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# Low carbon research and teaching in geography: pathways and perspectives

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Universities and research centres are major producers of greenhouse gas emissions. There are growing calls from within the university sector for more proactive approaches to reducing the emissions associated with research and teaching, and to contribute more to climate change mitigation. These debates have considered both the campus-based emissions of universities with large estates and the travel-related emissions associated with international staff and student communities. There is, therefore, an increasingly acute tension between universities' imperative to foster international networks and expand research and teaching, on the one hand, and their moral obligations to decarbonise, on the other hand. In this paper, we consider how academic departments can navigate this challenging paradox. Our study is based on an analyses of the Department of Geography at Durham University in the UK. We examine the major sources of emissions associated with this department and find that by far the largest contribution comes from air travel for staff research and student field trips. We then explore student perspectives and consider potential pathways towards a low carbon model of research and teaching. Overall, we find a high level of support for decarbonization in the academy, and potential for significant emissions reductions with minimal impact on quality of research and teaching.

Keywords: climate change, universities, low carbon, sustainability, transitions

## Introduction

The production of knowledge can be a carbon-intensive business. Universities typically maintain large estates, often operating energy-intense equipment and facilities. Large

universities attract staff and students from all over the world, many of whom regularly fly between their home country and their university. And researchers often travel internationally multiple times a year to conduct fieldwork and attend conferences and other events (Arsenault et al. 2019). Most universities have strong ‘internationalisation agendas’ that seek to promote international movement of staff and students for educational and research interchanges, and collaborations between institutions: academic visitors and exchange students are commonplace. All of this produces carbon emissions. Hamante et al. (2019), for example, estimate that a single academic attending an international conference is associated with greenhouse gas emissions equivalent to 0.8 tonnes of carbon (tCO<sub>2</sub>e), approximately 8 percent of the average annual footprint of someone living in the United Kingdom. Large conferences and networking events, such as the American Association of Geographers (AAG) and the American Geophysical Union (AGU), have carbon footprints of thousands of tonnes each year (see Parrish 2017; Walenta and Castro 2021). Yet, universities are also at the centre of research and debates on sustainability and low carbon transitions, and often have strong commitments to social responsibility. Higham and Font (2019) argue that this constitutes a form of “climate hypocrisy.”

Universities are under increasing pressure to manage the tension between the imperatives of fostering international networks and conducting internationally-facing research on the one hand, and growing calls for academic communities to adopt more low carbon approaches to research and teaching on the other hand (McCowen 2020). Some UK universities have responded by declaring a “climate emergency” (e.g. [University of Bristol](#)), while others have committed to ambitious net zero targets (e.g. [Edinburgh University](#) and the [University of Leeds](#)), and there is a growing emphasis in shifting research and teaching away from fossil fuels and carbon intensive activities to tackling

climate change and the low carbon economy. Accompanying this is a growing literature unpacking various elements of research and teaching: from campus-based emissions and the potential for universities to operate as living labs to test governance and technological solutions (Knuth et al. 2007); the teaching of sustainability and climate change in higher education (Fahey 2012); and emissions associated with university-related travel (Jepson et al. 2021; Wynes et al. 2019). While the literature in this area is expanding rapidly, very little work has been done to explore the views of students on environmental sustainability within their universities. Such debates raise serious questions around where responsibility lies for fomenting low carbon agendas in research and teaching – governments, research councils, universities, departments, or individuals (see Banks 2013; Hourdequin 2011). On a more pragmatic note, there is a great deal of interest in strategies for climate change mitigation in universities and departments, although of course such discussions should not replace those of a more structural and political nature.

The tensions described above are perhaps particularly exigent in geography; a discipline that is of course highly attentive to issues relating to environment and sustainability, and which has a long history of international and fieldwork-dependent research (Bruno and Martin 2021). Indeed, Nevens (2014) calls for more critical discussion of the power relations at play when geographers researching issues of social justice and climate change maintain the “ecological privilege” of carbon-intensive travel. Field trips are also an indispensable part of teaching geography in higher education (Krakowka and Richmond 2012), so much so that fieldwork appears in the benchmark statement of what a geography degree must include:

*“Geography is intrinsically a field-based subject. Field experience is an essential part of geographical learning and all geographers require the opportunity to plan, undertake and report significant fieldwork during their course.” (QAA 2019: 7)*

As a discipline, therefore, geography is well-placed to contribute to these debates, and is arguably duty-bound to do so. As one participant put it, “to me it seems obvious that a geography department will be at the forefront of sustainability as it's at the forefront of what we study” (Student focus group 2020). Moreover, the Covid-19 pandemic forces us to reflect on our research and pedagogical practices, and perhaps provides opportunity to adopt in the long-run some of the changes we have recently been obliged to make.

