Effect of destruction of trees on highway roads and its impact on climate change at Coimbatore – a case study

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Abstract Modernization and Globalization paved a way to the infrastructural development in cities. This causes an increase in the population and as a result lot of job opportunities are being created and this provides a path for people to migrate from rural to urban areas. This leads to increased pollutant gases which are released because of increased vehicles and industries. This causes a change in the Climate. The other major reason for climate change is the destruction of trees because of infrastructural developments like roads and bridges. This study mainly focuses on the effect of destruction of trees on the highway roads in and around Coimbatore city. The meteorological data like soil temperature, air temperature, relative humidity, wind speed and rainfall is analyzed for period of five years from 2015 to 2019 since the infrastructure development is more for the above said period. The main reason for this analysis is to project the amount of carbon capture and storage that is done by the trees. Though the carbon capture and sequestration by plants are being addressed by authors, correlation between the destruction of trees and climate change have not been well described in the literature made earlier which may cause increased pollutant gases in the atmosphere. This work elaborately describes the number of roads laid and bridges built in around Coimbatore city and trees that were cut down because of infrastructural developments. Alternate solutions for the reducing the destruction of trees in Coimbatore and necessary suggestions for implementation of policy decisions are addressed.
1. Introduction

Biological and climatic changes which causes global warming was mainly induced due to human beings, this was first identified by Alexander Von Humboldt [1] in the year 1800. All the vulnerable that are caused to the planet are mainly due to human beings’ interventions and activities. As per the Humboldt study, the major ways which affect the climate were deforestation, production of steam and gas etc. Several studies were made in these aspects. The effect of deforestation was predominantly observed by Ojekunle [2] and deforestation led to the decreased maximum relative humidity, increased air temperature and evaporation rate, increased soil temperature. Severity of global warming due to deforestation was clearly explained by Venkataramanan and Smitha [3].

Carbon-di-oxide (CO₂) capture and sequestration (CCS) is a process by which the CO₂ present in the atmosphere due to domestic and industrial application is captured, transported, and stored in a particular location deep into the soil. In this process, the greenhouse gas emissions are reduced to a great extent. The carbon-dioxide thus captured, is transported through pipelines, and is usually dumped in a permanent location. The CO₂ is injected deep into the porous rock under the soil which also prevents the upward movement of the stored CO₂. Such a process is called “Geological Carbon Sequestration”. If the process involves the capture of CO₂ from the atmosphere and fixes into the soil by means of plants, then it is called “Biological Carbon Sequestration”. Plants make use of available carbon dioxide for photosynthesis and some of the CO₂ is transferred to the soil as they decompose.

According to the authors, Gambhir and Tayoni [4], there are methods to mitigate the climate change and they are (i) afforestation of trees for CO₂ capture, (ii) Direct Air Carbon Capture and Sequestration (DACCS). DACCS is the emerging synthetic CO₂ removal technology which has a potential importance. Carbon dioxide removal is mainly by two processes namely the adsorption and absorption. CO₂ is dissolved into the sorbent material in the case of absorption, whereas adsorption is adhering of CO₂ to the sorbent material. As per the author [1], the changes on the earth are mainly due to the human intervention. Urbanization at Coimbatore may cause an increase in population to a projected population of 4.1 million people by 2031 with reference to the population statistics, Coimbatore Local Planning Authority, 2017 [10]. Development or conversion of single lane road into four and six lane roads and bridges built are increasing due to the increased population. Trees are cut down to promote these activities which are inevitable and as a result there is a change in the meteorological data. The trees are sources of oxygen and they help in carbon capture and sequestration. The impact of urbanization on different sectors is described by Thenmozhi et.al [6]. As per the IPCC 2007 [7], tree plantations both in cities and forests serve as the major source of carbon present in the atmosphere. The half life cycle of CO₂ is around 38 years and as described by Uma

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Shanker Singh [8] the sink of carbon dioxide must be increased by more tree plantation and reduction in deforestation. Fankhauser [5] described the essential meteorological factors while designing an Infrastructure. It considers the climate change while designing a building.

