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Responsible academia: optimizing conference locations to minimize greenhouse gas emissions

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The greenhouse gas (GHG) emissions attributable to many scientists, including ecologists and conservation biologists, are often much greater than those attributable to average non-scientists (Fox et al. 2009, Synolakis and Foteinis 2009, Burke 2010, Spinellis and Louridas 2013). The majority of these 'extra' GHG emissions are due to air travel, primarily to conduct research or to attend professional meetings and conferences (Achten et al. 2013). Considering the potential harm that GHG emissions can cause to the global environment, the scientific community should be aiming to better manage its academic activities to minimize GHG emissions and the associated ecological footprint (Favaro 2014).

It is unreasonable to suggest that scientists entirely eliminate GHG-emitting academic activities, as this would be counterproductive for the development of research and the spread of information. However, one way that the scientific community can reduce GHG emissions is through the optimization of meeting locations (Ponette-González and Byrnes 2011). In many cases, conference sites are chosen to be in exotic locations in the hope of increasing appeal and to facilitate the international spread of ideas. While exotic, hard-to-reach, meeting locations may increase attendance numbers and thereby increase meeting impact, holding meetings in these locations can have the adverse effects of increasing travel distances. Increased travel distances will in turn increase the GHG emissions of the attendees. This is contrary to the missions of many scientific societies, especially ecology and conservation societies. We therefore suggest that meeting locations be chosen to minimize overall travel distances of the targeted attendees. This would reduce carbon emissions and could have the ancillary benefit of making the meetings easier and cheaper to attend, especially by students or underfunded researchers.

To illustrate the effect that meeting site selection can have on GHG emissions, we examined the estimated travel distances and GHG emissions of the past four conferences of the International Biogeography Society (IBS: <www.biogeography.org/>). The IBS has approximately 900 members and has hosted multi-day conferences biennially since 2007 with approximately 200 to 400 guests (2007 in Canary Islands, Spain; 2009 in Merida, Mexico; 2011 in Crete, Greece; and 2013 in Miami, USA). While relatively-small, the meetings are extremely international (e.g. the meeting in Miami, Florida USA [hosted by KJF] had 409 attendees from > 40 countries).

Using meeting registration data obtained directly from the IBS, we estimated the air travel distances and GHG emissions associated with the travel of attendees to each of the society's four previous meetings. To estimate travel distances, we georeferenced the centroid of each attendee's home country, or in large countries with many attendees the home city of the associated attendee's institution. The roundtrip air travel distance of each attendee was estimated as 2 × the shortest-possible great-circle-distance to the meeting location. Using guidelines set by the USA's Environmental Protection Agency (US Environmental Protection Agency 2008), we then estimated the average CO_2-equivalent GHG emissions per attendee and the total emissions associated with each meeting. We compared each meeting's estimated GHG emissions to the emissions associated with the same attendee pool traveling to random meeting locations (potential meeting locations were restricted to the home countries/cities of past IBS meeting attendees) and that year's optimal meeting location. Optimal meeting locations were identified for each year as the site with the lowest total GHG emissions (see Supplementary material Appendix 1 for additional information).

Across all years, the average round-trip air travel distance per attendee of the IBS meetings was 9564.1 km. The average GHG emissions per attendee ranged from 2.5–3.0 tonnes CO_2, with an overall average of 857.1 tonnes CO_2 emitted per meeting. The average travel distances to the actual meeting locations was always significantly shorter than random, equating to an average saving of 3402.8 km of air travel per attendee and 324.1 tonnes CO_2 per meeting. If meetings had been held at their optimal locations, there would have been an additional average savings of 1866.6km of round-trip air travel per attendee and 162.3

tonnes CO_2 per meeting (Table 1; Supplementary material Appendix 1, Fig. A1).