This paper is based on a study of the Department of Geography at Durham University in the UK. Durham Geography is a very large geography department with sixty-five+ academic staff, several tens of postdoctoral fellows and research staff, and a few tens of support staff and technicians. The department has more than 850 students, of whom approximately 750 are undergraduates, thirty taught postgraduates and seventy research postgraduates. The department runs two primary three-year undergraduate programmes; a BSc in Physical Geography and a BA in Human Geography. These programmes have roughly equal numbers of students with a total annual intake of approximately 250. The department runs nine international fieldtrips most years (2019/2020 and 2020/2021 have, of course, been exceptional) on its undergraduate programmes. The department is housed across three buildings – two of them contiguous - on the Lower Mountjoy campus. Within these buildings the department houses a suite of six large laboratories, a workshop, two large lecture theatres and several seminar rooms with the rest constituting staff and postgraduate offices. One of the authors worked in the

department as an academic member of staff between 2016–2020 and the other author studied as an undergraduate between 2017–2020.

In this study, we estimate and categorize the major emissions associated with this department, paying particular attention to: 1) campus-based emissions; 2) emissions from aviation for research activities; and 3) emissions from aviation for student field trips. We also discuss various strategies for moving towards low carbon research and teaching. Overall, we find that there are a range of ways in which departments can quite easily reduce emissions, which are summarized in Table 1. We also find that such strategies are likely to receive support from students if approached in the right way.

*Table 1. Potential actions for reducing aviation emissions in research and teaching.*

Action	Research	Teaching	Notes
Change location of destinations		✓	Far-flung trips discontinued in favour of destinations accessible with ground-based travel.
Encourage ground-based travel when possible	✓	✓	E.g. train travel wherever feasible.
Reduce or combine less important trips	✓	✓	Assess relative costs/benefits of trips. Decision-making could be formalised by incorporating an emissions dimension to ethics review process, or through a Code of Conduct (see Le Quéré et al. 2015).
Encourage low-carbon practices	✓	✓	E.g. change promotions criteria to reduce pressure to present at international events.
Encourage virtual/online activities	✓	✓	The Covid-19 pandemic demonstrated that virtual conferencing and teaching events can be highly effective.

Facilitate low-carbon events	✓	✓	E.g. facilitating virtual participation in department events, meat-free catering etc.
Off-setting flights	✓	✓	Offsetting is a popular option, although fraught with ethical questions (see Bumpus 2011). The estimate costs of offsetting field trip flights are indicated in Figure 2.

Data for this study were collected from university estates, travel insurance authorizations for staff and student research, and field trip information from the curriculum over a twelve-month period in 2018-2019. UK-based research or fieldwork activities do not require the same type of authorisations, and only require near-exclusively rail or road-based travel and so we have not included those activities in our emissions estimates. A questionnaire on student perceptions was also circulated amongst students in August 2020, receiving 107 responses. This was then followed up in three in-depth student focus group discussions. In what follows, we first review the emerging debates on low carbon research and teaching in the literature. We then move on to presenting data on the department case study before drawing key lessons and charting potential pathways forward.

### **The low carbon academy: a review of the literature**

As institutions of change, universities have the moral responsibility to contribute to research on environmental change and educate the next generation on matters of sustainable development and climate change (Higham and Font 2019). As large institutions with intensive environmental footprints, universities don't only stand responsible for producing research and proposing solutions but must also remain

accountable for their own emissions. As Shields (2019: 594) puts it, the “production of knowledge” from universities must “transform the social and economic circumstances of its own creation.” On socio-economic issues like climate change, Stephens et al. (2008) argue that universities are not passive or reactionary organizations, but active agents capable of catalysing change. Carbon is embedded in university practices and there is growing recognition amongst academics and university managers that a business-as-usual approach in higher education will not sufficiently address global climate change reduction targets (Le Quéré et al. 2015; McCowen 2020; Shields 2019).

Accountability is an important issue for university emission reduction strategies. Non-binding agreements set by institutions are often extremely ambitious with vague and non-specific strategies. Research by Bekessy et al (2007), for example, assessed the development of an agenda around sustainability at the Royal Melbourne Institute of Technology over a period of twelve years. They found that the university gained the benefits of setting emission reduction targets, such as good public image, without achieving genuine progress in reducing emissions. This research criticized the embedded nature of sustainability reporting in higher education as a top-down process. At present, a “band-aid” approach is often taken towards sustainability policy at universities, where primary sources of emissions are ignored and smaller, easier to reduce sources are addressed. Transparency of emission sources and statistics about the emissions released, as well as clear and achievable strategies are essential for research and teaching at universities to progress on a low carbon trajectory.

