Journal of Interdisciplinary Science Topics

The Carbon Footprint of Travelling to Each Capital City By Aeroplane

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03/04/2023

Abstract
The desire to travel and discover new parts of the world has become easier to fulfil as globalism has allowed the world to be more connected than ever. The easiest way to do this is via aeroplane however this does come with a cost. Aeroplanes burn fossil fuels and hence they contribute to the CO_2 increase in the atmosphere. Here we will calculate the size of the carbon footprint of someone who goes to every country's capital in the world by aeroplane. I also calculate how much it would cost and how many trees would need to be planted to offset the carbon footprint.

Introduction
For a long time I have wanted to visit every country in the world. This can be done through a range of different ways from boat, trains to aeroplanes. The easiest and quickest way is through aeroplanes that are readily available and capable of taking you anywhere in the world that has an airport. However, air travel does have its consequences. Around 2.4% of the global CO_2 emissions come from aviation [1]. Planes burn fossil fuels emitting greenhouse gases of carbon dioxide, water vapours, nitrogen oxide and carbon monoxide. What's worse is that planes emit gases at higher levels in the atmosphere [2]. It has been calculated that planes emit 100 times more CO_2 per hour compared to buses and trains. That's around 1 billion tonnes a year which is even more than Germany. Air pollution from planes is responsible for 16,000 premature deaths a year [3].

UN countries
There is debate about whether some places are classified as countries or not and it can be a highly political issue. Some accounts suggest that there are 195 countries but for some the number is as high as 204. The countries and capital cities that were used to analyse the carbon footprint were taken from the UN that states there are 195 countries in the world [4].

With greenhouse emissions still raising and the effects of climate change becoming more prominent, it is important that we are aware of our carbon footprint and the impact we have on the environment around us. That is why I have calculated what my carbon footprint would be if I wanted to carry out my plan of visiting every country in the world. To make some the calculation easier I have assumed that I would be flying to each city instead of using different modes of transport.

Carbon offsetting
Carbon offsetting is the removal of emissions to compensate for the emissions produced. So in this case trees would be planted to offset the carbon made from the aeroplanes. Here we used the website clear.eco to calculate the carbon offset my flight from London Heathrow to each capital cities airport [5]. We measured the carbon in tCO_2e and we also calculated the supposed cost of offsetting the carbon. This was also done for the return flights. The $tCO2e$ is calculated through mathematical models that use the distance of the flights by using the Great Circle calculations between airport coordinates. The website uses QAS recommended RF1 values of 1.9 and 8% followed by the average efficiency of flights using the international emissions factors[6]. The tCO_2e is the carbon dioxide equivalent so this considers of other greenhouse gases. The total offset

was 356.88 tCO_2e. Some countries like Andorra values for carbon offset was not able to be found. The website also calculates how much it would cost to offset your carbon, so this was also included. This was calculated on an Excel sheet (see Appendix A). It cost £6776.88 to offset. Therefore if I wanted to pay this off on my current wage of £7/hr it would take:

$$\frac{6776.88}{7} = 968.13 \; hours.$$

Which would mean I work:

$$\frac{968.13}{52} = 18.62 \; hours \; a \; week.$$

This does not include buying tickets for flights themselves therefore carrying out my ambition of going to every capital city in the world is not only bad for the environment it is highly expensive.

The country with the highest CO_2 offset was New Zealand with a score of 2.94 and the country with the lowest was France with 0.08 which was surprising smaller than Belfast in Ireland.

How many trees?
Trees are a great way of offsetting carbon as trees absorb carbon through their leaves that is why I calculated how many trees would be needed to offset my carbon and greenhouse emissions.

According to Tree's for life 6 trees account for 1 tonne of CO_2 therefore 1 tree is 0.16 tonnes of CO_2 [7]. So, to calculate how many trees are needed you do:

$$\frac{356.88}{0.16} = 2231 \; trees.$$

Assuming that for a tree to grow a space is needed of $8 \; m^2$, as it is recommend trees are planted two metres away from each other, you would need [8]:

$$2231 \times 8 = 17844 \; m^2,$$

which is equivalent to approximately size of two and a half football pitches.

