Tourist aviation emissions: A problem of collective action.

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Abstract

While transportation currently accounts for 23% of total global energy-related CO_2 emissions, transport emissions are projected to double by 2050, driven significantly by continued high growth in global passenger demand for air travel. Addressing high growth in aviation emissions is critical to climate stabilization. Currently we rely on individual decisions to forego air travel as the means of reducing these high-risk emissions. In this paper we argue that encouraging voluntary responses to such risks cannot succeed due to the nature of human reason and the structure of the problem itself. We use decision making theory to explore why individuals have been generally unwilling or unable to act upon these risks, and collective action theory to illustrate the futility of relying on uncoordinated actors in such cases. Participation in the high-carbon air travel regime is a social convention, and transition from social conventions requires coordination among players. Our theoretical discussions lead us to conclude that it is our moral duty to promote coordinated collective action, via national or global policy mechanisms, to address tourist aviation emissions. We offer various avenues of future research to advance this moral duty.

Keywords: Climate change, aviation emissions; decision-making theory; risk assessment; cognitive bias; social conventions; collective action.

Introduction

Transportation currently accounts for approximately 23% of total global energy-related CO_2 emissions and transport emissions are projected to double by 2050 (Creutzig et al., 2015). Air travel produces a large and growing portion of the world's greenhouse gas emissions (Creutzig et al., 2015; Bows-Larkin et al., 2016). The rapid growth in demand for aviation is attributed in part to subsidization in the form of aviation fuel exemption (Oberthür, 2003), which suppresses the imperative for airlines to seek fuel efficiencies. Global passenger demand for air travel continues to grow at 5-6% *per annum* (Bows-Larkin et al., 2016), while efficiency gains have consistently failed to meet the 1.5% *per annum* target (2009-2020) set by ICAO (European Federation for Transport and Environment [EFTE], 2016). Indeed "even under the most aggressive technology forecast scenarios, the anticipated gain in efficiency from technological and operational measures does not offset the expected growth in demand driven emissions" (ICAO, 2016:12; see also Mayor & Tol, 2010; Peeters, Higham, Kutzner, Cohen, & Gössling, 2016). ICAO concedes that "…aviation emissions are expected to grow by up to 300% by 2050 unless action is taken" (EFTE, 2016:2; see also Owen, Lee & Lim, 2010; Lee, Lim & Owen, 2013a, 2013b). Public pressure is building upon the air transportation sector to significantly reduce aviation greenhouse gas emissions (Sgouridis, Bonnefoy & Hansman, 2011).

Addressing transport emissions is critical to climate stabilization (IPCC, 2014a), and the implications for the energy and carbon intensive tourism industry (Becken, 2011) are significant (Scott, Hall & Gössling, 2012). Tourism accounts for 5% of global carbon emissions (Peeters & Dubois, 2010), and even without accounting for radiative forcing (Scott et al., 2008), aviation dominates the emissions profile of the tourism sector (Scott, Peeters, & Gössling, 2010; Scott, Hall & Gössling, 2016a; 2016b). 40% of tourism emissions have been attributed to air travel (Gössling, Haglund, Kallgren, Revahl & Hultman, 2009). Aviation emissions continue to rise in both absolute and relative terms, as other sectors take action to mitigate emissions (Bows & Anderson, 2007; IPPC, 2014; Bows-Larkin et al., 2016). Indeed Eickhout and Taylor (2016: online) argue that the aviation industry has

> "historically found itself in a parallel universe when it comes to the industry's contribution to the fight against climate change. Airlines have been operating in a world where they pay no fuel taxes, are VAT-exempt, face no legally-binding fuel efficiency requirements, and have no limits placed on their CO_2 emissions".

An important debate surrounds the allocation of responsibility for a climatically damaging industry (Smith & Rodger, 2009; Cohen, Higham & Cavaliere, 2011; Young et al., 2014). The case for special consideration because of its importance to global business (in both developed and developing world contexts) continues to feature in national (Wood, Bows & Anderson, 2012) and international (ICAO, 2012; Aviation Benefits, 2016) discourses on aviation emissions. The aviation industry has intensified its efforts to convince policymakers that sustainable aviation can be achieved through technology, alternative fuels and operational innovations (Sustainable Aviation, 2011). The promise of technology breakthroughs, leading to efficiency gains and climatically neutral or zero-emissions aviation, has been described as a myth that has been perpetuated to stall meaningful climate policy action for international aviation (Peeters et al., 2016).

Meanwhile aviation industry data show that the global commercial fleet of civil aircraft has more than doubled every 20 years since 1970; from 3700 aircraft in 1970 to 9100 in

1990 and 21,000 in 2010 (Boeing, 2014 Airbus, 2014). Even greater has been growth in revenue passenger kilometres (RPK), which increased ninefold between 1970 and 2010, from 500 billion RPK in 1970 to 4500 billion in 2010 (Airbus, 2014). It is expected that by 2030 a global fleet of 40,000 civil aircraft will produce 10,000 billion RPK per annum (Boeing, 2014). An average annual worldwide growth rate of 3.5% is currently projected to 2050. At the same time it is expected that fuel efficiency gains will decline to <1% *per annum* in the 2020s with aircraft lifespans and fleet replacement stretching over a period of decades (Bows & Anderson, 2007; Peeters & Middel, 2007). These timelines take us far beyond the need for immediate climate action as outlined in the Paris Climate Agreement (2015). The most recent UN calculations estimate that aviation emissions between 2015-2050 will account for over one-quarter (27%) of the remaining carbon that may be emitted under the budget required to stabilize global temperature rise at +1.5-2.0°C as outlined in the Paris Climate Agreement (Carbon Brief, 2016).

