Tourism's climate mitigation dilemma: Flying between rich and poor countries

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\textbf{Highlights}

- The impacts of climate mitigation policies aimed at reducing tourism transport may be less severe than is often believed.
- Reducing tourism air transport affects poor and wealthy countries equally.
- A reduction in aviation may harm the development of some poor countries but may benefit others.
- Economic compensation for negative cases is feasible.

\textbf{Abstract}

Stronger demand for medium- to long-haul air transport is the main driver of the tourism industry's increasing greenhouse gas (GHG) emissions, causing the current development of global tourism to be environmentally unsustainable. Efficiency improvements and biofuel usage are unlikely to maintain pace with the projected growth in transport volume. Therefore, curbing the growing demand for air transport has been suggested as another option for the sustainable development of tourism. However, the political and industry discourse concerning the restriction of air transport tends to label such a restriction as unethical, as such limits would impair the development that tourism brings to poor countries. This paper investigates the possible impacts of air travel restrictions on the least developed countries (LDCs) and non-LDCs by examining global tourism. The impacts on LDCs are found to be 'neutral' on average, with both losses and gains in tourist arrivals. The extent of any losses does not appear to be beyond the scope of possible economic compensation.

\textbf{1. Introduction}

1.1. The sustainable tourism paradox

The ‘relationships between tourism and climate change are … likely to be controversial’. Becken and Hay (2007, p. 262) concluded after considering the conflicting requirements of tourism as a tool for developing poor countries and as a vector of climate change. There is a tension between climate change mitigation (planet) and poverty reduction (people) in the sustainable development of tourism, and air transport plays a key role in the discussions surrounding both issues (Daley & Preston, 2009; Gössling, Peeters, & Scott, 2008; Peeters, 2009). Air transport is a dominating and increasing factor in tourism emissions, and it is inevitable that both tourism and aviation will need to reduce those emissions (see Section 1.2). The dominating discourse in the tourism and aviation sector is that ‘measures taken to reduce air transport emissions...’
need to reflect coherence with strategies to reduce poverty and promote development in the world's poorest countries' (UNWTO & ICAO, 2007, p. 1). The industry discourse generally negates the option of reducing air transport to mitigate greenhouse gas (GHG) emissions and assumes that technology will be able to solve the problem (Gössling & Peeters, 2007).

However, several arguments contest this line of thought, citing the international community's commitment to 'hold the increase in global temperature below 2 degrees Celsius' (see for instance UNFCCC, 2009) as a point of departure. Parry, Carter, and Hulme (1996) coined the term ‘dangerous climate change’ as climate change beyond 2°C above the pre-industrial level (see also Rogelj et al., 2009; Rogelj et al., 2011; Schellnhuber, Cramer, Nakicenovic, Wigley, & Yohe, 2006). So with the term ‘dangerous climate change’ we always refer to a climate change of less than 2°C. To avoid dangerous climate change an emission reduction of 60%–90% with respect to global emissions in 2000 is needed (Parry, Lowe, & Hansson, 2008; Parry, Palutikof, Hanson, & Lowe, 2008; Rogelj et al., 2011). First, the aviation sector will not fit within such a sustainable future without a reduction in the (growth of) air transport (Lee, 2012; Mayor & Tol, 2010; Roghtengatter, 2010), i.e., without changes in travel behaviour (Dubois, Ceron, Peeters, & Gössling, 2011; Peeters & Dubois, 2010). These changes refer to travelling shorter distances and a modal shift to low-carbon transport modes (Peeters & Dubois, 2010). Second, insufficient mitigation efforts will likely lead to severe impacts from climate change on poor countries, resulting in, for instance, reduced agricultural production (Hertel, Burke, & Lobell, 2010), floods, and extended droughts (Mendelsohn, Dinar, & Williams, 2006; Parry, Palutikof, et al., 2008). Third, climate change may also affect destinations and global tourism flows, possibly leading to less (long-haul) travel (Ehmer & Heymann, 2008; Hamilton, Maddison, & Tol, 2005).