Eco friendly flights
One of the most damaging non-carbon consequences of flights are contrails which is the condensation from the planes. These only form in narrow atmosphere bands where the weather is cold and humid. It has been suggested that avoiding these could reduce the likelihood of these forming. The EU's aviation authority EUROCONTROL has started trails on contrails avoidance project. Research suggests that using biofuels may cut pollution by 60% depending upon where the biofuel is sourced. Another suggestion would be following the same suit as cars by going electric. One disadvantage of this is that so far they have only been able to do short haul flights [9].

Conclusion
Overall to carry out my wish of visiting every country in the world via aeroplane it will have a very damaging impact on the environment, and it would greatly increase my carbon footprint. To offset my carbon footprint would also be highly expensive and would take over 2231 trees. Therefore, if I were to carry out my plan of going to every country I should try to minimise my aeroplane usage in favour of more eco-friendly options like making use of ferries and trains.

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Appendix A

Name	CO_2	Cost (£)	Name	CO_2	Cost (£)
Albania	0.29	5.52	Malawi	1.24	23.63
Algeria	0.25	4.83	Malaysia	1.65	31.42
Andorra	?	?	Maldives	1.33	25.3
Angola	1.06	20.14	Mali	0.68	12.98
Antigua and Barbuda	1.07	20.25	Malta	0.33	6.23
Argentina	1.36	25.83	Mauritania	0.61	11.65
Armenia	0.57	10.76	Mauritius	1.53	28.99
Australia	2.65	50.4	Mexico	1.39	26.38
Azerbaijan	0.62	11.86	Moldova	0.34	6.46
Bahrain	1.58	30.03	Monaco	0.08	1.59
Bangladesh	1.24	23.64	Mongolia	0.94	17.9
Barbados	1.06	20.11	Montenegro	0.28	5.33
Belarus	0.29	5.51	Morocco	0.31	5.93
Belgium	0.09	1.64	Mozambique	1.43	27.23
Belize	1.3	24.72	Myanmar	1.3	24.63
Benin	0.7	13.32	Namibia	1.31	24.91
Bhutan	1.21	22.9	Nepal	1.15	21.81
Bolivia	1.57	29.73	Netherlands	0.1	1.92
Bosnia and Herzegovina	0.26	4.85	Nicaragua	1.35	25.66
Botswana	1.38	26.19	Niger	0.66	12.54
Brazil	1.37	26.02	Nigeria	0.74	14.15
Brunei	1.76	33.43	North Korea	1.35	25.65
Bulgaria	0.32	6.05	North Macedonia	0.31	5.86
Burkina Faso	0.68	12.89	Norway	0.18	3.45
Burundi	1.05	19.89	Oman	0.91	17.28
Cabo Verde	0.71	13.49	Pakistan	0.94	17.94
Cambodia	1.57	29.74	Panama	1.32	25.05
Cameroon	0.85	16.08	Paraguay	1.59	30.16
Canada	0.83	15.78	Peru	1.58	30.07
Central African Republic	0.86	16.36	Philippines	1.68	31.9
Chad	0.72	13.61	Poland	0.23	4.35
Chile	1.82	34.53	Portugal	0.24	4.63
China	1.27	24.21	Qatar	0.82	15.52
Colombia	1.32	25.11	Romania	0.33	6.25
Comoros	1.27	24.2	Russia	0.4	7.56
Congo	0.99	18.88	Rwanda	1.03	19.57
Costa Rica	1.36	25.8	Saint Kitts and Nevis	1.03	19.56
Côte d'Ivoire	0.78	14.74	Saint Lucia	1.06	20.05
Croatia	0.21	4.05	Saint Vincent and the Grenadines	1.07	20.31
Cuba	1.17	22.07	San Marino (No airport, use Italy's)	0	0
Cyprus	0.51	9.62	Sao Tome & Principe	0.87	16.55
Czech Republic	0.16	3.09	Saudi Arabia	0.77	14.64
Denmark	0.27	5.07	Senegal	0.68	12.91
Djibouti	0.92	17.54	Serbia	0.27	5.04
Dominica	1.04	19.74	Seychelles	1.28	24.22
Dominican Republic	1.09	20.74	Sierra Leone	0.77	14.53
DR Congo	0.88	16.63	Singapore	1.7	32.25
Ecuador	1.43	27.21	Slovakia	0.21	3.9
Egypt	0.55	10.47	Slovenia	0.19	3.66