Transport is recognised as an expensive and difficult sector in which to reduce energy demand (Anable et al., 2012). Various command-and-control, market-based and soft policy measures are available to achieve reductions in transport emissions (Friman, Larhult & Gärling, 2013; Sterner, 2007). Yet there remains a significant implementation gap due to social lock-in in transport policy (Banister & Hickman, 2013). High carbon transport use is entrenched (Randles & Mander, 2009; Higham et al., 2014) and institutionalised (e.g., through frequent flier programs; see Gössling & Nilsson, 2010; Young et al., 2015) such that 'radical transitions', are required, rather than relying on changes in the behavioural practices of flyers (Schwanen, Banister & Anable, 2011). High carbon transport use is a social convention that entrenches suboptimal social and environmental outcomes for everyone. It has been argued that such conventions can only be ended by coordinated action, since any unilateral exit simply disadvantages those leaving without affecting the convention itself (Mackie 1996; Hechter & Satoshi, 1997; Hardin 1982).

This paper specifically addresses the problem of aviation emissions, which threaten everyone's wellbeing (Owen et al., 2010; Anderson & Bows, 2011; IPCC, 2014a, 2014b). To date technical gains, operational efficiencies and voluntary action (via restraint or the purchase of carbon offsets) have failed to have any meaningful effect on emissions growth in this sector (Gössling, Broderick, Upham, Ceron, Dubois, Peeters & Strasdas, 2007; Higham, Cohen, & Cavaliere, 2014; Peeters et al., 2016), in the absence of structural change (Gössling et al., 2009; Schwanen, 2016). To date, but for very few exceptions (e.g., the EU emissions trading scheme), the national and global policy response to this threat has been to rely on individual decisions to forego or offset air travel as the means of reducing aviation emissions.

In this paper we consider rational individual responses to those risks, such as voluntarily foregoing air travel, in relation to the effect of cognitive biases on human reasoning, and the structure of the problem that needs to be resolved. We use cognitive science to demonstrate the challenges that individuals face when they try to evaluate and act on climate change risks. We also draw upon collective action theory to illustrate the futility of relying on uncoordinated actors in such cases, and the means by which we might escape the high-carbon transport regime. We argue that individual efforts to mitigate climate change by reducing or offsetting consumption of high-carbon transport can no longer be the preferred policy option, and that the problem of aviation emissions must be reframed as a question of collective rather than individual action. If so, it is our moral duty to promote collective action through national and/or global policy mechanisms. We explore the possibilities and conclude by offering our reflections on timely research questions arising.

(The failure of) uncoordinated individual responses to aviation emissions

The economic policies of neoliberal governments encourage unrestrained consumption of the products of global capitalism (Urry, 2010). Restricting aviation unilaterally has been portrayed as reducing competitiveness in the global market. The response of governments has therefore been to encourage voluntary public behaviour change towards lower carbon lifestyles (Barr et al., 2010), an approach that in the context of discretionary tourist air travel has been ineffective to date (Cohen et al., 2011; Miller et al., 2010). While low-cost carriers (LCCs) claim to have increased social inclusion in tourism, discretionary air travel is dominated by wealthy 'high emitters' who have used distance to reproduce and entrench existing class distinctions in holiday behaviours (Casey, 2010). This suggests that only collective action, instantiated through governments via multilateral agreements and national legislation, can substantially reduce or even slow the growth of aviation emissions that are far too high to be 'neutralised' by offset schemes (Becken & Mackey, 2017).

It is well established that voluntary behaviour change to reduce levels of personal aeromobility has not and will not adequately address high and growing aviation emissions (Lassen, 2010). Extensive literatures drawing upon a range of disciplinary perspectives address the challenges of relying on individual responses to common threats. The significant challenges of climate change have been extensively considered in the fields of economics, sociology and psychological science, among others (see Stern, 2007; Randles & Mander, 2009; Urry, 2009; van der Linden, 2014; van der Linden, Maibach & Leiserowitz, 2015). Similar attention has been paid to climate change specifically in relation to discretionary air travel and the tourism industry (Tol, 2007; Dwyer, Forsyth, Spurr & Hoque, 2012; Cohen et al., 2013). The literature now offers abundant evidence of a dissonance between awareness and attitudes and actual behavioural change (e.g. Kollmuss & Agyeman, 2002; Miller et al. 2010; Hares et al., 2010; Hibbert et al., 2013; Kroesen, 2013), despite growing public concern over the climatic and associated environmental impacts of air travel (Higham & Cohen, 2011; Higham et al., 2014). Little traction has been gained in achieving emissions reductions in tourist air travel practices through voluntary consumer-led responses, whether that be through the public travelling less, holidaying domestically rather than abroad, giving preference to less distant destinations, transport modal shifts, or paying to offset the GHG emissions of flights (Miller et al. 2010; Dickinson et al. 2010; Mair, 2011; Cohen et al., 2014; Becken & Mackey, 2017). These failures have led to increasing calls for progressive political action to achieve radical aviation emissions reductions (Cohen et al., 2014; Young et al., 2014; 2015).

Given widespread acceptance that climate change is a major risk to human wellbeing (Stern, 2007; IPCC, 2014a) and that international air travel is a largely discretionary activity that is a major cause of carbon emissions (Bows, Anderson & Peeters, 2009; Becken & MacKey, 2017), why have voluntary consumer-led strategies been so ineffective? We will argue that such strategies are bound to fail owing to the way human beings reason about future harms. We begin by arguing, that despite the beliefs just noted, travellers do not behave as if their discretionary air travel is morally problematic. We then employ the heuristics and biases literature (Kahneman *et al.,* 1982) to explain this apparent disconnect between our beliefs about the harms caused by air travel and the insouciance with which we engage in this harmful activity. We set out a variety of well-established cognitive heuristics and biases that make it all but certain that travellers will not curb their own flying and that voluntary carbon offset schemes will not raise funds sufficient to cover the real costs of international air travel.[1]

Problems of risk and rational decision-making

The moral status of air travel

Human reasoning about future harms such as those associated with anthropogenic climate change (ACC) lead us to critically consider the moral status of air travel. Unlike the act of lying, most who travel by air do not treat flying as morally problematic (Cohen & Higham, 2011; Higham et al., 2015). Even though a 'white lie' might be best for all concerned, nobody wants to be caught in the act of lying. By contrast, even though commercial jet flight is always a harm to the environment and often a discretionary activity, flyers are not embarrassed to be seen boarding a plane. The behaviour of flyers suggests that, either they believe the benefits of their flight to outweigh its marginal costs, or perhaps they believe that flyers in general cannot accurately estimate of the costs and benefits of air travel and hence they cannot be held responsible for failing in this particular moral calculation (Higham et al., 2015).