The views of university students, and their role in enabling and/or constraining low carbon agendas in universities is often overlooked in existing scholarship. Wachholz et al (2014) referred to current students as the “climate change generation,” living and learning in an era with greater awareness and scientific certainty of climate change. As



one of the largest stakeholder groups at universities, students are often those who are calling for change and transformation in university policy (Nejati and Nejati 2013). Students can facilitate change in several ways, for example by demanding change in the way important issues, such as climate change, are taught (Wachholz et al. 2014). A university campus is more than just the infrastructure where research and teaching occur. The campus itself is a space for responsible citizenship and stakeholder engagement where a low carbon transition can occur (Rooney and McMillin 2010). Student's voices matter in the implementation of low carbon research and teaching in higher education and our paper focuses on the importance and necessity of student involvement.

In higher education, the largest sources of travel emissions come from student fieldtrips and research-related travel (Hoolohan et al. 2021). Accounting for 24 percent of global anthropogenic carbon emissions, carbon is embedded in travel (Wang and Ge 2019), and although aviation is responsible for two-to-five percent of emissions, it is a particularly difficult industry to decarbonise (Graver et al. 2019). Traditionally, field trips are perceived as integral to a geography student's learning and understanding of the world. Overseas travel often requires air travel, which leads to high carbon footprints. Ultimately, the social benefits of travel are impossible to quantify but nevertheless they do lead to transformative learning experiences (Waring et al. 2014). Moreover, many geography programmes in the UK have been competing in a figurative arms race, which has intensified since the introduction of tuition fees in 1998, to offer glamorous field trip destinations in order to attract prospective students, although there are emerging, more co-operative debates – facilitated by the Royal Geographical Society – about addressing the collective carbon impact of geography programmes might be reduced. Despite the widely recognised pedagogical benefits of field trips, the moderation or prevention of climate change is posing a predicament for higher education (Schott, 2017). What should

be prioritised, the long-term societal benefits of field trips or tackling climate change and environmental degradation, is the question.

Emissions embedded in research-related academic travel can typically be split into two categories: research and dissemination, where dissemination is inclusive of travel for conferences and presentations. Carbon emissions are, of course, not uniform across the sector, but vary by researcher, type of research and purpose of travel (Crumley-Effinger and Torres-Olave 2021). Waring et al (2014) calculated emissions from air and road travel of researchers in Maine's Sustainability Initiative over a three-year period. The study concluded that travel for dissemination purposes had much higher associated emissions than research travel. Research-related travel was typically for longer periods of time in comparison to travel for dissemination, which was typically short term, often long-haul travel for international conferences and presentations. There is a growing literature, then, that suggests that academics can substantially reduce travel-related emissions without negatively impacting the quality of research (Wynes et al. 2019). The Tyndall Centre, for example, have published guidelines to encourage researchers to seek alternative travel wherever possible, cut down on unnecessary journeys and achieve more with each journey (e.g. by taking longer trips and participating in more events per trip) (Le Quéré et al. 2015). There seems to be growing consensus that, when it comes to reducing emissions from academic travel, there is significant low hanging fruit to be picked (Klöwer et al. 2020).

While we argue for more proactive efforts towards decarbonizing research and curricula in geography (and beyond), and indeed agree with Higham and Font (2019) and MacDonald (2021) that this is an urgent and moral imperative, it is also important to highlight what we are *not* arguing for. Following on from a long tradition in critical geography of problematizing attempts to download responsibility for emissions

reductions to the individual (see Slocum 2004; Paterson and Stripple 2010; Rice 2013), we are not claiming that the onus for decarbonizing academia rests on the shoulders of individual academics, administrators or students. Doing so would be to deny the structures in which individuals operate and the parameters (be they economic, institutional, cultural) that define or shape their actions. Rather, we agree with Hoolohan et al. (2021) that the higher education sector requires systemic material and cultural change towards a decarbonization agenda – a shift that geography departments can, and *should* lead.

The COVID-19 pandemic in 2020-2021 will inevitably change the nature of discussions like this. The period February to June 2020 saw a dramatic and unprecedented fall in global CO<sub>2</sub> emissions as people stopped travelling and economies slowed (see Gössling 2020; Le Quéré et al. 2020). While emissions have increased again, the step change forced by the virus offers an opportunity to rethink some of our work practices and adopt certain changes, such as videoconferencing, long-term (Manzanedo and Manning 2020). Research into remote working and the benefits they bring began prior to COVID-19, but with recent lockdowns as a result of the pandemic, remote work and virtual conferences have become commonplace (see Clancy 2020). In this virtual transition, there are further potential advantages than just cutting carbon. These include opening up conferences, which Martin (2021) describes as “spaces of enclosure” to groups previously excluded. Indeed, decarbonizing research dissemination could help facilitate the decolonization of knowledge by reducing the barriers to participation.