El Salvador	1.36	25.91	Somalia	1.08	20.59
Equatorial Guinea	0.84	15.92	South Africa	1.51	28.68
Eritrea	0.83	15.77	South Korea	1.38	26.27
Estonia	0.28	5.36	South Sudan	0.93	17.68
Eswatini	1.44	27.3	Spain	0.2	3.73
Ethiopia	0.92	17.54	Sri Lanka	1.38	26.14
Finland	0.29	5.48	State of Palestine	0.56	10.71
France	0.08	1.59	Sudan	0.77	14.66
French Guiana	1.1	20.87	Suriname	1.11	21.11
Gabon	0.9	17.03	Sweden	0.23	4.33
Gambia	0.7	13.28	Switzerland	0.21	3.98
Georgia	0.56	10.59	Syria	0.56	10.61
Germany	0.26	4.99	Taiwan	1.53	28.99
Ghana	0.8	15.11	Tajikistan	0.85	16.05
Gibraltar	0.27	5.18	Tanzania	1.14	21.56
Greece	0.38	7.19	Thailand	1.49	28.38
Grenada	1.09	20.73	The Bahamas	1.1	20.82
Guatemala	1.37	25.92	Timor-Leste	2.06	39.21
Guinea	0.75	14.25	Togo	0.79	14.93
Guinea-Bissau	0.72	13.66	Trinidad and Tobago	1.11	21.01
Guyana	1.13	21.39	Tunisia	0.32	6.04
Haiti	1.1	20.88	Turkey	0.44	8.42
Honduras	1.34	25.34	Turkmenistan	0.74	14.05
Hong Kong	1.51	28.58	Uganda	1.01	19.25
Hungary	0.23	4.41	Ukraine	0.33	6.31
Iceland	0.29	5.57	United Arab Emirates	0.86	16.35
India	1.13	21.37	United Kingdom	0	0
Indonesia	1.83	34.73	United States	0.91	17.28
Iran	0.69	13.1	Uruguay	1.72	32.64
Iraq	0.64	12.17	Uzbekistan	0.82	15.59
Ireland	0.12	2.33	Venezuela	1.17	22.13
Israel	0.56	10.59	Vietnam	1.44	27.37
Italy	0.23	4.33	Western Sahara	0.45	8.62
Jamaica	1.17	22.27	Yemen	0.88	16.65
Japan	1.5	28.42	Zambia	1.24	23.52
Jordan	0.57	10.85	Zimbabwe	1.3	24.6
Kazakhstan	0.62	11.68	Afghanistan	0.89	16.98
Kenya	1.07	20.27	Austria	0.2	3.78
Kuwait	2.22	42.41	New Zealand	2.94	55.79
Kyrgyzstan	0.85	16.24	Papa new guenie	2.26	42.95
Laos	1.45	27.61	Samoa	2.46	46.69
Latvia	0.26	5.01	Solomon islands	2.34	44.49
Lebanon	0.54	10.32	Tuvalu	2.38	45.15
Lesotho	1.47	27.87	Vatican city	0.23	4.33
Liberia	0.8	15.15	Vanuatu	2.52	47.8
Libya	0.37	6.95			
Liechtenstein	0.27	5.17	**Total one way**	**178.44**	**3388.44**
Lithuania	0.27	5.17	**Total return**	**356.88**	**6776.88**
Luxembourg	0.14	2.66			
Madagascar	1.42	26.94			