It might be objected at this point that flyers do not have to make accurate assessments of the costs of their flights because such information is readily available from carriers and various environmental and governmental organisations. There is some incomplete and mostly non-transparent information available (Becken & Mackey 2017), and flyers make assessments of the epistemic reliability of what information they do receive (Higham et al., 2016) and hence information discouraging unnecessary flights or promoting the benefits of carbon offsets has been found to be commonly ignored if it does not reinforce travellers' preferred views on the relevant costs and benefits (Gössling, Broderick, Upham, Ceron, Dubois, Peeters & Strasdas, 2007; Cohen & Higham, 2011). In this case, even if flyers believe the general scientific consensus about global warming (Higham et al., 2014), they might have little confidence in the available information if they think, for example, that environmental groups simply want to limit flying in general (and hence will not really be interested in their particular consequentialist calculation), or that airlines and governments will benefit from under-selling the environmental costs and perhaps overselling the benefits of offset schemes.

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[1] In this paper we aim to establish that any emissions reduction scheme that relies on voluntary individual decision makers rather than collective action will necessarily fail due to cognitive and structural problems outlined in this and the following section. However, realistically, even if individual travelers were cognitively able to estimate and mitigate the harms caused by their flying behaviour, they would not be able to do so because the scale of aviation emissions is too great for offsetting to do more than aid in transition to a more sustainable equilibrium (see Becken & Mackey 2017).

Cognitive biases and judgments about harms caused by flying

The insouciance of flyers may be usefully explained by the cognitive heuristics and biases characteristic of human assessments of future costs and benefits. These habits of mind have evolved in us to promote fast and efficient reasoning in common situations, but they have been demonstrated to produce faulty reasoning when employed in domains unlike those in which we evolved (Gigerenzer & Todd 1999). So are people really unable to comprehensively assess and act upon the costs and benefits of their own air travel?

Availability bias

When asked to make judgments of relative risk, people rely on their ability to call to mind instances of the harms in question (Esgate & Groome 2005). A sensible means for a hunter-gather to assess the likelihood of encountering a lion, was to call to mind actual sightings and reports from trusted friends. In the modern world, the same inductive mechanism works less well. Subjects in a study by Lichtenstein et al. (1978) judged incorrectly that deaths from accidents were more common than deaths from diseases (when the latter are 16 times more common than the former). They also judged that murder was more common than deaths from diabetes or stomach cancer. In a follow-up study, Coombs and Slovic (1979) show that such judgments are correlated with selective reporting in newspapers. We are more likely to see reports of deaths by accident or foul play than deaths from illness, and hence we intuitively think of accidents and murders as more likely ways in which we might die.

So what does availability bias tell us about our reasoning concerning air travel and global warming? In one sense the relevant harms are all around us (weather destruction, flooding, extinctions, famine etc.) but these are sorts of harms that have always occurred and hence do not specifically signal future risk in a warming world. The sort of harms that would *unequivocally* signal global climate catastrophe (radical permanent climate shift, massive sea level rise, etc.) are all yet to happen and hence are not cognitively available to tweak the intuitions of the travelling public. Kates (1962) argues that under-reaction to threats of flooding may arise from 'the inability of individuals to conceptualize floods that have never occurred.' Hence availability bias makes us think that global climate catastrophe is unlikely, despite what the scientists say (IPCC, 2014b), and so it predisposes us to think that the benefits of our travel in all likelihood outweigh the costs.

Confirmation bias

Wason (1960) shows that people look for confirming rather than disconfirming evidence for theories they antecedently prefer. This is true both in the way we test theories and in the way we choose sources of information to assist in theory evaluation. When asked to assess a mathematical rule, subjects who expressed high confidence in their assessments routinely failed to consider potential falsifying instances. More generally, people look for patterns that confirm their preconceptions, failing to test patterns that would prove them wrong. If we really wanted to test our world-views, right wing people would watch left wing newscasts on the off-chance that their opponents might prove them wrong, but that's not the way humans generally function (Wason, 1960).

Taber and Lodge (2006) show that this effect is even stronger when the theory in question is emotionally charged (e.g. political beliefs). When the phenomenon in question is highly stochastic, like climate, it is very easy to find phenomena that corroborate one's own beliefs. Similarly, as long as people believe there are some skeptical experts, confirmation bias will motivate them to ignore the views of non-skeptics. So, it should not be surprising that some travellers are still skeptics about global warming. This effect will be stronger for people who rely on social media for their news as social media amplifies the opinions of like-minded people (Bozdag 2013). It will be stronger still in individuals who have a great desire to travel or who are politically sceptical about government intervention in daily life because these factors will make such decisions more emotionally charged. So confirmation bias may cause those who fly regularly to think that their travel decisions are better supported by the science than they really are.

Probabilistic reasoning and the Conjunction fallacy

The problem of assessing costs and benefits in the face of global warming is made all the more difficult by the fact that the evidence is highly probabilistic. Human beings are much better at making simple logical deductions than they are at assessing probabilities. People routinely break the rules of probability claiming, for example, that the future risk of A+B is greater than the risk of A (Tversky & Kahneman 1974; for an application in the context of environmental policy, see Medvecky 2012). Moreover, assessments of likelihood are often influenced by the specificity or vividness with which phenomena are described (Yudkowsky 2008). As the dangers of global warming are diffuse and wide-ranging, people are likely to mentally discount them while accentuating the risks of vivid and specific (but unlikely) scenarios involving terrorism for example. Faced with this problem, newscasters can accurately depict climate using diagrams and statistics which, by their nature, are insufficiently vivid. Alternatively, they can show hair-raising videos of wild weather but, as most people are now well aware, weather and climate are very different things.