Thus far, the consequences of air travel restrictions have not been widely researched, and existing studies are generally incomplete in their coverage of the problem. Some studies use international tourism and a limited number of destinations as their basis (e.g. Gössling et al., 2008; Pentelow & Scott, 2011), and others examine the global level in terms of policy scenarios and generally neglect domestic tourism (Mayor & Tol, 2010). Because domestic tourism often supports a large share of a country's tourism industry (WTTC, 2012), these studies are not fully qualified to discuss the effects of a reduction in travelled distances on poor and wealthy countries. In this paper, we investigate the possible impacts of air travel restrictions on least developed countries (LDCs) and non-LDCs (see list in UN-OHRLS, 2009) by examining all global tourism flows, including domestic tourism. The impacts are tested by assuming cut-off distances (i.e., one-way travel distances above which there is no travel). One difference between this study and other contemporary approaches is that we assume that trips above the cut-off distance do not simply evaporate but are instead redistributed throughout the remaining markets (see 1.4). By using this approach, we seek to provide crucial input for an important policy discussion that would otherwise remain focused only on the two extreme scenarios. The following sections elaborate on the mitigation of tourism’s contribution to climate change (1.2) and the role of tourism in poverty alleviation (1.3). We would like to emphasise that these two subjects are the cause for this paper, not the objective, as further clarified in Section 1.4.

1.2. Tourism’s climate mitigation challenge

The contribution of tourism to climate change ranges from 5%, in terms of CO₂ emissions only, to 12% when non-carbon impacts on climate change, primarily caused by air transport, are included (Gössling, Hall, Peeters, & Scott, 2010; UNWTO-UNEP-WMO, 2008).

The share of air transport in these emissions ranges from 40% of CO₂ to 75% of all GHG emissions (Gössling et al., 2010; UNWTO-UNEP-WMO, 2008). Tourism emissions are projected to increase for the next several decades (Åkerman, 2005; Dubois et al., 2011; Mayor & Tol, 2010; Scott, Peeters, & Gössling, 2010). Between 2005 and 2035, emissions will increase by a factor of 2.6 (UNWTO-UNEP-WMO, 2008). The emissions of air transport may increase at least until 2060 (Mayor & Tol, 2010). To avoid ‘dangerous climate change’ and to attain sustainable development, global GHG emissions must be reduced by up to 90% within this century (Parry, Lowe, et al., 2008; Parry, Palutikof, et al., 2008; Rogelj et al., 2011). When the global emission reduction scenario to avoid dangerous climate change is confronted with these increasing tourism emissions, both lines may be crossed by mid-century (Bows, Anderson, & Peeters, 2009; Scott et al., 2010). Thus far, efficiency gains in aviation have been unable to compensate for the growth of the sector (Mayor & Tol, 2010; Owen, Lee, & Lim, 2010; Penner, Lister, Griggs, Dokken, & McFarland, 1999).

The growth of tourism-related emissions is caused primarily by an increase in travel distance because travel distance is increasing more rapidly than the number of guest nights and trips (Peeters & Dubois, 2010; UNWTO-UNEP-WMO, 2008). Tourism volume itself is expected to increase by 3.3% (UNWTO, 2011a) to 4.1% per year (Peeters & Dubois, 2010), whereas the growth of air transport is estimated to be 6% (Airbus, 2011). The key role of longer travel distances and the increasing share of air transport in rising tourism emissions is confirmed by a detailed study from the Netherlands (de Bruijn, Dirven, Eijgelaar, & Peeters, 2012). Consequently, it is important to find specific strategies for reducing aviation emissions.