Even very large conferences such as the European Geophysical Union (EGU) have been able to run reasonably successful online meetings (EGU 2020), and there are further changes that could be made – for example to conference format – that might increase the effectiveness of virtual conferencing in the future (Milić et al. 2020). Before

the pandemic there was an entrenched culture of in-person participation in conferences and workshops that the coronavirus has forced us to collectively reconsider (Viglione 2020). Nevertheless, we should be careful not to overstate the potential benefits of online learning and research to the decarbonization agenda (Filimonau et al. 2021).

### **Thinking about carbon produces carbon: research and teaching in geography**

Carbon becomes embedded in research and teaching in all sorts of ways. In other words, intellectual labour, which people don't usually associate with material transformation in the same way as other forms of labour, is underpinned and predicated on flows of carbon. It is beyond the scope of this paper to trace all of these flows, which include the carbon embedded in energy and water supplies to buildings (which can be significant in buildings with laboratories, for example), food on campus, other forms of consumption on campus (e.g. printing), travel to and from campus, and even personal travel by staff and students that universities draw from other countries (see Shields 2019). Energy consumption is, of course, one of the largest contributors to department-based emissions. In this case study, annual emissions related to energy directly consumed in the department buildings amounted to an estimated 600 tCO<sub>2</sub>e. This is a relatively small contribution to the total estate emissions for the university, however, which stand at 31,000 tCO<sub>2</sub>e. To contextualise this figure, Durham University has a large estate with sixteen colleges, and an unusually high proportion of students living on campus as a result. Indeed, much of the decision-making around these emissions falls outside the direct remit of any individual department.

There is a perception among many students and staff that environmental issues should be foregrounded more in the university's activities. The People and Planet sustainability league, which ranks UK universities according to thirteen environmental

and social categories, places Durham University at ninety-sixth out of 154 (People and Planet 2019). Durham University have not yet followed comparable institutions by declaring a climate emergency or targeting net zero. In 2019, over 200 students rallied at a climate strike on campus, demanding change in the university's sustainability policy. Demands from students included a guarantee to make all new university buildings carbon neutral and for revision of the university Sustainability Action Plan. A second climate strike was held in February 2020 as demands had still not been met.

These views are certainly echoed among geography students. The questionnaire returns showed that 96 percent of survey respondents said that their university's approach to environmental sustainability was important to them and 62 percent said that their university was not doing enough through its sustainability strategy. It is unsurprising that there is a high level of environmental awareness amongst geography students, but many of the survey respondents were also actively involved in environmental groups or initiatives, including Extinction Rebellion. Of these, many were directly involved in a variety of student-led campus-based initiatives to pressure the university into increasing its contribution to climate change mitigation, for example through campaigns to reduce meat products in catering. Across the board, we identified strong, albeit varying levels of support from students for a variety of strategies to reduce greenhouse gas emissions, with divestment from fossil fuels, use of renewable energy and facilitating environmental citizenship receiving the most support (see Figure 1). An important role of universities is also to embed themes of sustainable development, climate change and transitions in the curriculum to train students to think critically about environmental challenges. Many universities, for example, have committed to increasing their module teaching on sustainability and climate change as a form of social responsibility. Again, we found very high levels of student support for this, with 92 percent saying they would like to receive

more teaching on sustainability. The student voice can facilitate change in teaching content. Following student demand, the university have added a new “Introduction to Climate Change” module at Level One, starting in October 2021.