It may be due to these cognitive biases that travellers are unlikely to be reliable at estimating the real risk posed by global warming and hence are likely to underestimate the cost of their own individual acts of air travel to themselves and future generations. That said, many people do agree that global warming is a threat and that it is exacerbated by air travel (Higham et al., 2016). This leads us to consider what cognitive bias tell us about the prospects for voluntary carbon offset schemes.

Cognitive biases and judgments about carbon offset payments

Payments to ameliorate future costs are sensitive to perceptions of risk (Zhou-Richter et al 2010). Someone who knows their car will eventually expire, knows that it is prudent to try to save the full amount of a replacement. Someone who owns a house and thinks it possible, but unlikely, that their house will burn down, will be willing to pay an amount for insurance that is leavened by their perception of the fire risk (Zhou-Richter et al

2010). This is unfortunate given the difficulty for travellers of assessing the likely harms caused by a particular flight. The problem is made worse given the cognitive biases outlined above which make travellers likely to underestimate the extent to which an isolated individual act of air travel will exacerbate the risks of global warming. A further problem is presented by cognitive biases that diminish our ability to make intuitive numerical assessments of value, and particularly of judgments about how much we should pay to ameliorate future harms.

Anchoring and Adjustment

Human reasoning can be strongly affected by information that has little to do with the problem an individual is trying to solve. For example, when asked to make a snap judgment (in under five seconds) of the product of the numbers one through eight, subjects presented with the calculation "1 x 2 x 3 x 4 x 5 x 6 x 7 x 8 = ?" guessed on average 2250. Those presented with the calculation "8 x 7 x 6 x 5 x 4 x 3 x 2 x 1 = ?" guessed on average 512 (Tversky & Kahneman, 1974). Anchoring is a cognitive bias in which people's intuitive judgments are strongly influenced by in initial reference value and then adjusted around that value. The anchor might be an initial estimate of the value of some item over which individuals are bargaining but the anchoring effect still occurs where the initial value is obviously wrong and unrelated to the problem at hand (Strack and Mussweiler, 1997) and even where subjects are specifically warned to guard against the effects of anchoring with respect to a particular judgment (Wilson et al., 1996).

Given that advertisers are well aware of this effect, they are in a good position to influence travellers to make low estimates of what counts as a reasonable carbon offset. Given Tversky and Kahneman's findings, we can predict that airlines that offer carbon offsets to the value of $200 or $100 or $50 or $20, will receive different offset payments than ones that offer offsets to the value of $20 or $50 or $100 or $200. Passengers of the first airline will anchor on $200 and adjust from there while passengers of the second will anchor on $20 and so likely end up with a much lower estimate of the value of a reasonable carbon offset fee. If this is right, the effectiveness of voluntary carbon offset schemes are likely to be strongly influenced by factors that have little or nothing to do with the amount of harm done by global air travel and the amount of money required to ameliorate that harm. A further problem for voluntary offset schemes is raised by a group of studies suggesting that estimates about what it is reasonable to pay to ameliorate uncertain future harms, are often completely decoupled from estimates of the relevant risk. The discussion here addresses cognitive presumptions, setting aside the manifold reasons to reject offsetting as an adequate response to accelerating aviation emissions (Smith & Rodger 2009; Becken & Mackey 2017).

Scope insensitivity

Kahneman and Knetsch (1992) argue that people donating to charity often see themselves as purchasing moral satisfaction and that the amount they are willing to pay is relatively insensitive to the actual nature and extent of the harm to be ameliorated. Subjects were asked how much of a tax increase they would accept to install nets protecting migrating birds from drowning in uncovered oil ponds. They were told that the problem affects 2,000 or 20,000 or 200,000 birds annually. The average assessment of a reasonable payment to prevent this harm was $80, $78, and $88 for each of the three cases. Kahneman et al. (1999) argue that willingness to pay here is most likely driven, not by the size of the problem, but by "a mental representation of a prototypical incident, perhaps an image of an exhausted bird, its feathers soaked in black oil, unable to escape" (p. 212).

Scope insensitivity will obviously limit the estimated size of 'reasonable' carbon offset payments in a way that is insensitive to the actual costs of the relevant harms or the costs of possible amelioration strategies. If the amount that air travellers are prepared to pay in voluntary carbon offset schemes is driven, not by the magnitude of the harms caused by air travel, but by the subjective cost of moral satisfaction or achieving a warm fuzzy feeling from 'helping', then such schemes will be insensitive to the size of the harms they are designed to ameliorate.

Evolution has bequeathed human beings a psychology that focuses on proximate threats and opportunities (Dyke & Maclaurin 2002). Consequently we are poor at estimating the risks of large-scale, complex, long-term threats such as global warming. Our intuitions about how to deal with possible threats are relatively insensitive to large-scale long-term dangers (Dyke & Maclaurin 2013). It is therefore inevitable that most people will have unreliable judgments about modifying their behaviour in light of global warming. In short, it is evident that the effects of international air travel on global warming cannot be addressed by encouraging individuals to abstain from travel or make charitable donations to carbon offset schemes (Gössling et al., 2007; Miller et al., 2010; Hibbert et al., 2013; Kroesen, 2013; Young et al., 2014; Bows-Larkin et al., 2016; Becken & Mackey 2017)

A problem of collective action

We have now identified the problem: unconstrained and accelerating emissions associated with air travel threaten everyone's wellbeing (IPCC, 2014b); neither technological efficiency gains nor voluntary action via restraint or the purchase of carbon offsets have had or can have a meaningful effect on emissions growth (Bows-Larkin *et al.*, 2016). We have also demonstrated that the most common present-day response to the problem - encouraging voluntary, individual rational responses to those risks - cannot succeed due to the nature of human reason and the structure of the problem itself. At this point, then, rather than despair of the possibility of bringing our travel-related aviation GHG emissions under control, we turn to a much more promising solution - reframing the issue as a problem of coordinated collective action.