The main mitigation options for aviation include improving aircraft energy efficiency and operational efficiency, using alternative fuels, and buying emission rights from other sectors (several chapters in Gössling & Upham, 2009). These options are also cited by the International Air Transport Association (IATA, 2009). However, the industry acknowledges that technology and operational improvements, including improved air traffic control, less holding, and taxing are not sufficient to reduce the emissions from global aviation below 2005 levels (IATA, 2009; ICAO, 2009; Sustainable Aviation, 2008). In scientific research, there is also a consensus that although efficiency improvements are important, such improvements are insufficient to compensate for even low projected volume growth (Chèze, Gastineau, & Chevallier, 2011; Lee, 1998; McCollum, Gould, & Greene, 2009; Owen et al., 2010; Peeters & Middel, 2007; UNWTO-UNEP-WMO, 2008). With regard to further reductions, the industry has varying ideas, with biofuels being advocated as the main option (ATAG, 2011; IATA, 2009; WTTC, 2010) and emission trading – buying emission rights from other sectors – suggested by British Airways (2012) and Sustainable Aviation (2008). A more recent publication indicates that biofuels will not be able to provide more than 10% of emission reductions in aviation in the short term (IATA, 2012).

Currently, bioenergy covers approximately 10% of all human energy needs, and biofuels cover approximately 2% of road transport fuel (Edenhofer et al., 2011). Bioenergy potential is estimated to be between 50 and 500 EJ (exajoule: 10²⁴ J) (Edenhofer et al., 2011), compared with approximately 15 EJ for aviation in 2007 (Rye, Blakey, & Wilson, 2010). However, there is a great deal of uncertainty. First-generation biofuels have been strongly linked to conflicts with food production, and the large-scale use of second-generation biofuels cannot be expected in the short term because of ecological and technological barriers (International Energy Agency, 2009; Sims et al., 2011; Timilsina & Shrestha, 2011) and a range of other issues, such as availability, indirect land-use change, social impacts, large water footprints, and undesirable GHG balances (Ariza-Montobbio & Lele, 2010; Dray, Schäfer, & Ben-Akiva, 2012).
CO2 emissions from aviation represent 2% of total emissions available. This availability is currently not a problem because the carbon cost will most likely be as times the impact of all historical aviation CO2 emissions (Lee et al., 2010; Owen et al., 2010). Furthermore, there are some promising third-generation biofuels, such as microalgae; however, current high yield promises may contribute to radiative forcing by a magnitude several times the impact of all historical aviation CO2 emissions (Lee et al., 2010; Owen et al., 2010). Such other contributions consist of emissions of NOx, particles, water vapour, and phenomena like contrails and contrail induced cirrus clouds.

Clearly, with regard to the future of sustainable tourism, developments with less growth or even de-growth in long-haul tourism are not unlikely (e.g. Hall, 2009). Apart from climate mitigation, there are also other reasons for imminent reductions in aviation. For instance, one long-term impact of a cost of US$40 per ton of CO2 could be a 7.4% reduction in demand (Anger, 2010). In scenarios that aim to avoid dangerous climate change, the carbon cost will most likely be as much as US$250–300 per ton of CO2 (Edenhofer & Kalkuhl, 2011), thus potentially causing more significant impacts on aviation demand growth. Finally, one overlooked factor is that biofuels will not reduce the non-carbon impacts of aviation on climate change, which may contribute to radiative forcing by a magnitude several times the impact of all historical aviation CO2 emissions (Lee et al., 2010; Owen et al., 2010). Such other contributions consist of emissions of NOx, particles, water vapour, and phenomena like contrails and contrail induced cirrus clouds.