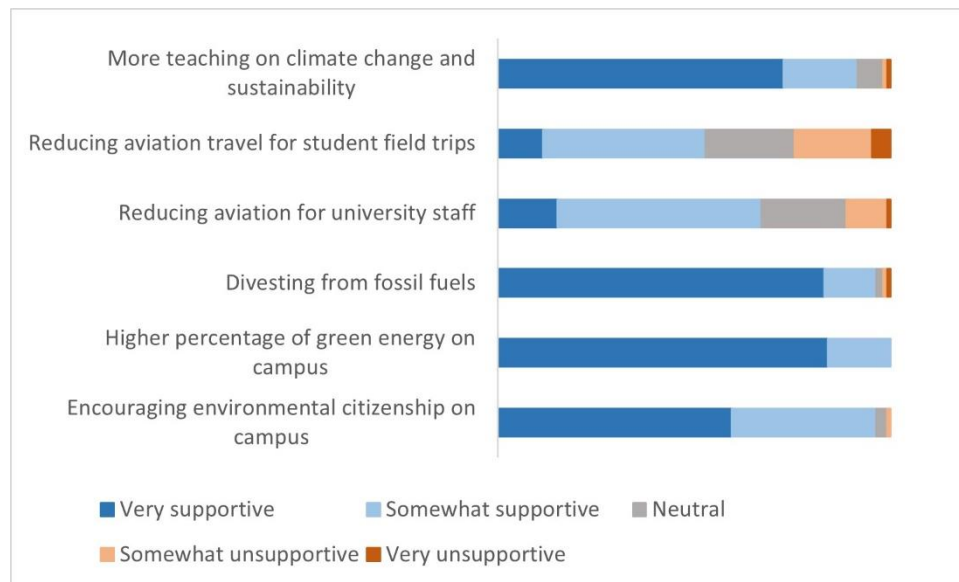


Figure 1. Student perceptions on strategies to reduce university emissions.

### ***Aviation emissions from research and teaching***

Fieldwork is a central part of the production of knowledge and pedagogy in geography, and has been throughout its disciplinary history (Gerber and Chuan 2000; Fuller et al. 2006). Moreover, research-intense departments like the Department of Geography at Durham University, necessarily maintain large international networks. Air travel accounts for the single largest source of greenhouse gas emissions associated with the department in this study. Flights for both research and teaching produced an estimated 1,601 tCO<sub>2</sub>e over a twelve-month period in 2018–2019<sup>1</sup>, which is around three times

<sup>1</sup> This was calculated using internally-approved travel requests and the *atmosfair* online calculator: <https://www.atmosfair.de/en/offset/flight>

higher than the estimated annual CO<sub>2</sub> footprint of department buildings on campus. Aviation is, therefore, the elephant in the room for climate change mitigation in departments. It also represents significant low-hanging fruit because there are relatively straightforward ways of reducing air travel without negatively impacting research output or learning outcomes (Wynes et al. 2019).

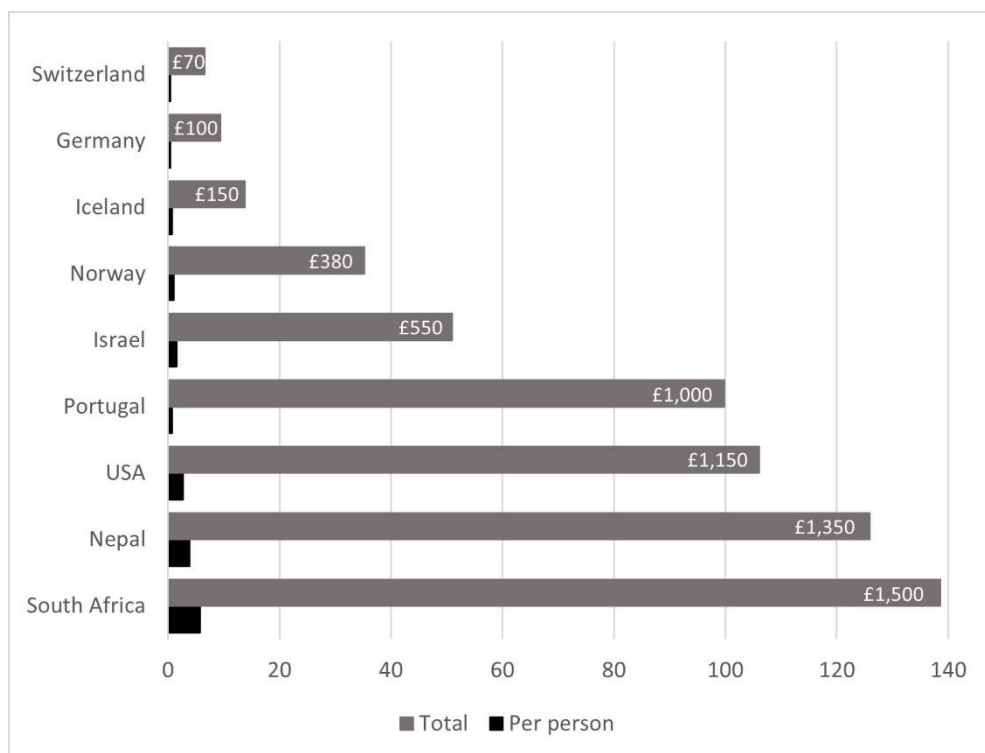
### *Research*

Academics in research-intensive departments and groups necessarily maintain international networks and internationally focussed research agendas. International travel is an essential part of academic work. This study estimates that over a twelve-month period, air travel for staff research activities produced 621 tCO<sub>2</sub>e in 250 department-approved trips. This includes travel for fieldwork, conference and workshop attendance, PhD examinations, and other research-related activities. Individual student research travel, primarily by PhD students (also including some Master's and undergraduate dissertation research), produced a further 394 tCO<sub>2</sub>e from 152 trips. This amounts to a total research footprint of 1,016 tCO<sub>2</sub>e for air travel.

