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Management of Ecological Balance

A study of Bangalore University Campus

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Abstract

This research study was conducted to find out if Bangalore University is carbon positive, neutral or negative when it comes to sequestering emissions generated by consumption of electricity. The study was done due to the increasing concerns of people about the changes in climate and the increased levels of carbon emissions which is polluting our surroundings. This field work study was conducted inside the boundaries of Bangalore University. Data was collected regarding electricity from the engineering department of Bangalore University and all the parameters required to calculate the carbon sequestered was collected during the field work. The small difference between the amount of carbon emitted and sequestered is a major concern and steps should be taken to ensure that the amount of carbon sequestered increases. More green spaces should be created and felling of trees should be reduced. Further research is required to take into account the various other emissions which are caused by vehicles, use of building materials and so on.

INTRODUCTION

In our vast universe, the splendid spaceship - the only living planet, Earth is covered by a thin layer made of life-supporting essentials: - oxygen, nitrogen, carbon dioxide, argon, and water vapour. This finely balanced mixture of components is established and balanced by the life cycles of plants, animals, and microbes. Carbon, hydrogen, and oxygen are primarily essential to sustain life on Earth. Over millions of years, dynamic processes occurred in nature, both physically and chemically and came to a stage where the environment was favourable for life to begin on Earth. But only we human beings tried to modify the environment to fulfil our needs. Advancements in technology and industrialization lead to serious disturbance in the ecological balance.

OBJECTIVE

In this research, we are aiming to find out the amount of carbon being emitted in kgs of Carbon dioxide (CO_2) by the consumption of electricity in Bangalore University Campus. We will also calculate the carbon sequestered by the trees of Bangalore University. We will then compare the carbon sequestered and carbon emitted to find whether Bangalore University is carbon negative, neutral or positive i.e. the carbon emissions are less than the carbon sequestered, the carbon emissions are equal to the carbon sequestered or the carbon emissions are more than the carbon sequestered respectively. We being students of economics and studying in Bangalore University Campus understand the need to protect our Earth and this study is necessary to find if the environment we are studying in is carbon neutral. If not, the necessary steps can be taken to make this place environmentally healthy. With the increasing pollution that is affecting the wellbeing of our Earth, this research becomes important to ensure that the environment is a better place for our future generations. We need to take account of these emissions and make efforts to reduce them.

DATA COLLECTION

To find the carbon emissions we require the electricity consumption of Bangalore University and to find the carbon sequestered we need measurements of the tree height and diameter. We obtained the electricity bill from the engineering department which had the units of electricity used by the whole of Bangalore University Campus in a month. The heights and diameters of trees were taken in areas demarcated inside Bangalore University.

MODEL

In this research the following assumptions are considered to simplify economic processes and to make them easier to understand.

Assumptions:

1) There are two types of emissions namely one time and recurring emissions. Electricity is a recurring emission and the only factor that is considered in this research report. Other emissions caused by usage of steel, cement, water is kept constant.

2) ρ in all calculations is the same i.e. the mean of wood densities of all Indian tree species is used in finding the above ground biomass. Above ground biomass (AGB) is used to find the amount of carbon sequestered by trees and is explained further in the next paragraph.

3) The height used in the above ground biomass formula measured using Tree-H app is accurate and the measurement is taken from the base of the tree to the tip of the canopy.

4) We assume that electricity consumed every month is nearly the same. We have also considered that there are no heavy electrical appliances used or newly installed in Bangalore University over the past year which may alter the monthly electricity consumption.

5) We assume that calculations of carbon emissions per kWh of electricity done using online calculator developed by 'Energy Efficiency and Conservation Authority' are accurate for per kWh of electricity consumed in India.

6) Bangalore University campus has been prey to forest fires, grazing and firewood collection. This is bringing down the average age of trees. So, to take this into account, we assume that the trees in Bangalore University are 10 years on an average.