Developing countries, poverty alleviation, and climate change

Measures directed at curbing the continued growth of aviation have encountered strong opposition from the tourism and air transport sectors, based on what we term the ‘poverty ethics argument’ (see for instance many examples in Lipman, DeLacy, Vorster, Hawkins, & Jiang, 2012). The core of the argument is that reducing air transport would hamper the poorest countries in developing their economies in a sustainable manner. The concept of using tourism as means of development has progressed through several stages, including a significant amount of support in the 1950s, followed by scepticism during the 1970s and 1980s and renewed support for the use of tourism to alleviate poverty beginning in the 1990s (Scheyvens, 2007). The UN World Tourism Organisation (UNWTO) initiative known as Sustainable Tourism – Eliminating Poverty (ST-EP), which was announced in 2002, was a direct response to the Millennium Development Goals (MDGs), which were intended to eradicate extreme poverty by 2015 (WTO, 2005). In 2007, at the UN Conference on Climate Change in Bali, Indonesia, Francesco Frangialli, former secretary-general of the UNWTO, framed his case for unrestricted aviation growth fully within a poverty alleviation context: ‘Those who say “do not travel far from home and avoid taking planes to save several tons of carbon emissions” should think twice. Because these long-haul trips are often to countries that are home to the planet’s poorest populations’ (UNWTO-UNEP-WMO, 2008, p. 21). Aviation is viewed as ‘a key driver in the development of sustainable travel and tourism’ (Lipman et al., 2012, p. 3). Therefore, slowing down aviation and tourism growth simply to reduce carbon emissions will be in no one’s interest. It will destroy jobs and undermine our efforts to reduce poverty (van Schalkwyk, 2012, p. 188).

However, such assumptions appear to exclude the possible negative impacts of climate change on the same poor countries. In fact, these impacts will be the most severe in developing countries (IPCC, 2007; Mendelsohn et al., 2006; Parry, Potacikof, et al., 2008). The World Bank (2012, p. 64) warns that unmitigated climate change ‘could seriously undermine poverty alleviation in many regions’. However, knowledge of the economic effects of climate change remains limited (Tol, 2009). Furthermore, climate change will also affect global tourism flows in an adverse manner overall, particularly with respect to long-haul travel and developing countries (Ehmer & Heymann, 2008; Hamilton et al., 2005).

1.4. Rationale and research questions

As the previous sections indicate, there is a fair likelihood that the unlimited growth of air transport cannot be reconciled with the ambition to mitigate dangerous climate change. Meanwhile, because some LDCs have become increasingly dependent on intercontinental tourism via air transport, there is growing concern that any reduction in growth of air transport would undermine efforts to alleviate poverty in these countries. Thus, a dilemma exists between local development and global environmental sustainability.

Global studies addressing the potential effects on international and domestic tourism flows of hypothetical restrictions to air transport are not available. Numerous assessments of climate mitigation policies on tourism adopt a destination perspective, use an elasticity-based model, and focus on international tourism (e.g. Gössling et al., 2008; Pentelow & Scott, 2011). Consequently, more than 80% of global trips are ignored (Peeters & Landré, 2012), and the assumed cost increases of air transport always result in the loss of tourism. Although this approach may be valid for specific destinations confronting competition from other destinations, the impacts on a global scale may be different. This is an important issue because the argument is used against both regional and global measures for curbing air transport demand. Therefore, we will use a novel approach that is more grounded in tourism geography (Peeters & Landré, 2012) than in tourism economics to investigate the possible impacts of restricting air travel on LDCs and non-LDCs.
by examining all global tourism flows and by including domestic tourism. By using this approach, we seek to provide necessary input for an important policy discussion that will otherwise remain focused only on the two extreme scenarios. We hypothesise that the outcome may be less straightforward than is depicted in cur-focused only on the two extreme scenarios. We hypothesise that tourism. By using this approach, we seek to provide necessary input redistribution by examining all global tourism all known country-to-country tourist the Centre for Sustainable Tourism and Transport (CSTT) containing distances above which there is no air travel). To assess the problem on assuming hypothetical cut-off distances (i.e., one-way travel distances (Swartz, 2010) between the main airports of the origin