2. Methodology

2.1 Study Design

The prime focus of this study is to conduct an online survey on the number of State and National Highway roads, bridges built in and around Coimbatore city and to account for the number of trees cut down due to these infrastructural development, to study the variation of temperature, humidity and other parameters due to the decrease in the number of trees and is shown in ‘figure 1’. Based on these results obtained, analyze the effect of destruction of trees on Highway roads and on Climate change at Coimbatore. With this study, the solutions to control the increase in air temperature are proposed. The location for research proposed is Coimbatore City located at Tamil Nadu. The study involves three parts: Part I explain the details of the online survey made for this cause.

Figure 1. Flowchart of workflow
Part II elaborates on the infrastructural developments done on highways including state and national highways. Part III describes the details of trees cut down due to the development of roads and bridges. The correlation between trees destructed and change in climate because of infrastructural development are analyzed in the results and discussion section.

**Part I – Online Survey Details.** An online survey questionnaire was prepared, and the secondary data was collected. The questionnaire has 51 questions and shared across different people like school and college students, faculty members, NGOs, and public. The number of respondents for this questionnaire was one hundred and eleven. The survey questionnaire is about the awareness on the development of infrastructure on highway roads at Coimbatore, impact on several parameters like temperature of air and soil, relative humidity, wind speed and rainfall, effect of destruction of trees, suggestions about the climate control etc. It also explains the correlation of trees data and meteorological data with the climate change. Around 5% of School students, 52% of College students, 42% of working people, 3% employers, 3% unemployed, 2% of Social workers and 2% of Entrepreneurs and others 1% responded to this.

2.1.1. **Part II - Infrastructural developments at Coimbatore.** The number of roads were laid and widened in and around Coimbatore city since 2011. The study is taken for a period of 2015 to 2019. In the Pollachi to Coimbatore highway road section, two flyovers, eight minor bridges, one grade separator and one road over bridge [12] were laid. A four-lane road was laid on the same road section. Similarly, road widening project from Chengapalli to Walayar section of NH-47 started since 2015. Six lane road was laid from Chengapalli to Coimbatore bypass and four lane road from Coimbatore bypass to Tamilnadu/Kerala border. Similarly widening to four lane road and bridge in the project NH67, construction of high-level bridge at Ettimadai [13] is under progress.

2.1.2. **Part III - Details of destruction and plantation of trees at Coimbatore.** Number of trees was cut down during the road widening /newly laid roads and during the construction of bridges. During 2016-17, in the national highway road of Dindugal to Bangalore (NH209), widening of roads from Pollachi to Coimbatore was made and 2239 trees were cut down [12] and 500 saplings were planted. 24,000 plants were handed over to district rural development agency for plantation due to the non-availability of space for plantation on the highway road. In the region of Coimbatore to Avinashi road, 7500 saplings [13] were planted. Similarly, from Coimbatore to Mettupalayam road, 2023 trees being cut down due to road widening work and 200 saplings were planted. In Chengapalli to Walayar section of NH-47, no trees were cut down, but 13,053 saplings were planted along with the project corridor.

3. **Results and Discussions**

The first stage of the work is to promote awareness on the climate change, analyze the effect of destruction of trees on climate change because of the infrastructure development. Hence the results of online survey were analyzed. Around 25% of people have highly agreed that infrastructure developed contributed more to climate change,
41% of people have agreed more and only 3% have highly disagreed as shown in ‘figure 2’.

More than 77% of people have agreed that the changes in climate is because of reduction of trees as shown in ‘figure 2’. Around 46% have given that the climate change is moderate and 28% have replied that it is very high due to the destruction of trees. The destruction of trees on the highway roads due to the roads and bridges are more. The parameters like air temperature, rainfall etc., are affected by the destruction of trees as in ‘figure 3’ and proper sustainable infrastructure have helped climate change as in ‘figure 3’.

The variation of air temperature, relative humidity, rainfall and windspeed before and after the infrastructural developments is analyzed since 2015 based on the results obtained from the Agro Climate Research Centre, Coimbatore [14]. The average, maximum values and the standard deviation results are shown in table 1. and the ‘figure 4’ are shown below. The table shown below shows a considerable fall in the average rainfall and rise in the maximum air temperature from 2015 to 2019. This change is a
microlevel change. The change in wind speed from 6.3 Kmph to 4.5 kmph may be due to the flyover and other huge infrastructures built across which has a major impact of 33.33%.