The IBS will hold its next conference in January 2015 in Bayreuth, Germany. At the time of writing, no list of attendees was available. To predict the travel distances and GHG emissions that will be associated with this meeting, we created a pooled list of possible attendees based on all registrants of past IBS meetings. We then determined the emissions that would result from the travel of these potential attendees to all possible meeting locations (possible meeting locations restricted as described above). Based on these methods, the IBS meeting in Germany is predicted to result in average emissions of 2.5 tonnes CO_2 per person. This is 0.2 tonnes CO_2 more per person than would be incurred if the meeting were held at an overall optimal location of London, UK. Assuming 450 attendees, this equates to 78.9 tonnes extra total CO_2 emissions vs the optimal.

Overall, the IBS is performing well in selecting meeting locations close to the optimal locations and has been improving consistently through time. The proximity of the actual meeting locations to the optimal meeting locations may reflect selection criteria by the conference committee that either intentionally or unintentionally minimizes average travel distances. Alternatively, this may reflect the relatively-restricted geographic distribution of meeting attendees, which is heavily biased towards the USA and Europe.

Society meetings play an important role in the development of new ideas and the distribution of information. We understand the professional benefits associated with meetings and we are not suggesting that conferences be eliminated or replaced with entirely-virtual meetings. However, efforts should be made to minimize the GHG emissions associated with these gatherings. As illustrated here, significant reductions in GHG emissions can be achieved by optimizing meeting site selection. Our methods determined the optimal meeting location based on past patterns of attendance. Ideally, meeting locations would be chosen to minimize travel distances for targeted pools of attendees. In some cases the targeted attendees will mirror past attendees; in other cases, conference organizers may elect to target all society members or to target specific underrepresented regions in an attempt to broaden participation.

Beyond optimizing site selection, conference-related GHG emissions can be reduced by providing alternative methods for participation. For example, emissions can be reduced by making more of the meetings available online either through an online portal that allows people to attend the meeting virtually, or by uploading content online (e.g. as in Evolution Society Meeting 2014). Furthermore, conferences can offer or endorse programs through which attendees can pay to offset their emissions (many societies do in fact already encourage participants to offset their GHG emissions). Optimizing meeting locations and reducing meeting-associated GHG emissions will not be sufficient to reduce scientists' GHG emissions down to the levels of average non-scientists, but would be a clear step in the right direction and would help scientists to set a positive example for the greater global community.

Table 1. Estimated travel distances and GHG emissions associated with attendance of past IBS conferences and predicted for attendance of the 2015 IBS meeting. Actual values are compared to travel and GHG emissions if meetings were held at random and optimal locations (see Supplementary material Appendix 1, Methods).

Meeting		Average flight distance (one-way)							Green house gas emissions				
Year	Number of attendees	Canary Islands, Spain	Merida, Mexico	Crete, Greece	Miami, USA	Bayreuth, Germany	Random location [mean (95% CI)]	Optimal meeting location	Average CO_2 equivalent emissions per attendee (tonnes)	Total CO_2 equivalent emissions for meeting (tonnes)	Extra round trip travel (km) per attendee vs optimal	Extra CO_2 equivalent emissions per attendee (tonnes) vs optimal	Extra CO_2 equivalent emissions for meeting (tonnes) vs optimal
2007	311	4710.52	–	–	–	–	6798.03 (6400.41–7216.22)	3534.16	2.58	802.37	2352.72	0.64	200.38
2009	207	–	5472.19	–	–	–	6192.99 (5828.63–6577.16)	4484.10	3.00	620.41	1976.18	0.54	112.03
2011	385	–	–	4591.49	–	–	7211.14 (6844.07–7627.57)	3660.04	2.51	968.19	1862.89	0.51	196.41
2013	406	–	–	–	4665.71	–	6043.27 (5632.79–6453.74)	4028.42	2.56	1037.51	1274.59	0.35	141.71
2015	450	–	–	–	–	4643.53	6599.33 (6245.17–6989.48)	4323.45	2.54	1144.48	640.16	0.18	78.89

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Supplementary material (Appendix ECOG-01366 at <www.ecography.org/readers/appendix>). Appendix 1.

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