An intensive online survey of climate change due to development of roads and bridges on the highway road at Coimbatore – an evidence

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Abstract. Climate change plays a major role in global warming. Coimbatore is a city with equal distribution of industrial and agricultural development and is fully surrounded with greenery in the past. Due to the increase in population and development of industries, development of infrastructural facilities for transportation becomes necessary. When compared to other districts, most of the human population make use of their own vehicles. The net result of industrialization in Coimbatore is the growth in infrastructure, ease in access to different places at reduced time with loss in trees. In this study, it was found that more trees were cut down in the past five years of period which causes reduced rainfall, increased air and soil temperature, increased pollutant gases. Because of these changes, there exists a decrease in underground water level and the quality of the air becomes poor. Hence, an online survey was conducted to validate the results obtained through meteorological data to obtain the actual outcome. Opinion poll was conducted in person and through online at Coimbatore to get the actual feedback from the public audience to mitigate the change in climate.
1. Introduction

The economic and social development of a country depends on the growth of cities in each State. This growth is mainly due to the industrial development and as a result, it leads to the increase in population. As per the author Sabrina Deckker [6], flow of population in the urban center is mainly driven by the climate change. The book clearly explains the contribution of local governments in taking up their role in addressing the climate change, develop a policy that governs the climate change and restructure the planning based on the suggestions obtained from multiple stakeholders, identify the barriers or challenges enforced during Urban policy making, process the implementation plans that connect the theoretical idea with actual scenario. The book addresses the key climate change issues faced by the cities and the role that the cities play in response to the climate change. Coimbatore is one of the most technologically developed cities in Tamil Nadu, has more than 25,000 small, medium, large scale industries and textile mills [1]. The total population of Coimbatore statistics census of 2011 is 34,58,045 [2] and the expected population would be 4.1 million by 2031 [5]. Vehicles produce large amount of pollutant gases to the environment, especially CO₂ gas. Even though the CO₂ increased in environment, we can recover the consequences by trees, but trees are very less in highways, so there is a considerable rise in temperature.

2. Review of literature

The study of climatic conditions with infrastructural developments, disaster management, transportation, economic conditions etc. has been made by different authors and is explained. Schweikert A, Chinowsky P, Espinet X, and Tarbert M [4] studies initially focused the climate change on the road infrastructure with reference to the developing and developed countries. Climate change imposed severe cost impacts in terms of repair and maintenance, connectivity loss etc. But this may be reduced or mitigated by pro-active adaptation measures. To protect the existing infrastructure and future ones, the model focuses on the impacts of the built environment to the changes in the climatic variables such as rainfall, wind speed, relative humidity, and air and soil temperature. Broto V C and Bulkeley H [3] examined where and when urban climate change occur. They also examined the experiments, the follow-up of initiatives and how they are directed. The authors [7] discussed on the correlation between various meteorological parameters, and the level of gaseous contents in the atmosphere. The results explicitly describes that the level of ozone concentration was higher in the urban environments, major changes in temperature and relative humidity has been observed in the month of May, and more fluctuation in the rainfall during the month of August. The reason for higher ozone level may be due to the increase in the vehicles as a result of development of Highway Roads and other Infrastructures. The correlation of monthly average ozone concentration with temperature shows negative correlation, methane and NO₂ shows a negative correlation with ozone whereas highest positive correlation was observed with temperature.
3. **Methodology**

3.1. **Study design**

The main objectives of study is to conduct a survey, to account for the number of State and National Highway roads laid and bridges built in and around Coimbatore city, to account for the number of trees cut down due to this infrastructural development, to study the variation of temperature, humidity and other parameters due to the decrease in the number of trees and has been addressed by Thenmozhi et.al. [10]. The survey questionnaire is based on the following research questions. They are:

1. The level of awareness to public and politicians about global warming
2. The attitudes of educators, student community, public, politicians and social workers towards the cause?
3. Suggestions or suitable measures that helps to avoid the destruction of trees as a cause of infrastructural development due to globalization
4. Suggestions to mitigate the problems in the eco system that occur due to modernization and globalization
5. Feedback on the impact and solution of building these structures on to the climatic changes?

3.2. **Research Methodology**

The research questions 1 and 2, will be an objective type of questionnaire and for 3 and 4 it will be a descriptive design, research question 5 will follow an experimental design along with the online feedback. The respondents expected are educators, student community, industry persons, politicians, and social workers inclusive of NGOs, farmers and other public people left out in the list.

3.2.1. **Sampling design:** Sample population to be taken are students, faculty of various Engineering, Management, Arts and science colleges, schools, public, people involved in industries etc. The sample size of the design structure would be based on the online survey. The descriptive type of questions will be either a group discussion which includes all the above said category of people or a written survey with the people who responds to it. This group need not be the same group and have the same number of respondents as said in sample design 1. The experimental type of questions or design contest would be devised with a small peer group of 10 to a maximum of 100 people who could suggest the real time solution for this problem statement. This could also be collected from Spokesman and people who work on this for a long time in the field.