Escaping the high-carbon air transport regime

"Collective action arises when the efforts of two or more individuals are needed to affect an outcome" (Sandler 2004: 17). We have been looking at the individual-level decision to take a flight and therefore emit a certain amount of GHGs, increasing, however marginally, the risk of damage from associated climate change. The relevant *outcome* here is the threat risk we seek to reduce, and this threat risk arises from the aggregated effects of the industry as a whole.[2] Although as individual flyers our decisions may increase experienced risk by a small amount, the risk we seek to mitigate is the one arising from all of our actions, aggregated, not the risk that arises from our (*per impossibile*) isolated behaviour. We might, with Derek Parfit, call the individual-level approach the error of "ignoring the effects of sets of acts." The moral logic of sets of acts is different than the moral logic of isolated ones (Parfit 1984, 70). This is why the trope of accusing climate change activists of hypocrisy when they fly is mistaken. Their moral duty is to promote the collective actions that can reduce the wrong in question (excess GHG emissions). Not only are they incapable of effecting the desired change via uncoordinated action, but in many cases they would be acting contrary to duty by weakening themselves vis-à- vis the defenders of the high carbon transport regime (see footnote 3).

Once we reframe the problem of adding GHG emissions to the global atmospheric sink via airline travel as a collective action problem, we can see that refraining from doing so is likewise collective. It is helpful to think of the remaining capacity of the earth's systems to absorb excess GHGs as a global public good, one that no one can be excluded from using, but one that requires action on at least some and probably many people's parts to provide. In cases of public goods like the global atmospheric sink, the best description of the moral dilemma faced by all of us is the 'tragedy of the commons' (Hardin, 1968; Ostrom, 1990; Brousseau, 2012). In the absence of coordinated collective action to reduce emissions, each of us faces a choice between (1) reaping the immediate, excludable[3] gains associated with airline travel along with the miniscule, delayed, and distributed costs of damage done by our additional individual emissions, or (2) foregoing immediate excludable gains, and avoiding the small portion of costs our travel would have distributed to us along with everyone else on the planet. Combine this structural circumstance with the arguments given earlier about human reason and risk assessment, and one can see that nearly everyone would choose certain short-term individual gain over uncertain long-run collective loss prevention (see also Akerlof, 1991).

The 'tragedy' in the tragedy of the commons now makes itself plain: if everyone chooses short-run gain and its associated distributed costs, everyone will end up worse off. An individual recognizing this collectively irrational outcome could choose unilaterally to forego air travel and its associated gains and emissions. Then that individual would lose the excludable benefits of air travel while experiencing all of the distributed effects of everyone else's emissions; the 'warm glow' gained by refusing to dump excess GHGs into the atmosphere is more than counterbalanced by the cold reality that the collective outcome remains unsustainable (Andreoni, 1990; Kahneman & Knetsch, 1992). Our

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[2] This is the heart of the dynamic associated with the tragedy of the commons (Hardin, 1968): while each contributes a small portion of the total load on a system, each *experiences the effects of the system as a whole.* While the system remains functional, this encourages unsustainable free riding. Once the system becomes overloaded, everyone is much worse off. Moreover, identifying the problem in time to prevent system overload will not resolve it, because unilateral sacrifice will only marginally delay a tragic outcome while rendering the sacrificer powerless. As Hardin tartly puts it, "conscience is self-eliminating."

[3] 'Excludable' means that a good and its associated benefits can be restricted to a single user; conversely, "non-excludable" gains cannot be restricted but may be enjoyed by anyone.

moral duty, then, is to now advance coordinated collective action on tourist aviation emissions.

The intergovernmental international aviation policy context.

The international policy context regarding aviation emissions is historically complicated (Stern, 2007; Smith & Rodger, 2008). Twenty years ago international aviation emissions were excluded from the Kyoto Protocol (1997), due to the lack of agreement on the calculation and allocation of emissions (see Smith & Rodger, 2009). At that time responsibility for addressing international aviation emissions was devolved to the International Civil Aviation Organisation (ICAO)[4]. Over the course of two subsequent decades (since 1997) there has been a growing sense of apprehension and disquiet arising from the lack of effective action and progress made under the ICAO framework (Smith & Rodger, 2009). More recently, the European Parliament's Committee on Environment, Public Health and Food Safety (2015: 9) observed that, "Initiatives and actions taken by ICAO and IMO [International Maritime Organisation] to address GHG emissions started late and have been insufficient … they do not take appropriate account of global decarbonisation requirements".

After many years of failure to adequately respond to international aviation emissions (Bows, Anderson & Peeters, 2009), most notably the 15th Conference of the Parties (COP15) United Nations Framework Convention on Climate Change (UNFCCC) (the *Copenhagen Summit 2009*), a breakthrough was achieved at the 21st Conference of the Parties (COP21) to the UNFCCC. The Paris Climate Agreement (*L'Accord de Paris*), which was drafted between 30 November-12 December 2015, carries the commitment of 196 countries (Parties to the Agreement) to the overarching goal of stabilizing global average temperatures below +2°C relative to pre-industrial levels (UNFCCC, 2015). Indeed most of the signatories have committed to the 'intent to pursue a +1.5°C target'. This "…remarkable international consensus …has set the world on a new path of international collaboration on the grand challenge of global climate change… "(Scott, Hall & Gössling, 2016b: 1). Governments now face the significant challenge of developing policies and strategies to meet their National Determined Contributions (NDCs) that are aligned with stated 2030 emission reduction goals (UNFCCC, 2015).