Electricity is generated by burning fossil fuels mostly coal and when coal is burnt a lot of carbon is emitted. For every tonne of coal burned, approximately 2.5 tonnes of CO_2 are produced. When this electricity is used to run various appliances again carbon is emitted. The more the electricity is consumed, the more the electricity is generated and more fossil fuels are burnt which in turn emit carbon. The electricity bill from the engineering department which had the units of electricity used by the whole of Bangalore University Campus in a month was extrapolated for a year. Five 50 m*50 m plots were demarcated in unbuilt areas right opposite to built areas in Bangalore University Campus. Seven 400m stretches were demarcated along each road of Bangalore University Campus. Two parameters were taken into consideration while measuring the trees, Girth at Breast Height (GBH) and Height of the trees. Girth at breast height is the circumference of the tree at 1.37m from the ground level. The heights of trees were measured using an app named 'Tree-H'. The lengths of road in Bangalore University Campus were measured using an odometer and the seven linear stretches' values will be extrapolated to the total road length. The total area of Bangalore University was found using ISRO's geoportal 'Bhuvan'. Then, we put down all the data measured and collected into an excel sheet. Using a formula of Above Ground Biomass (AGB) from 'Tree allometry and improved estimation of carbon stocks and balance in tropical forests'[i], the total AGB for each of the stretches and plots were calculated. AGB is all living biomass above the soil including stem, stump, branches, bark, seeds and foliage. The formula used for 'dry forest stands' is:

$$AGB = 0.112 * (\rho * D\hat{}2 * H) \hat{} 0.916$$

Where, is the wood density; D & H are diameter at breast height and height of tree respectively.

Diameter is extracted from GBH by dividing GBH by π[ii]. ρ is calculated as the mean of wood densities of all tree species found in India.[iii]. Wood density is the ration of the oven-dry mass of a wood sample divided by the mass of water displaced by its green volume. Height and diameter are calculated in meters. Wood density is measured in kg/m^3.

After that, the values obtained from these calculations are extrapolated to the total area of Bangalore University Campus. Since the linear stretches were measured only along one side of the road the values are multiplied by a factor of two to include the trees on either side of the road. The five 50 m*50 m plot values are extrapolated to the total area of Bangalore University Campus.

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[i] *J. Chave, C. Andalo, S. Brown, M. A. Cairns, J. Q. Chambers, D. Eamus, H. Fo¨ lster, F. Fromard, N. Higuchi, T. Kira, J.-P. Lescure, B. W. Nelson, H. Ogawa, H. Puig, B. Rie´ ra, T. Yamakura: 'Tree allometry and improved estimation of carbon stocks and balance in tropical forests'*

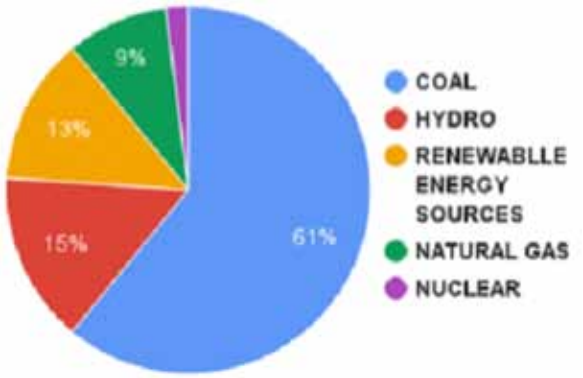
[ii] π*=3.1416 in all calculations*

[iii] *https://en.wikipedia.org/wiki/List_of_Indian_timber_trees*

Lastly, the carbon emissions generated by electricity in Bangalore University Campus was calculated using CO_2 emission calculator developed by Energy Efficiency and Conservation Authority.[iv]

The calculations and results are divided into three sections, the first section containing the calculations of carbon emissions, the second containing the calculations of carbon sequestered and the last section contains the results. They have been divided into sections for better understanding.

SECTION-I



In India, electricity is consumed round the clock. There are various sources of electricity of which coal is the most important source. Bangalore University is a campus spread over an area of 4.85 km^2[v]. To run such a huge establishment a lot of electricity is required.

Electricity Consumption

Figure-1 shows the electricity consumption in kWh of Bangalore University in the month of March. Figure-2 shows the CO_2 emission calculated values for electricity consumed in one month.