### *Teaching*

Field work is, of course, an indispensable part of being a geographer, and organised field trips are central to most geography programmes in higher education (Krakowka and Richmond 2012). Experience in field work provides students with both practical skills and in-depth understanding that is difficult to replicate on campuses. Moreover, many of the processes and topics studied in geography are not present or appropriate to observe in the UK, meaning that international field trips are often important. The estimated emissions produced by air travel to each field trip location is given in Figure 2, totalling

586 tCO<sub>2</sub>e per year. Of these, a field trip to Portugal is compulsory for First Year physical geography students, while the other trips are optional – although in practice, most students attend at least one international trip during the course of their degree programme. The current structuring of the BSc degree programme means that students must travel internationally as part of their course, BA students could avoid international study and only go on UK-based field trips if they wish.



*Figure 2. Aviation emission associated with undergraduate field trips by country destination in 2018-2019. The estimated cost of offsetting these emissions is also indicated, based on the average price of offsetting per tCO<sub>2</sub>e under the [Gold Standard](#) accreditation scheme.*

### ***Options and pathways***

Reducing the contribution of geography departments to greenhouse gas emissions will not be an easy process. Nevertheless, with respect to aviation for teaching and research



purposes, which in this study constitutes the single largest source of emissions, our research identifies a series of strategies for departments to contribute to the low carbon academy, without negatively impacting research quality and student learning experience. These are summarised in Table 1.

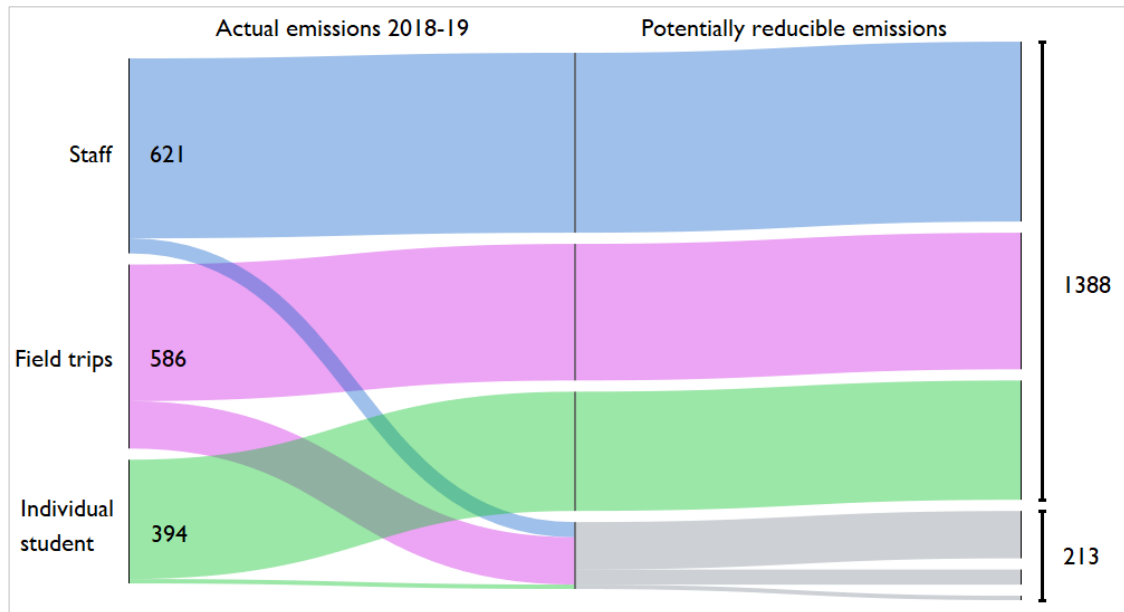


Figure 3. Estimated emissions (tCo2e) from aviation over a 12-month period in 2018-2019 for staff research travel, individual student travel (primarily postgraduate research students) and student field trips. The grey lines on the right hand side of the diagram show the 213 tCo2e of those emissions that are potentially mitigated with overland travel (i.e. within mainland Europe). Replacing air travel with train travel could reduce this 213 tCo2e to 34 tCo2e, which amounts to a potential saving of 179 tCo2e. This diagram was produced using [RAWGraphs](#).

One strategy to reduce the carbon footprint, for example, is to encourage ground-based travel instead of flying where possible. Figure 3 shows the proportion of air travel emissions that could be reduced by using overland travel, where destinations are feasible

(i.e. in mainland Europe). If these trips were undertaken by train rather than plane this would amount to a saving of 179 tCO<sub>2</sub>e per year, equivalent to an 11 percent reduction in air travel emissions<sup>2</sup>. Of course, such measures would depend on a variety of factors, including the willingness of funders (research councils, universities and departments) to pay the higher costs of overland travel, and the time demand associated with such journeys, potentially including increased time away from home for those with caring responsibilities.