The Paris Climate Agreement was celebrated as a great diplomatic success (Harvey, 2015) and a critical turning point in the transition to a low carbon global economy (Vidal, Stratton & Goldenberg, 2009). However, the success of the Paris Climate Agreement (2015), and its implications for global wellbeing, will be determined by the execution of 2030 NDCs (Clémençon, 2016). Scott et al. (2016b:1) observe that the Paris Climate Agreement "… sets a new trajectory for international and national climate policy" and the climate policy responses of the Paris signatories will largely determine whether the

[4] The International Civil Aviation Organisation (ICAO) is a specialized agency of the United Nations. ICAO was established by the Convention on International Civil Aviation (Chicago Convention) 1944 to coordinate and regulate international civil aviation. ICAO provides frameworks to address air space sovereignty, international aeropolitical arrangements, airworthiness and safety and, over the last two decades, addressing the challenge of aviation emissions mitigation.

most severe consequences of human-induced climate change can be averted (Bailey & Jackson Inderberg, 2016). One particularly notable omission from the Paris Climate Agreement, however, was specific targets for international aviation (Scott et al., 2016b). Critical questions relating to precisely how aviation emissions mitigation will be achieved, and the policy relationship between international aviation and national NDCs, remained unanswered at the close of the Paris climate negotiations.

The exclusion of aviation from the Paris negotiations was considered "a major shortcoming" in the Paris Climate Agreement (Scott et al., 2016b: 6). The United Nations responded by charging ICAO with the critical task of addressing this significant gap in the provisions of the agreement (Tollefson, 2016). While the Paris Climate Agreement has been recognized as an important, if long overdue, progressive step, the intergovernmental policy response to the exclusion of aviation emissions, was delegated to the 39th ICAO General Assembly (Montréal, Canada, 27 September-7 October 2016). The Air Transport Action Group (ATAG) issued a press release at the conclusion of the COP21 Climate Talks in Paris, appealing to governments attending ICAO's 39th Assembly to "…redouble their efforts in progressing a global market-based measure for the aviation sector (and)… to increase their engagement and ambition to reach agreement (ATAG, 2015: np).

Collective action

As we saw in the first section of this article, the accelerating effects of uncontrolled air-travel-related GHG emissions are a growing threat to our collective social and environmental well being (Bows-Larkin *et al.*, 2016), even threatening our continued existence (IPCC, 2014a, 2014b). The collective action perspective does not expect individuals to respond in an uncoordinated way to the risks of tragic outcomes like this one, since uncoordinated individual action merely exposes each individual to the certain loss of personal benefits of air travel and the likely costs of everyone else's unchecked emissions (Higham *et al.*, 2016). Instead, the collective action perspective directs our moral reason to search for the means to coordinate our actions and reduce both risks and uncertainty (Ellis, 2016). What, then, should we do?

Standard solutions to problems of the commons include privatisation and regulation (Hardin 1968; Sinden 2007). The privatisation solution eliminates free riding and gives actors longer run interests in sustainable management of the resource. Privatisation works well for some resources (relatively bounded fisheries, for example), but cannot work for the global atmospheric sink, which is unbounded in principle (Libecap 2012; Sinden 2007). To achieve the coordination that would reduce GHG emissions to sustainable levels, we must regulate our common behaviour so that our aggregated pursuit of short-run individual interests does not, as Garrett Hardin puts it, "bring ruin to all" (Hardin 1968).

To argue that collective action is needed is not to argue that market signals do not work to coordinate mass behaviour: price signals are essential to any collective effort, via international agreement and/or national legislation, to reduce aviation emissions. Cap-and-trade schemes like the proposed Australian carbon pollution reduction scheme or the recently strengthened European Union Emissions Trading System can reduce absolute emissions if they combine an inclusive market with a 'sinking lid' scheme for annual reductions in permitted emissions such that emitters experience a real and increasing price for carbon-intensive activity. Other essential aspects of such a policy include strong monitoring and enforcement, systems to reduce volatility, and mechanisms like price collars to ensure that the outcome of the scheme improves on business as usual (Schmalensee & Stavins 2017).

We can view the high carbon air transport system as a suboptimal social convention that requires coordinated action to change (Lewis 1969, Mackie 1996, Hechter & Satoshi 1997, Sugden 2004). For these kinds of problems, including not only high-carbon transport but a wide variety of social norms that members cannot unilaterally abandon without paying prohibitively high personal costs, coordination in the form of regulation is essential (Hardin, 1968; Hardin, 1982). But, crucially, the regulation solution does not require a global sovereign or even an all-inclusive regulatory regime (Ostrom, 1990). Research supports the efficacy of commons-managing regimes that operate as clubs (Nordhaus, 2015), begin with a critical mass of key actors (Brechin, 2016), harness the advantages of leadership to encourage early adoption of new standards (Sandler, 2004), and focus on short-run co-benefits of cooperation rather than long-run sustainability (Olson, 1965).

How to get there from here

Global leadership for collective action

Global policy leadership has been the exclusive domain of the member nations of the ICAO. Following the Paris instructions of the UNFCCC (2015), on Friday 7th October 2016 the ICAO 39th General Assembly passed a resolution to implement a global regime to address aircraft CO_2 emissions, claiming in doing so to be the first industry sector to adopt a global mechanism to address its carbon emissions. On that date the ICAO members agreed a global market-based mechanism (GMBM), the 'Montréal Agreement', in the form of a carbon offsetting and reduction scheme for international aviation (CORSIA). This differs from the 'cap and trade' approach of the European Union's aviation emissions trading scheme (ETS) in that it does not required airlines to stabilize or reduce CO_2 at source (Rock, 2016). The agreement begins with a voluntary pilot phase (2021-2023), the purpose of which is unclear (Hodgkinson & Johnston, 2016). The first 'formal' phase (2024-2026), which is also voluntary, and the second mandatory phase (2027-2035) then follow. The USA and China were notable early volunteer phase participants, although the subsequently elected Trump Administration has reversed this commitment. Brazil, one of the fastest-growing aviation markets, declined to join until the mandatory second phase in 2027 (Hodgkinson & Johnston, 2016). India and Russia also chose to opt out of the voluntary phases of the agreement.