1) The total electricity consumed in one month is the sum of the readings coming under the consumption column in Figure-1: (29410+53935+40370+68090) = 1,91,805 kWh
2) The electricity consumed in one year is:
   191805 * 12 = 23,01,660 kWh
3) CO2 emission levels for one month is:
   24.69 tonnes of CO_2/24690 kgs of CO_2
4) CO_2 emission levels for one year is:

296.22 tonnes of CO_2/296220 kgs of CO_2

SECTION-II

Total area of Bangalore University = 4.85 km^2

Total road length of all roads in Bangalore University = 9 km

5 block plots measured = 5*(50*50 m) =12500 m^2 = 0.0125 km^2

7 linear stretches measured = 7*400 m = 2800 m

=2.8 km

Rho = 820.2857143 kg/m^3

Sum L = 57447.78491 kgs of CO_2

Sum B = 15964.73348 kgs of CO_2

Sum L and Sum B are the Total AGB of all linear stretches s and Total AGB of all 50m*50m block plots respectively.

47% of AGB is Carbon sequestered by trees.

The trees are 10 years old, so 47% of AGB is carbon sequestered by trees spread over 10 years.

To bring this value to that of one year we divide the total carbon sequestered by 10.

Carbon Sequestered

Sum L is Total AGB of trees over 2.8 km, then carbon sequestered by trees over 9 km:

= [0.47*[(57447.78491*9)/2.8]]/10

= 8678.718934 kgs of CO_2

Sum B is Total AGB of trees over 0.0125 km^2, then carbon sequestered by trees over 4.85 km^2 :

= [0.47*[(15964.73348*4.85)/0.0125]]/10

=291132.8798 kgs of CO_2

Total Carbon sequestered

= 8678.718934 + 291132.8798

=299811.5988 kgs of CO_2

[iv] *https://www.eecabusiness.govt.nz/tools/wood-energy-calculators/co2-emission-calculator/*

[v] *Calculated using area mapping tools in ISRO's Geoportal 'Bhuvan'. https://bhuvan-app1.nrsc.gov.in/bhuvan2d/bhuvan/bhuvan2d.php#*

SECTION-III

Carbon Emitted	Carbon sequestered
296220 kgs of CO_2	299811.5988 kgs of CO_2

Carbon sequestered is 1.012 times the carbon emitted thus; Bangalore University is Carbon negative i.e. the amount of carbon emitted is less than the amount of carbon sequestered.

CS-CE = 299811.5988 -296220

= 3591.598752 kgs of CO_2

We humans have been guilty of 'ecocide'. So finally, the life-supporting carbon dioxide has become a poisoning component in the atmosphere. But due to the large number of trees in Bangalore University, the campus has not fallen prey to the carbon emissions which is destroying the environment. It is high time to rescue our planet from global warming and climatic change. Not deforestation but afforestation can sequester carbon in the environment.

RECOMMENDATIONS

1) Prevention of cattle grazing and forest fires increases the biomass of grasses which per year is greater than the amount of carbon sequestered by trees.
2) If forest fires are prevented regeneration of saplings from fallen leaves increases multi-fold.
3) Decrease in tree felling will increase sequestration.
4) Reforesting with tree species which are indigenous to scrub and dry deciduous forests shall enhance the biodiversity which is critical for the health of the Bangalore University forest.

MANAGEMENT OF ECOLOGICAL BALANCE

There are two ways to maintain ecological balance:

i) Minimisation of consumption of electricity generated by fossil fuels and switching to other renewable resources such as:
   a) Installation of solar panels.
   b) Use of solar batteries when the panel is not in use.
   c) Installation of Automatic sensors which switch on and off appliances as when required both in indoors and outdoors.
   d) Setting up of hydro-electric plants (one plant for a group of five departments) which are run on harvested rain water.

ii) Maximisation of biomass in Bangalore University Campus by planting seeds of grasses because grasses can sequester huge proportion of carbon emitted. Trees with high biomass which grow fast can also be planted. Such as:
   a) *Melia dubia* - Neem
   b) *Terminalia catappa* – Indian almond
   c) *Muntingia calabura* – Cherry tree
   d) *Gmelina arborea* – White teak
   e) *Aesculus hippocastanum* – European Horse chestnut
   f) *Solanum tuberosum* – Potato
   g) *Bambusoideae* – Bamboo
   h) *Panicum virgatum* – Switchgrass
   i) *Miscanthus* – Silvergrass

LIMITATIONS

This study has two limitations: 1.Only one type of emission is considered i.e. the emissions from electricity consumption & 2.The study site is limited to Bangalore University campus.