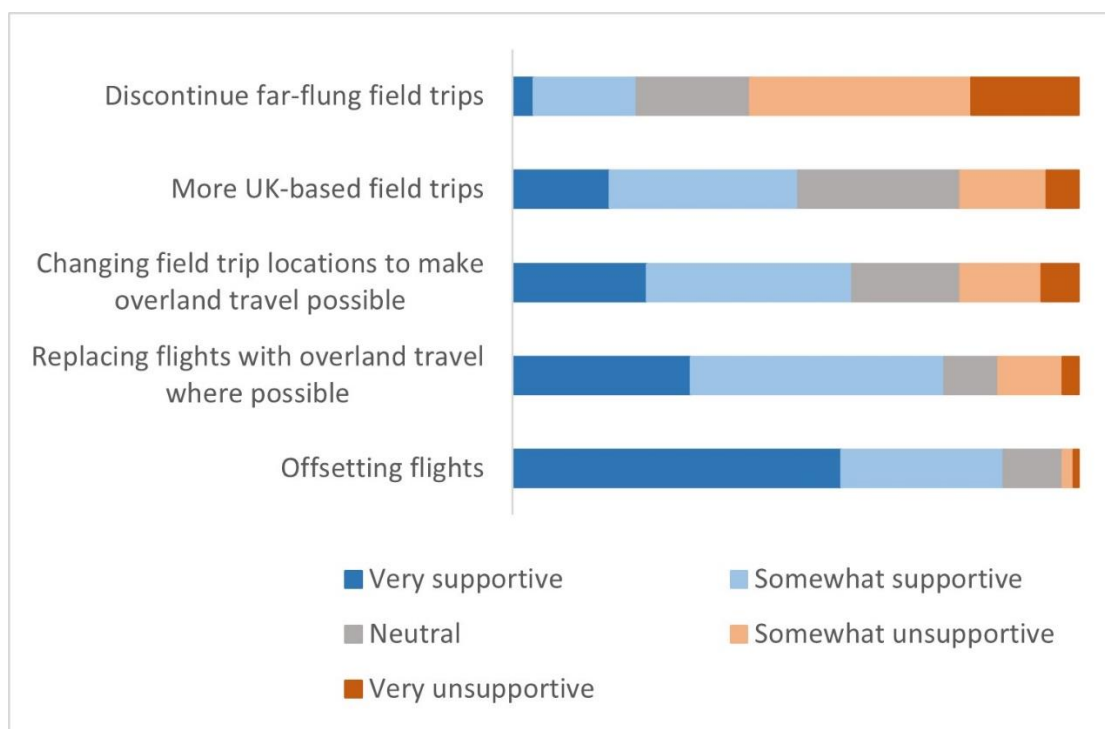
Students in our study consistently highlighted the importance of field trips to student learning. Many of our participants expressed how valuable field trips are to their learning experience, and how they will often shape perceptions, understanding and even future life choices. 75 percent said that the provision of international field trips was important to their choice of course and university. One student commented “I think being a top university it is important to have these opportunities”. Another expressed “Field trips in general were an important factor when I applied.” Despite student desire for field trips, it was frequently highlighted that the main determinant for choosing a university was not the provision of far-flung or glamorous field trips. This was highlighted during the focus groups where one participant commented:

*“The type of people who do a geography degree are quite in tune with the debates around climate change. If a geography student turned around and was not happy as no far-flung field trips were not offered, it wouldn’t make sense”.*

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<sup>2</sup> Based on Defra greenhouse gas conversion factors, train travel produces 16 percent of the emissions of short-haul flights.

71 percent of students would have considered a course that only offered UK and European field trips. Although field trips are identified as an integral part of the course, it seems that the destination is not what matters most. This shows an important shift in perceptions. Traditionally, geography departments might use glamorous field trips as a way to attract potential students. As the generations of students become more carbon-conscious, as one participant put it, far flung-field trips “can turn from an asset to a ‘black mark’ against a department’s name.” Evidence for this shift towards a more environmentally conscious student body is one important finding from our study which we recommend integrating into decision making on the provision of international field trips.



*Figure 4. Student perceptions on various options for reducing emissions associated with undergraduate field trips.*

Our study found substantial, albeit varying, support for a range of possible actions for reducing fieldtrip emissions, as shown in Figure 4. There is potential for overland travel to lead to significant emission reductions, although of course this is not feasible for all field trip destinations. When questioned about changing locations of field trips to make overland travel possible, 60 percent of students were supportive of the idea. Switching to overland travel would also present new pedagogical opportunities. For example, working in multiple locations along the route could provide a wider breadth of experience and understanding of geographical processes. This option is inevitably largely confined to trips from the UK to other European countries.