2.1. The global tourism and transport database (GTTD)

The impacts of reductions in travel distances are assessed by assuming hypothetical cut-off distances (i.e., one-way travel distances above which there is no air travel). To assess the problem on a global scale, a global tourism and transport database (GTTD) was developed. The GTTD is a Microsoft Excel database we developed at the Centre for Sustainable Tourism and Transport (CSTT) containing all known country-to-country tourist flows and estimated domestic flows. GTTD can calculate the relative change of arrivals per country if a hypothetical cut-off distance is assumed. In addition, trips beyond the cut-off distance can be redistributed. To test our hypothesis, three series of four cases (cut-off distances) are presented. The three series comprise ‘only international trips’, ‘international plus domestic trips’, and ‘international plus domestic trips plus redistribution’. The cut-off distances are 1500, 3000, 6000, and 10,000 km. These distances have been chosen rather arbitrarily, as there is no general standard for long-haul travel, and we sought to show the impacts for a range of distances. GTTD contains a total of 12,568 records (tourist flows) for 221 countries for the year 2005. Each record describes the number of trips, the average one-way distance between origin and destination, the total return distance travelled, and the direction of the trips (e.g., Austria–Belgium and Belgium–Austria are distinguished in two records). Furthermore, the database contains data pertaining to the population, GDP/capita, and surface area for each country as well as a variable that indicates whether a country is an LDC.

The GTTD uses UNWTO international tourist arrival data (UNWTO, 2007). The following three data issues are addressed: reliable domestic tourism figures are not available, distances are unknown, and UNWTO data provide only arrivals per country, not departures. To overcome these barriers, the following steps were taken (see Peeters & Landré, 2012 for a more detailed description of our method):

1. For the majority of countries, arrivals are known for a varying range of countries of origin. By summing all arrivals per country of origin, we calculated departures and thus created a full origin-destination table (12,118 international origin-destination records).

2. Domestic tourist trips per country are based on the relation between the number of trips/capita and GDP/capita (see Peeters & Dubois, 2010; Peeters & Landré, 2012). This ratio, multiplied by population, delivers the expected domestic plus international departures per country. From this number of arrivals, the departures calculated in step 1 were subtracted to obtain the number of domestic trips.

3. The international distance was calculated using the great circle distance (Swartz, 2010) between the main airports of the origin and destination countries. For travel between neighbouring large countries (e.g., the USA and Mexico), this approach resulted in improbably large distances for large flows. We corrected these few cases by hand, assuming a power law relation between distance and the number of trips (‘distance decay’; see further Peeters & Landré, 2012).

4. The domestic average distance was calculated based on a relation between the country’s total land area and the domestic tourist trip distance averages per EU country (as in Peeters, Szimba, & Duijnsveld, 2007). We assumed the EU relation to be valid for most developed countries in the world, with OECD90 countries as defined in IMAGE-team (2006), and we reduced this distance by 20% for all other countries. The reduction is based on the concept that distance travelled is a function of the speed of travel (Banister, 2011; Hupkes, 1982; Zahavi & Talvitie, 1980) and that developing countries will have a less well-developed road infrastructure (see also Peeters & Landré, 2012).

5. For small countries, only one record describes domestic tourism. For the 15 largest countries in terms of domestic arrivals (such as China, India, and the USA), domestic arrivals were redistributed over distance classes with averages of 200, 400, 600 and up to 6000 km one way (or the largest distance physically possible within the specific country). This procedure was necessary to avoid an excessive number of trips in a relatively high-distance class. Here also, a distance decay distribution was assumed (Peeters & Landré, 2012).

A more detailed description of the above procedure can be found in the study by Peeters and Landré (2012). Table 1 summarises the main properties and data of the GTTD. The total number of trips in the database decreases 3% and 1% (international trips), respectively, from those reported by UNWTO (UNWTO-UNEP-WMO, 2008).

