times of India*, January 8, 2017. https://timesofindia.indiatimes.com/city/hyderabad/open-spaces-form-less-than-4-of-hyderabads-area-disappearing-fast/articleshow/56400329.cms.

Web Page:

Google Maps. “Kasu Brahmananda Reddy Park.” Google Maps. Accessed June 6, 2018. maps.google.com.

“Hyderabad Population 2019.” World Population Review, November 6, 2018. Accessed December 28, 2018. http://worldpopulationreview.com/world-cities/hyderabad-population/.

“Kasu Brahmananda Reddy National Park.” Travel Guide. JourneyFix. Accessed November 18, 2018. http://www.journeyfix.com/indian-wildlife/kasu-brahmananda-reddy-national-park/overview-19-64.html.

Masters, Bridge. “The Positive Economic Impacts of Bridges.” Bridge Masters Inc., March 16, 2018. https://bridgemastersinc.com/positive-economic-impacts-bridges/.

“Smart Cities Mission,” February 18, 2017. Accessed November 21, 2018. http://smartcities.gov.in/content/.

University of Exeter. "Calculation of CO2 Emissions." Economic Effects of Money Laundering. April 8, 2009. Accessed February 01, 2019. D https://people.exeter.ac.uk/TWDavies/energy_conversion/Calculation of CO2 emissions from fuels.htm.

“What Is Impact Assessment?” Convention on Biological Diversity, April 11, 2008. Accessed June 6, 2018. https://www.cbd.int/impact/whatis.shtml

APPENDICES:

APPENDIX A: Field Survey Results

(A) KBR Park Entrance Junction

S.No	Scientific Name	Number of trees within the total sample area (N)
1	*Cassia roxburghii*	3
2	*Delonix regia*	5
3	*Azadirachta indica*	2
4	*Ficus religiosa*	1
5	*Plumeria rubra*	4
6	*Peltophorum pterocarpum*	0

(B) Road No.45 Junction

S.No	Scientific Name	Number of trees within the total sample area (N)
1	*Cassia roxburghii*	2
2	*Delonix regia*	5
3	*Azadirachta indica*	3
4	*Ficus religiosa*	0
5	*Plumeria rubra*	2
6	*Peltophorum pterocarpum*	3

(C) Film Nagar Junction

S.No	Scientific Name	Number of trees within the total sample area (N)

1	*Cassia roxburghii*	7
2	*Delonix regia*	2
3	*Azadirachta indica*	1
4	*Ficus religiosa*	3
5	*Plumeria rubra*	1
6	*Peltophorum pterocarpum*	0
7	Unknown	1

(D) Maharaja Agrasen Junction

S.No	**Scientific Name**	**Number of trees within the total sample area (N)**
1	*Cassia roxburghii*	4
2	*Delonix regia*	2
3	*Azadirachta indica*	3
4	*Ficus religiosa*	2
5	*Plumeria rubra*	2
6	*Peltophorum pterocarpum*	0
7	Unknown	2

APPENDIX B: Survey Questions

1. What is your age?
2. How are you connected to the road around KBR Park?
3. How bad is the traffic on this road?
4. Do you feel the government has to provide a solution to the traffic?
5. If yes, what solution do you find most acceptable? If not, imagine a scenario where this road was brimming with traffic, and decide which solution is most acceptable.
6. Why did you pick the previous option?

7. If you live here, do you feel the construction of the flyover will improve your health and reduce the extent of noise, sound and air pollution?
8. If you work here, do you feel the construction of the flyover will improve your business?
9. If you travel using this road, do you think the construction will make travel time decrease significantly?
10. The government was planning to build a flyover around the park to ease the traffic. However, this will come at the expense of the trees around the park. Which of the two(trees/flyover), do you think has a higher importance?

APPENDIX C: Survey Results

If you travel regularly using this road, do you think the construction will decrease travel time significantly?	**Count**
1 - No Change(1)	3
2 - Insignificant Difference(2)	2
3 - Moderate Change(3)	12
4 - Significant Change(4)	9
5 - Massive Change(5)	3

*Weighted average score = [(1*3) + (2*2) + (3*12) + (4*9) + (5*3)]/29

= [(3)+(4)+(36)+(36)+(15)]/29 = (94)/29 = 3.24

Wage Category(in lakhs)	**Environmental Score**
0.5	3.33
2.5	3.50
12.5	3.40
25.0	3.33

If you work here, do you feel the construction of the flyover will improve your business?	Count
Absolutely Not(-2)	9
Not Really(-1)	5
No difference(0)	0
Somewhat(1)	6
Yes(2)	0

*Weighted average score = [(-2*9) + (-1*5) + (0*0) + (1*6) + (2*0)]/20

= [(-18)+(-5)+(0)+(6)+(0)]/20 = -(23-6)/20 = -17/20 = -0.85

If you live here, do you feel the construction of the flyover will improve your health and reduce the extent of noise, sound and air pollution?	Count
Absolutely Not(-2)	3
Not Really(-1)	1
No difference(0)	3
Somewhat(1)	6
Yes(2)	2

*Weighted average score = [(-2*3) + (-1*1) + (0*3) + (1*6) + (2*2)]/15

= [(-6)+(-1)+(0)+(6)+(4)]/15 = [10-7]/15 = 3/15 = 0.2

What solution do you find most acceptable?	Count
Flyover	12
Metro	15
Alternate Roads	9
Underground Tunnel	0
Other	3

APPENDIX D: Interview Questions

1. So Sir/Madam I have been researching, and the government predicts that building the flyover would reduce the carbon emissions by a whopping 47.65 tonnes per day. On the other hand, the trees around the KBR Park only sequester about 80 tonnes of CO2 per year. Yet the building of the flyover is protested against. What are the other factors that come into play?
2. Sir/Madam, the Telengana government promised to plant about 3 times more trees than what they would cut (9000 trees). Would this be in the vicinity of the flyover or at a whole different location itself?
3. Sir/Madam, if we do build this flyover while cutting all the trees, we are making the road into a concrete jungle. Concrete is a great absorbent of heat and this would only increase the temperatures of our already hot summers. UHI(Urban Heating Impact)
4. Sir/Madam, the government predicts that if the flyover is not built, the amount of carbon emissions would increase almost three folds by 2035. When the government makes these predictions, do they take into account the fact that 20 years from now, electronic cars might be more commonly used?
5. There has been a significant amount of research done in highly developed countries to say that additional roads/lanes only increase the vehicular miles travelled and the amount of carbon emissions as a result of induced traffic. ... . Would you believe that something similar would happen with this flyover?
6. Sir/Madam, in the long run this flyover itself will see a lot of traffic. What will we do then? Instead, right now, why don't we enhance our public transportation, provide a

metro rail which is fast, efficient and stops at multiple locations? Or perhaps provide people with cycling lanes and better ways to walk?

7. Sir/Madam, in the long run this flyover itself will be crowded and result to a greater amount of carbon emissions. That aided with the atmospheric vapour created by the national park, KBR, right beside the flyover would result in very foggy conditions perhaps like Delhi and Bombay. How can we avoid that?

8. Sir/Madam, would it be possible to divert the traffic to alternate roads and alternate locations instead of building the flyover?

9. Sir/Madam, what would the difference between an underground tunnel and a flyover be? Would building an underground flyover not require the trees to be cut? If yes, then why do we not see that as an option?