Another option would be to discontinue far-flung trips. In our case study, this could lead to departmental emission reductions of approximately 370 tonnes of carbon per year. This pathway was received positively by some students, with several highlighting the importance of what you study over where you study. One student commented that “there are lots of opportunities closer to home where you can study similar things...I think we could do really interesting trips to Europe and get the same out of it really.” Participants across the three focus groups emphasised a multitude of opportunities for field locations closer to home. Some respondents highlighted this as a “necessary sacrifice,” and as a leading geography department we should be at the forefront of change towards low carbon research and teaching. Nevertheless, 21 percent of students were strongly against changing the locations of field trips. For many students, fieldtrips are an important part of their interest in the discipline. A number of our participants pointed to the pedagogical value of international field trips, with several commenting that they learn more in the field than in the classroom. For example:

*“It's important to orientate yourself in another culture and be able to use your skills in an unfamiliar environment. Whilst the domestic trips may offer some of this, it's no substitute for many of the fieldtrip locations.”* (Undergraduate student 2021)

*“In order to learn about certain things in detail, it's sometimes necessary to be able to carry out fieldwork. It also provides us with very useful skills. I am taking a lot of glaciology modules so to actually see a glacier and do fieldwork there, it is necessary to leave the UK.”* (Undergraduate student 2021)

Our findings highlight the importance of considering location on a case-by-case basis rather than just having a blanket policy for all field trips. Particular destinations were identified as unique locations where particular physical and/or social processes could not be studied in a UK or European context.

An alternative pathway would be to give students the option to avoid air travel completely during their degree programme. 43 percent of students responded that they would be interested in a “no flight degree pathway.” The benefits of a no flight pathway were centred around carbon footprints and financial viability. Multiple respondents mentioned a “minimal flight mentality,” conscious of the resulting emissions from aviation. One student commented “I found it frustrating that I would have to pay for and then contribute to global warming to go and learn about environmental issues”. Others reiterated this point further adding “It is up to us to show the immediate importance of greener travel and a higher degree of awareness. Some trips must have alternative destinations”. Those opposing a no flight pathway recommended reducing other areas of departmental emissions at first, such as academic travel for dissemination, and estate emissions.

Finally, across our study, participants highlighted the importance of student input in decision making. As one out it, “Communication is important. People might not be happy if you just cancelled field trips, but if you explained the reasons for it, there would be less of a backlash.” If significant changes were to occur to degree programmes like this, then transparency in decision-making and consultation with students would be important. Indeed, such changes could even be used as a pedagogical tool, whereby students could be involved in re-designing field trips as a way of teaching issues relating to environmental challenges. A more adaptable, organic approach involving a myriad of stakeholders inclusive of students would be beneficial to achieving emission reduction targets.

## **Conclusion**

By studying the emissions associated with a single geography department in the United Kingdom, we have been able to build up a detailed picture of where emissions come from and sketch out potential pathways to decarbonisation. To our knowledge, this is the first study of its type to have been published. The key challenge is for departments to find ways of doing this while maintaining excellent research networks and high-quality teaching. Of course, there is no one-size-fits-all model here, but a combination of the actions suggested in Table 1 is likely to lead to significant reductions in teaching and research emissions. Furthermore, given that students are numerically the largest group in most departments, the absence of consideration of student perspectives on this topic in the literature is stark. Overall, and perhaps unsurprisingly for geography students, we found a high level of awareness of the issues and strong support for more proactive measures at department and university level. The student community is increasingly carbon-conscious, and it is likely that carbon-intensive methods of teaching, for example

through far-flung field trips are becoming less popular. While students value field trip experience highly, the opportunity to see ideas taught in the classroom come to life was most valuable to students over the offering of glamorous field locations.

Decarbonising the academy will not be a simple process. Departments sit in complex institutional webs between the individuals that work and study in them, the Schools, Faculties and Universities in which they operate, and wider networks they connect to. This, of course, raises challenging questions around responsibility (i.e. what responsibility do departments have to decarbonise?) and agency (i.e. what can departments actually do?). Such questions are difficult to disentangle because they both link to broader societal challenges posed by climate change and are highly context specific. Nevertheless, we have taken a pragmatic approach in this paper, and asked what steps individual departments can take to decarbonise geography research and teaching. We have focussed in particular on emissions from aviation for two reasons: first, because this represents the single largest source of emissions associated with our study; and second, because emissions from flying perhaps constitute the lowest hanging fruit for decarbonisation.

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