![Figure 4. Meteorological change with respect to infrastructure development since 2015](image)

| Year | Maximum Air Temperature (°C) | Air Relative humidity (%) | Wind Speed (Kmph) | Rainfall (mm) |
|------|-----------------------------|---------------------------|-------------------|--------------|
|      | Average Max Std. dev Max Average Std. dev Max Average Std. dev Max |                      |                   |              |
| 2015 | 32.0 38.5 1.5 73.5 13.6 96.9 6.3 12.2 3.0 2.2 8.3 79.5 | | | |
| 2016 | 32.9 40.3 1.8 68.3 12.6 95.6 5.8 12.7 3.2 0.8 4.4 58.0 | | | |
| 2017 | 32.3 39.6 1.9 72.3 13.7 96.9 6.0 10.4 3.5 1.5 6.4 74.0 | | | |
| 2018 | 33.3 39.8 2.3 74.4 10.8 98.9 4.5 10.5 3.5 1.1 5.8 62.5 | | | |
| 2019 | 33.5 39.9 1.7 67.3 13.8 98.2 4.5 12.7 3.1 1.2 7.8 132.5 | | | |

The above results indicate that there is an increase in air temperature during the period of study and a decrease in the rainfall. This is mainly due to the trees cut down because of built roads and flyovers which matches with the results of the Abolghasem Sayadi et.al [9]. The increase in temperature can be compensated by planting more trees, building green and resilient buildings, and including this as a policy as specified in Ankit Bhardwaj and Radhika Khosla in 2018 [11]. Further, sensitization programs to promote awareness to the public in this regard to be made. The trees in the Avinashi road, Mettupalayam road, Pollachi road and Thadagam road were cut down due to the infrastructural developments described earlier. Because of this, several thousands of bats lost their homes as per the report studied [15]. Around 3600 bats relocated their home to VOC park of Coimbatore because of the decreased number of trees. Hence proper maintenance and plantation of trees is a way to promote the extinct of certain bird species and reduce the harmful particulates in the air thereby improving the climate change. Less carbon in the atmosphere reduces the greenhouse gases and climate change.
effect. With reference to the document [16], the carbon sequestered from a tree is calculated.

As per this reference, the amount of CO\textsubscript{2} sequestered is calculated on an average tree. On an average, the trees which were cut down from Pollachi to Coimbatore highway road were 2239. The species of trees cut down mostly were Tamarindus Indica. If the average life of the trees cut down were 15 years, the amount of carbon capture made will be, weight of CO\textsubscript{2} sequestration /year = weight of CO\textsubscript{2} / age of tree

\[ = 3.6663 \times \text{weight of C / age of tree} \]

Since the dimensions of the trees are not known, the amount of CO\textsubscript{2} sequestered as suggested by Pachaiyappan P et.al., [17]. With reference to article [19], trees with an average age of 10 years can capture carbon around 21.7724 kg /year. So, on an average the carbon capture for 4262 trees is around 92,793 kg / year since the average age of trees is assumed to be more than 10 years. The equal amount oxygen is given by the trees. Similarly, with reference to [13] and [14], the number of trees planted is about 45,253 Young trees absorb 2,66,843 kg of CO\textsubscript{2} / year. The carbon emissions issues related to Coimbatore can be reduced by planting trees like Gmelina arborea, Delonix regia and Cassia siamea in close proximity so that the carbon can be removed in a short span of time. Air Pollution Toleration Index (APTI) is more for Thespesia populnea and Pongamia pinnata and they perform excellently in urban areas. In this study made by A. Balasubramanian et.al, [18] among 25 species of trees Thespesia populnea was found to be excellent in all urban areas. Air Pollution Toleration Index is more for the tree species Alstonia scholaris, Azadirachta indica, Mangifera indica and Muntigea calibera.

4. Conclusion
Road construction makes the removal of trees and other plants which lead to the loss of carbon sequestration. To compensate the loss of carbon sequestration, new plants should be grown and this study details about the amount of carbon sequestration lost and obtained because of the infrastructure development. The current study clearly explains that there climate change is significant because of the reduction of trees with reference to carbon sequestration at Coimbatore during the period 2015 to 2019. Also, evidence with respect to meteorological data and online survey was taken as reference to justify the result that there is change in the climate. Land provisions for Urban forestry, vertical gardening in flyovers need to be incorporated to maintain the future climate change to promote healthy environmental conditions.

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