FUTURE STUDY

There is scope to continue this research further by considering various other parameters. There are two types of emissions namely one-time emissions and recurring emissions. One-time emissions are emitted from those resources that are used only once for e.g.: steel, cement, sand etc. Recurring emissions are those emitted from resources which are used repeatedly for e.g. Water, petrol etc. The emissions from these sources can also be included to extend this study.

The study site in this paper is limited to the boundaries of BU and can be extended beyond BU. There are a lot of vehicles which passes through BU every day and these vehicular emissions can be taken into account for further study.

To calculate carbon sequestered the carbon offset by fallen leaves and roots of the trees can also be calculated in future study.

DISCUSSION

Vehicular emissions are the main sources of carbon emission in today's age. As the vehicles traversing on the road increases day by day so does the emissions.

If a person has to travel 300 km the various transportation modes are car, bus, train, and aeroplane.

The kg of CO_2 emitted per unit of consumption is[vi]:

For petrol = 2.31 kg of CO_2

For diesel = 2.68 kg of CO_2

So, emission per person is:

By Car: 18 litres of petrol required, 4 people can travel.

18*2.31= 42

42/4 = 10.5 kg of CO_2 per person

By Bus: 75 litres of diesel required, 40 people can travel.

75*2.68 = 201

201/40 = 5.025 kg of CO_2 per person

By Train: 1500 litres of diesel required, 1950 people can travel.

1500*2.68 = 4020

4020/1950 = 2.06 kg of CO_2 per person

By Airplane:

0.18 kg of CO_2 per person per km is required.

0.18*300 = 54 kg of CO_2 per person

These above calculations show that the Carbon emissions from airplane is the highest followed by car, bus and the least carbon emitter train. Thus, it is advised to reduce travelling by plane and shift to trains to decrease vehicular carbon emissions.

CONCLUSION

Bangalore University is home to a rich variety of flora. With the increased carbon emissions, Bangalore University is a heaven for people who are tired of the pollution.

But for the past few years a lot of vehicles have started using the roads of Bangalore University to escape traffic and this has polluted Bangalore University. Thanks to the numerous species of trees in Bangalore University these emissions are offset. Bangalore University is carbon negative i.e. the amount of carbon sequestered by the trees in this region is more than the amount of carbon being emitted. More such green spaces are required to avoid a catastrophic climate change. Change starts at the individual level. Thus, more people should involve themselves in creating green spaces in their own homes and localities. People should turn into either carbon neutral or carbon negative to maintain a balance in the environment. Inhabitants of planet Earth should change their lifestyle towards an environmentally friendly approach.

As Mahatma Gandhi once said, "The earth, the air, the land and the water are not an inheritance from our forefathers but on loan from our children. So, we have to hand over to them at least as it was handed over to us." Give our next generation the gift of Nature!

APPENDIX

Figure-1: Bangalore University electricity consumption in March 2019.

TOD meter readings for meter ID 1815464576

Time Zone	Name of the Zone	Present Readings	Previous Readings	Consumption	MD Reading
06:00 Hrs to 10:00 Hrs	Morning Peak	29410	44350	29410	402.6
10:00 Hrs to 18:00 Hrs	Normal	53935	95080	53935	508.4
18:00 Hrs to 22:00 Hrs	On Peak	40370	44395	40370	456.8
22:00 Hrs to 06:00 Hrs	Off Peak	68090	72645	68090	409.8

Figure-2: CO_2 emission values calculated using the EECA calculator for one month

[vi] *These values are taken from the following website: https://people.exeter.ac.uk/TWDavies/energy_conversion/Calculation%20of%20CO2%20emissions%20from%20fuels.htm*