2.2. Redistribution

The number of trips/capita is a function of GDP/capita capita (Peeters & Dubois, 2010; Peeters & Landré, 2012). The global number of departures for each country is a function of population

| Table 1 |
| An overview of the GTTD main characteristics. Although the main data source was UNWTO (2007), all of the data that are provided here are obtained directly from the GTTD. See text for an overview of all sources. |

<table>
<thead>
<tr>
<th>Record base for international</th>
<th>Nation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record base for domestic</td>
<td>Nation (except for the 15 largest flows)</td>
</tr>
<tr>
<td></td>
<td>200 km-wide-distance classes for largest domestic flows (e.g., 0-200, 200-400)</td>
</tr>
<tr>
<td></td>
<td>Correction for large neighbouring countries</td>
</tr>
<tr>
<td>Poverty indicator</td>
<td>LDC/other</td>
</tr>
<tr>
<td>Geographical aggregate</td>
<td>SRES regions</td>
</tr>
<tr>
<td>Base year</td>
<td>2005</td>
</tr>
<tr>
<td>Global tourist arrivals</td>
<td>International</td>
</tr>
<tr>
<td>Total</td>
<td>735</td>
</tr>
<tr>
<td>LDC</td>
<td>10</td>
</tr>
<tr>
<td>Non-LDC</td>
<td>725</td>
</tr>
<tr>
<td>Global tourist transport</td>
<td>International</td>
</tr>
<tr>
<td>(10^6 passenger-km):</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3721</td>
</tr>
<tr>
<td>LDC</td>
<td>92</td>
</tr>
<tr>
<td>Non-LDC</td>
<td>3627</td>
</tr>
<tr>
<td>Average distances</td>
<td>International</td>
</tr>
<tr>
<td>(one-way km):</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2531</td>
</tr>
<tr>
<td>LDC</td>
<td>4343</td>
</tr>
<tr>
<td>Non-LDC</td>
<td>2504</td>
</tr>
</tbody>
</table>
and average GDP/capita (Peeters & Landré, 2012). Consequently, there is scope for the redistribution of arrivals if certain long-distance markets become restricted. This concept has not been thoroughly addressed in the previous literature, but some indication can be found in the increase in domestic trips when international trips decline, for instance because of economic crises (UNWTO, 2009) and the subsequent reverse development (UNWTO, 2011b). According to the concept of redistribution, if, for instance, the cut-off distance is set at 10,000 km one way, then a tourist from the UK initially planning to fly to Australia would no longer be able to do so. This tourist is then assumed to find another destination that can still be reached rather than remaining at home. The extent to which the GDP/capita rule will hold is unknown. Obviously, when the distance is reduced to zero, no tourism will remain. However, we assume that travel will continue as long as a reasonable number of destinations can be reached; therefore, even in the hypothetical case the one-way distance cut-off is below 1500 km. Although this assumption may appear to be implausible, it should be noted that 78% of all global trips are less than 1500 km one way (based on GTTD). To calculate the redistribution of trips above the specific cut-off distance, the following relatively simple procedure has been applied. First, the total number of departures per country above the cut-off distance is calculated. These trips are then redistributed proportionally to the current shares of remaining outbound departures (thus, including domestic departures). To clarify this procedure, we provide a calculation example. Assume that country of origin X has 10000 domestic departures at an average of 650 km, 400 departures to country A at 980 km, 150 departures to country B at 3400 km, and 40 departures to country C at 8500 km one way. Now assume that the cut-off destination is 6000 km, such that only the 40 trips to country C will be redistributed with $40*1000/(1000 + 400 + 150) = 26$ to domestic destinations, $40*400/(1000 + 400 + 150) = 10$ to country A, and $40*150/(1000 + 400 + 150) = 4$ to country B. The total number of arrivals remains at 1590 but with no trips above the cut-off distance of 6000 km. This result defines all departures and arrivals and the changes caused by the cut-off distance assumptions. Other methods of redistribution are also possible; see Section 4.2 for a discussion.

3. Results

This section presents three series of calculations with each of the four cases (cut-off distances). The impacts are measured as the percentage of change in arrivals per country with respect to unrestricted travel and restricted total arrivals as well as the distances travelled for all countries divided over LDCs and non-LDCs. The first series considers only international tourism and assumes that trips above the cut-off distance will disappear. The second series is based on the same assumption but for both international and domestic tourism together. The third series considers the global number of trips to be constant and applies the redistribution of trips above the cut-off distance. Figs. 1–3 show the percentage of change in total arrivals per country as a function of GDP/capita separately for LDC and non-LDC countries. The size of the bubbles is proportional to the total number of arrivals without a distance restriction.