A critical review of the Montréal Agreement reveals that CORSIA will only apply to CO_2 emissions (excluding NOx and particulates among others) (Rock, 2016). The claim that ICAO has achieved a global agreement is undermined by the fact that CORSIA is voluntary and only applies to international flights of signatory nations. This excludes all domestic flights (about 40% of total global aviation emissions), which will only be accounted for in national emission inventories (such as the EU's aviation ETS) if and where such inventories come to exist. Rock's (2016) critique of the global coverage of CORSIA extends to:

1. *Exemptions:* in addition to domestic aviation emissions, exemptions also apply to all airlines that are responsible for emissions below the threshold figure of 10,000t CO_2 per annum, all aircraft below 5,700 kg maximum take-off mass, and all flights to or from Least Developed Countries (LDCs), Small Island Developing States (SIDs) and Landlocked Developing Countries (LLDCs).
2. *Level of ambition:* Only emissions that exceed the international aviation 2020 future baseline will be subject to CORSIA.
3. *Distort behaviour:* As the scheme comes into effect, there is potential for airlines to re-route their scheduled international services to include near-destination airports that are located in countries that are exempt or excluded from CORSIA (i.e., LDC, SIDs or LLDCs), to avoid ICAO offsetting obligations (Rock, 2016).

Even if CORSIA were able to overcome all of these serious problems, its anticipated use of offsetting and anticipated efficiency gains in a context of continued growth means that absolute reductions in emissions will not happen (Becken & Mackey 2017). These points highlight the failure to reach agreement on the goal of carbon neutral growth from 2020, which was agreed in principle at the 37th ICAO Assembly in 2010. CORSIA is estimated to apply to only 40% of total global aviation emissions. Despite this, the United Nations Secretary-General Ban Ki-Moon welcomed the adoption of an emissions standard and congratulated the ICAO member states on progress towards controlling international aircraft emissions. He also called for 'further strengthening of emissions standards as quickly as possible, in line with the scientific imperative for action' (United Nations, 2016). EU Transport Commissioner Violeta Bulc claimed that after years of failed negotiations the most important outcome was to secure a deal in Montréal (*Bulletin Quotidien Europe*, 2016). The more critical appraisals of the Montréal Agreement centre on three key concerns.

First, there is doubt surrounding the very concept of *carbon offsetting*, not only because of the impracticalities of offsetting (see Smith & Rodger, 2009), but because offsetting has little effect on net emissions and may function only as a 'diversion from regulations that genuinely encourage emissions reduction, such as carbon pricing' (Hodgkinson & Johnston, 2016). In addition, the Montréal Agreement is predicated upon *carbon neutral growth* from a future (2020) baseline, which has been criticized as a 'low bar for an international climate agreement' (Milman, 2016). All emissions up to the 2020 benchmark, both pre-dating and post-dating that year, will not have to be offset, 'despite representing the vast bulk of future emissions' (Milman, 2016). Third, CORSIA is seen to be beset by loopholes. Participation is voluntary during the first phases (2021-2026) (Ryan, 2016) and nations that volunteer to take part can opt out (Milman, 2016). Writing in *The Age* (9 October 2016), Ryan (2016) suggests that 'the aviation industry has managed to get away for years with doing nothing about its growing carbon-emission problem, and now it's giving itself even more years to do very little'. Fundamentally, aviation continues to exist with no limits on it CO_2 emissions (Eickhout & Taylor, 2016). While claiming a global agreement for aviation, it is evident that ICAO has (again) failed to adequately respond to the UNFCCC (2015) imperative to address global aviation emissions in accordance with the Paris Climate Agreement.

Sub-global leadership for collective action

Rational coordination of our collective flying behaviour toward sustainability is possible at the global (intergovernmental) and sub-global (national) levels. Just as the global ban on CFCs was possible once major industrial producers realised that it was in their interests to lead rather than resist the transition, so wide-reaching regulation of air travel will be possible once some countries and NGOs step up to lead the way (Murdoch & Sandler, 1997; Sandler 2004). For example, countries that adopt air transport carbon charges that return to the maintenance and enhancement of their tourism sectors will enjoy immediate short-run advantages over their competitors in the sector, as they will be replacing marginal and relatively invisible price advantages under the old regime with highly visible and marketable low-carbon advantages under the new one. [5] Even though solutions at the sub-global level would still allow free riding and cost externalisation in the short term, these sub-global solutions would pave the way for a more comprehensive regime in the future.

Once some have seized the advantages available to early adopters, the constellation of interests constraining the rest of the world shifts. Now everyone has an interest in joining the successful club rather than the group caught in a collective race to the bottom (cf. Roelfsema, 2007). They now share an immediate reason to empower a central authority capable of solving their commons problem by insuring that no one is able to free ride profitably. Ideally this process would be undergirded by global norms articulated by the ICAO, which would further encourage individual countries to show the leadership that would make transition from the high carbon regime possible. To date, efforts to address international aviation emissions at the sub-global level have only been advanced by the European Union (Duval, 2013). While the ICAO has expressed it strong preference to avoid a 'dreaded patchwork' (Rock, 2016) of national responses to reducing aviation emissions, that pathway now seems inevitable.