3.2.2. **Workflow:** The prime objective is to conduct a survey on infrastructure development on climate change. For this, areas in and around the Coimbatore city has been taken for the study mainly Pollachi road, Avinashi road, Mettupalayam road and other areas of Coimbatore. Primary data used for the study is the online questionnaire prepared. This is collected by using questionnaires, which is of objective type and descriptive type. The respondents are those people described in the research methodology. The sample size of
the design structure would be based on the online survey. Literature survey was made, and a questionnaire was prepared based on the literature survey. Secondary data related to roads and bridges, trees cut down are gathered from the Highways department and National Highway Authority of India, submitting RTI (Right to Information) through online portal of Central Government of India. Similarly, the data base gathered from online survey, has fifty-one questions, related to level of awareness among the selected population as well as the solution to mitigate the current issues and the process is described in the work flow as shown in ‘figure 1’.

Figure 1. Methodology of study
4. **Results and discussion:**

*Figure 2.* Piechart of survey sample size and feedback on awareness on climate change

The sample size responded to the survey has been described in ‘figure 2’ as shown above and the awareness level on the climate change people in table 1.

**Table 1.** Knowledge of awareness about the climate change and Global warming among the population measured by their self

| Knowledge of awareness | Frequency (No. of samples) | Percent | Valid Percent | Cumulative Percent |
|------------------------|---------------------------|---------|---------------|--------------------|
| I. not at all          | 9                         | 8.2     | 8.2           | 8.2                |
| II. very less          | 9                         | 8.2     | 8.2           | 16.4               |
| III. Moderate          | 64                        | 58.2    | 58.2          | 74.5               |
| IV. very High          | 18                        | 16.4    | 16.4          | 90.9               |
| V. Extremely high      | 10                        | 9.1     | 9.1           | 100.0              |

**Table 2.** Multiple correlation - between the rainfall, pollution, temperature, economic decline human health and the climate change.

| Factors/variables (%) | Rainfall (A) | Pollution (B) | Temperature (C) | Economic decline (D) | Human health (E) |
|-----------------------|--------------|---------------|------------------|----------------------|------------------|
| Rainfall              | 1            | 0.65881       | 0.672495         | 0.304253             | 0.498248         |
| Pollution             | 0.65881      | 1             | 0.675209         | 0.431867             | 0.579894         |
| Temperature           | 0.672495     | 0.675209      | 1                | 0.259455             | 0.566922         |
| Economic decline      | 0.304253     | 0.431867      | 0.259455         | 1                    | 0.424458         |
| Human health          | 0.498248     | 0.579894      | 0.566922         | 0.424458             | 1                |
The current survey implies that, the population of Coimbatore can sense the changes in climate. There is relation between rainfall, pollution, temperature, economic decline, human health with the climate change, which is shown in table 2 statistical view of multiple correlation. This addresses the correlation of all the variables like rainfall, pollution, temperature, economic decline and human health with one another. The correlation between pollution and rainfall is about 0.6588%. Similarly, 0.67 and 0.675 percent of positive correlation exists between temperature and rainfall, temperature with pollution which confirms with the increase in climate change and global warming. There exists a least correlation among economic decline and rainfall. From the table 2, the inference obtained is that the temperature increases with increase in pollution. ‘Figure 3’ represents the impact of infrastructure development on change on climate and the target audience responsible while the creating an awareness on climate.

Figure 3. Survey on change in climate and target audience for raising awareness about resilient and Eco-friendly infrastructure development

‘Figure 4’ represents the suggestions on sustainable infrastructure development and the effectiveness of adaptation measures taken currently or in future are to be monitored and evaluated. It has to be monitored on a regular intervals. The major reason for global warming is Climate Change Adaptation (CCA). The Alternative actions can be considered as incremental adaptation. Resilience infrastructure has not been implemented as per the survey, and has to be implemented at a faster rate in near future. Most of the responses state that, no adaptations are being undertaken/planned relevant to decreasing or controlling the temperature.

In this study, it is found that around 4262 trees [8-9] are being cut down during the study period since 2015 which causes reduced rainfall, increased air and soil temperature, increased pollutant gases which matches with the meteorological data obtained [10]. Around 42.73% of the population gave suggestion to plant trees on the sides or in the middle wherever possible to mitigate the current issues. Suggestions for growing high oxygen producing plants within the infrastructure to reduce greenhouse gases as well provision for renewable energy sources on the flyovers are to be provided for lighting and other purposes.
5. Conclusion
The intensive study reports that the meteorological data complies with that of the survey and there is a considerable climate change in Coimbatore due to the infrastructural developments. Also, most of the people at Coimbatore has moderate level of awareness related to climate change. Hence adaptions like organizing sensitization programs, promoting tree plantation camps, providing publicity through social media, development of App for updates on climate change and exploitation of trees etc., to be created for promoting the awareness among the public. Creating awareness is mandatory but execution and providing solution for the current issue is the most important one. Saving indigenous trees and planting new trees which are suitable for that particular location are to be made in the reserve sites on individual area to save the globe.

Acknowledgement
This work is being carried out under ICSSR Minor Research project grant 2019-2020. The authors wish to acknowledge ICSSR for the funding to carry out the minor project.

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