3.1. Series 1: international trips without redistribution

Fig. 1 shows the impacts of a reduction in the number of international trips for the four cut-off distances. This series represents the most common method of analysing the impacts of reducing tourism transport volumes on individual countries. The series ignores domestic tourism and uses the destination as the focal point, also ignoring second-order impacts stemming from the entire tourism system. In this case, only the 735 million international tourist trips (Table 1) are included, and trips above the cut-off distance are assumed to be lost to the tourism industry. For the rather moderate restriction to 10,000 km one-way travel, some small countries (e.g., remote countries, such as French Polynesia and Micronesia) would be deprived of more than 50% of their arrivals, but large and wealthy remote countries, such as Australia and New Zealand, would also suffer significant reductions of 38% and 40%, respectively. In contrast, China would observe a reduction of only 5%, and countries such as Mexico, Germany, and the Netherlands, would experience no reduction at all. The impacts become much stronger when the cut-off distance is set at 1500 km: 99 of the 221 countries confront a loss of more than 50% of international arrivals, whereas only 10 countries lose less than 10%.

Note: Because of a restriction in the UNWTO data on which we based our analysis, we rarely specified all markets at the country of origin level. Aggregates such as 'other Asia' and 'other world' have been ignored, causing a loss of approximately 2% of global international arrivals and possibly affecting some individual country impacts if the data of these countries have a low resolution.

Unfortunately, these results misrepresent reality because domestic markets are not considered, although these markets will generally be less affected by the assumed cut-off distances. To demonstrate this effect, the next case will include domestic tourism.

3.2. Series 2: international plus domestic trips without redistribution

Series 2 accounts for international and domestic tourism arrivals but ignores redistribution. By including domestic tourist arrivals, this series features effects that are less severe, as can be observed by comparing Fig. 2 with Fig. 1. In the case of a cut-off at 10,000 km, no countries confront a reduction of more than 30% of total arrivals. French Polynesia may lose 19%, Micronesia 13%, New Zealand 18%, and Australia 6%. However, losses remain substantial in the case of restrictions to 1500 km: 28 of the 221 countries confront a loss of more than 50% of international arrivals, whereas 101 countries lose less than 10%.

3.3. Series 3: international plus domestic with redistribution

This final series depicts a more holistic assessment of the impact of a reduction in trip distance on the tourism industries of all countries in the world. The series assumes both domestic and international tourism as well as a redistribution of trips to simulate a scenario in which tourists will easily find another destination in case of restrictions. Fig. 3 clearly shows that some countries gain and others lose, and the impacts are much less severe compared with those observed in the first and second series.

At a 10,000 km cut-off distance, LDCs will witness changes in their international and domestic tourist arrivals between –3.7% (Cambodia) and +8.0% (Tuvalu). The impacts are more severe for non-LDCs, ranging from –23.0% (American Samoa) to +35.5% (Marshall Islands), whereas the next positive impact is only 4.2% (Australia). New Zealand will lose 5.6% of arrivals in this case. The total global travel distance is reduced by approximately 6.6%. At 6000 km, the total distance is reduced by 16.5%; at 3000 km, the distance is reduced by 35.9%; and at 1500 km, which could be a non-air scenario, 52.7% of all travel kilometres are avoided.

3.4. Comparing the impacts on LDCs and non-LDCs

This section examines the GTTD for evidence regarding whether LDCs will suffer more from reduced travel than other countries.
Fig. 4 indicates that for all four cut-off distances in Series 3, the differences between LDCs and non-LDCs are not large, but the share of states suffering is larger in non-LDC countries than in LDCs. The shares of suffering countries at the 6000 km cut-off distance vary from 41% for LDCs to 62% for non-LDCs.