[5] Many factors affect demand for tourism products. While demand normally falls as price rises (and in fact, overall, this is the mechanism on which we must rely to reduce overall air-travel related emissions), factors such as substitutability and patterns of demand particular to some kinds of tourists will affect demand for relatively green tourism destinations. Carbon charges earmarked for return to tourism infrastructure investment could substantially reduce the substitutability of a region's tourism product while only marginally increasing the cost of that product (within elasticity of demand). For example, a study of determinants of demand for international leisure travel to New Zealand found that consumption behavior of tourists in their countries of origin was most highly correlated with demand for travel, while the cost of airfare was relatively unimportant (Small & Sweetman, 2009). A study comparing elasticity of demand for international leisure travel to New Zealand among 16 market segments found low price sensitivity to changes in airfare for most groups, concluding that "international visitors to New Zealand are unlikely to greatly change their travel behaviour...even for transport price increases (e.g., the international airfare)" (Shiff & Becken 2011, p. 571). A study for the industry group International Air Transport Association found that demand for aviation is relatively price insensitive, and thus "demand-side policies…that try to reduce emissions by raising the price of travel for passengers are likely to fail" (Smyth and Pearce 2008). Appropriate policy instruments would therefore include offsets only as a transitional measure, while using a combination of 'sinking lid' emissions caps and carbon pricing to signal real costs to the aviation industry.

Conclusions and avenues of future research

Air travel produces a large and growing portion of the world's greenhouse gas emissions (Boeing, 2014; Airbus, 2014). As a driver of anthropogenic climate change, aviation threatens everyone's wellbeing (IPCC, 2014a). The allocation of responsibility to respond to this threat may centre on uncoordinated individual consumers and/or coordinated sub-global (national) or global (intergovernmental) policy action. Our paper addresses the failure of uncoordinated individual responses to aviation emissions (Kollmuss & Agyeman, 2002; Miller et al. 2010; Kroesen, 2013), by way of a theoretical analysis of the nature of human reason and the structure of the problem itself. Drawing on decision-making theory we highlight the inability of individuals to accurately evaluate and act on the growing risks associated with aviation emissions. We conclude that participation in the high-carbon air travel regime is a social convention, and effective transition from social conventions requires policy-led coordination among players (Banister & Hickman, 2013; Schwanen, 2016), which in turn promotes our moral duty to seek collective action through urgent global or sub-global policy leadership.

We are facing a problem that individuals acting independently cannot resolve. It is a problem that not only hinders cooperation, but blinds and delays us from seeing the costs associated with unrestrained anthropogenic climate change, which we will ultimately have to collectively confront (Stern, 2007; IPCC, 2014a). Ambitious reductions in transport CO_2 emissions can be achieved by reducing total global demand for high carbon transportation (speed, distance and frequency), energy intensity (fuel efficiency and modal shifts), and/or carbon intensity (fuel shift) (Peeters & Dubois, 2010; Scott, Hall & Gössling, 2012). We argue that such ambitious reductions cannot be achieved by individuals operating in isolation due to a variety of cognitive heuristics and biases that make it most unlikely that travellers will voluntarily reduce, or otherwise mitigate the impacts of their own flying, or that any such efforts will achieve 'deep-cut' carbon mitigation (Becken & Mackey, 2017).

The same cognitive heuristics and biases are likely to also apply to carbon offsetting. Barriers to the uptake of carbon offsetting fall into two categories; lack of knowledge and awareness (Chang, Shon, & Lin, 2010; Gössling et al., 2009; McKercher, Prideaux, Cheung, & Law, 2010) and the public perception that offsetting schemes lack credibility and are confusing and intransparent (Broderick, 2008; Gössling et al., 2007; Polonsky, Grau, & Garma, 2010; Higham et al., 2016). Decision making theory and collective action theory have not been specifically tested in past research relating to aviation emissions reduction. Firstly, then, the research agenda should address cognitive biases and decision-making problems, and how the attitudes of air travelers might be influenced to encouraging meaningful voluntary air travel behavior change.

Collective action can take various forms and many political, economic, legal, religious and media (mass and social) institutions have important roles to play in building a gathering momentum of collective action. The Paris Climate Agreement requires that aviation emissions peak and then decline rapidly (Scott et al., 2016). To achieve this, policy-makers must "…use the full suite of policies at their disposal" (Creutzig et al., 2015:911) in order to meet the nationally-defined commitments expressed in the Paris Climate Agreement. While steps towards a collective response were achieved in the

Montréal Agreement (2016), our theoretical discussions lead us to conclude that current international policy mechanisms, as expressed at the conclusion of the ICAO 39th General Assembly (Montréal October 2016), are inadequate, falling well short of the aspirational goals articulated in the Paris Climate Agreement (UNFCCC, 2015). This represents a continuation of the longstanding failure of the ICAO to provide an adequate collective (intergovernmental) response to the aviation emissions quandary (Bows-Larkin et al., 2016). The contributions of these institutions are worthy of further research. Who are the members of ICAO and ATAG; who are represented in the executive structures; who is represented in their executive structures; what have been, and who is accountable for, their past actions? It is interesting to consider that government ministers and international agency leaders are prone to the same biases that we have addressed in this paper. There is little reason to believe that national and international agencies are any less prone than individuals to the same biases and this, too, should be subject to empirical research.

Our discussions lead us to conclude with a call for urgent sub-global policy action on the part of national governments to respond to their own national and international aviation emissions, in accordance with their own Paris commitments as expressed in their NDCs (Scott et al., 2016). Thus, the way appears to have been opened for a so-called 'patchwork' (Rock, 2016) of national responses to aviation emissions mitigation, following the failure of an adequate intergovernmental response in Montréal. This signals a need to consider the competitive opportunities available to national tourism destinations that seek a position of leadership in sustainable aviation. Two decades of failed global measures[6] has opened the way for leadership exercised by vanguard national governments to change the game for the rest of the world. The ways and means by which national and regional destinations may make it possible to choose the collectively rational option of transition to sustainable travel offers a particularly timely and opportune avenue of research. To date we have seen **"...** little appetite among policy-makers for seriously discussing thorny transport issues in public debates and international climate negotiations" (Creutzig et al., 2015:911). Unless this changes, little can be done to shake aviation from its 'parallel universe' (Eickhout & Taylor, 2016) and address aviation's ever growing contribution to high-risk emissions.

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