Air travel in academia and its external costs

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Despite scientists being at the forefront in warning against climate change, flying to conferences or visiting projects is a key part of their work. Mapping flight data from a German-Indonesian research project shows that about 70 researchers flew 240 times around the world within only five years. Internalizing the associated environmental damages into the project budget would require an additional 20 percent for travel costs. Solutions to reducing researchers' carbon emissions are readily available, but require a cultural shift in academia.

Aeromobility in academia is omnipresent and environmentally harmful

Air traveling is ubiquitous in academia, especially in international research collaborations. While research exchange is deemed important for capacity building, disseminating knowledge, and tackling international challenges, the inherent air traveling contributes to climate change via greenhouse gas emissions and causes external costs. These costs can be assessed by calculating the social cost of carbon (SCC), i.e. the monetized future damages caused by emitting one ton of carbon dioxide (CO_2) or its equivalent today. The SCC is intended to include detrimental changes in human health, loss of agricultural productivity, property damages from increased flood risk, and other harms.

How to quantify the external costs of academic jet-setting

Although scientists have warned for decades against climate change, their efforts to transparently communicate travel data and to quantify associated external costs are rare. To better understand the SCC of air travel in academia, we consider an example: The German-Indonesian research collaboration "Ecological and Socioeconomic Functions of Tropical Lowland Rainforest Transformation Systems (Sumatra, Indonesia)" including one German and three Indonesian Universities.

Figure 1: Flights within a German-Indonesian research project (2013-2017)

Notes: The figure shows 442 business trips starting in Göttingen. The thickness of lines represents the number of flights.

In particular, these considerations include all project-related trips for about 70 researchers affiliated to the University of Göttingen (Germany) from 2013-2017. The data include the time frame and the destination (city or country) of each trip. Distances are measured via *google maps*. All journeys exceeding a distance of 800 km from Göttingen to the destination are assumed to be flights. Most of these 442 trips are outward and return flights between Germany and Indonesia due to project-related retreats or field work in Indonesia. The remaining project-related travel was mostly for participating in academic conferences around the globe. All of the trips are displayed in Figure 1.[1] As shown in Table 1, the overall distance covered within these 5 years was about 10 million km or approximately 240 trips around the world.

The greenhouse gas emissions caused by air traveling include CO_2 emissions from burning kerosene and non-CO_2 warming effects emitted from planes in high altitudes.[2] Here, the 10 million km of air traveling

[1] It was not possible to reconstruct domestic flights and stops and thus all flights are assumed to be direct flights. Therefore, the calculated distances as well as the estimated emissions and SCC are lower bounds.

[2] The greenhouse gas emissions are calculated assuming an average kerosene consumption per passenger of 0.0306 l/km (Girardet and Spinler, 2013) and CO_2 emissions per liter kerosene of 0.00258 t (Nojoumi et al., 2009). The resulting CO_2 emissions are multiplied by a factor of three that accounts for non-CO_2 warming effects (the so-called radiative forcing index, following the *IPCC*, see Stocker et al., 2013).

Table 1: Results

	Overall (2013-2017)	Per year & capita
Roundtrips	442	1.26
Distance	9,636,107 km	27,532 km
Emissions	2,282 t of CO_2 eq.	6.52 t of CO_2 eq.
Social cost of carbon	68,569 €	196 €

Notes: The first column shows statistics for the entire research project over 5 years. The second column shows per year per capita estimates assuming an average of 70 researchers involved in the project.

translate into about 2,300 t of CO_2 equivalents.[3] The corresponding average per year per capita emissions of more than 6.5 t of CO_2 equivalents are far beyond what is considered compatible with meeting the Paris Agreement's goals. Assuming a SCC of 30.05 € per ton of CO_2 as proposed by Nordhaus (2017), the future damages caused by all emissions within the five years are estimated to be about 70,000 €. These SCC equal about 20% of all travel costs of the research project.

Reducing academic aeromobility requires a new mindset

The substantial externalized costs raise the question on how to reduce academic jet-setting while maintaining the potential benefits of international exchange. This question is particularly relevant if one contemplates the responsibility emerging from doing research in a country such as Indonesia that is highly vulnerable to climate change. Clearly, means to reduce academic air travelling are available with using phone calls and video conferences being the most simple ones. Market-based approaches such as paying for emissions (carbon offsetting) or implementing an emission trade scheme between universities may incentivize carbon-light international exchange and lead to lower environmental damages. Funding agencies cutting funds for air traveling may induce the same mechanism. Though, as academic aeromobility is commonly recognized as a key component of a scholar's ability to cultivate and maintain international collaborations, a cultural shift would be vital. To get a new perspective, comparing potential benefits of academic air traveling with carbon-light alternatives of international exchange may be as revealing as computing the external costs of current habits.

[3] Using the methodology developed by the non-profit organization *atmosfair* to calculate emissions caused by the flights in the dataset at hand, a quite similar estimate of 2,510 t of CO_2 equivalents is obtained, see `https://www.atmosfair.de/wp-content/uploads/atmosfair-flight-emissions-calculator-englisch-1.pdf` for details on the methodology.

References

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