A linear regression analysis (using PSAS SPSS 18.0), with the fraction of the change in arrivals as an independent variable and income per capita as a dependent variable, revealed ANOVA 95% significance levels of 0.574 (10,000 km), 0.883 (6000 km), 0.592 (3000 km), and 0.364 (1500 km); thus, the slope of the regression line was zero, and income did not significantly contribute to the variance. We also tested whether the means of the changes in the number of trips per cut-off distance differ between the two groups (LDC and non-LDC) using an independent samples T-test. The results reveal two-tailed significance values between 0.095 and 0.440, which is larger than 0.05; therefore, the null hypothesis that there would be no differences between the two groups of countries can be accepted at the 95% level.

In conclusion, the percentage reduction in arrivals linked to any of the four cut-off distances does not significantly depend on average income, and the mean reductions do not significantly differ between LDCs and non-LDCs for any of the four cut-off distances.

The impact on arrivals is an important parameter, but it is not necessarily fully correlated with the affected local tourism economies. The contribution to tourism-related direct GDP (no multipliers applied) has been calculated using the World Tourism and Travel Council (WTTC) Economic Data Research Tool (WTTC, 2013). This tool uses an input/output method as allowed by data availability and includes both domestic and international tourism (WTTC, 2012; WTTC & Oxford Economics, 2012).

Fig. 5 has been created to tentatively show the potential GDP gains or losses for all countries with a percentage gain or loss as indicated on the x-axis. For instance, the graph shows the total potential losses for LDCs to be 1.4 billion US$ (which is the sum of all losses suffered by countries with <0% change in case of a 1500 km cut-off distance). This potential loss decreases if we consider only countries with a greater loss of arrivals. Fig. 5 shows that the economic gains and losses do not differ substantially for non-LDCs but that they do differ significantly for LDCs in the case of the 1500 and 3000 km cut-off distances. The figure also shows a maximum potential loss of US$76 billion for non-LDCs, or 4.1% of the direct global tourism GDP of US$1.84 trillion US$ in 2005 (WTTC, 2013). Regarding LDCs, the losses would not exceed US$1.4 billion in case of the 1500 km cut-off distance, which is 0.076% of the global tourism economy and 9% of the total US$15 billion LDC tourism economy (WTTC, 2013). The contribution of tourism to the total GDP of all LDCs, which was estimated to be US$850 billion for 2005 using the GDP and population data of GTTD, is 1.6%.
Finally, we examined the impacts on individual countries. At the 10,000 km limit, no LDC is affected by more than a 4% reduction in arrivals, which is well within the normal variability of international tourism flows. At the 6000 km cut-off, the Dominican Republic indicates a loss of 77%, whereas the Maldives loses 19% of arrivals. Interestingly, at 3000 km, the Dominican Republic receives such a large number of redistributed trips that its loss is reduced to 14%. At the other end of the scale, cut-off distances of 6000 km and 10,000 km present small LDCs, such as Tuvalu, Kiribati, Sao Tome and Principe, Vanuatu and Solomon Islands, with small gains because a loss of the most distant markets is offset by a larger gain from closer markets whose lack of restrictions would enable them to travel farther away than these island nations. Therefore, small island nations will not always suffer from reductions in distances.

4. Discussion and conclusions

4.1. Main results

This paper seeks to answer four questions linked to the hypothetical restriction of distances travelled. (1) What is the impact on global tourism flows? (2) What is the impact on LDCs? (3) Do these impacts on LDCs differ from those on developed countries? (4) Can the potentially negative impacts on LDCs be alleviated, thereby combining the ambitions to reconcile poverty alleviation and mitigate climate change? A short answer to question (1) is that such restrictions would cause a shift of arrivals from some countries to others. Overall, approximately half of all countries would witness an increase in arrivals, whereas the other half would confront a loss in arrivals. This finding is valid for all four cut-off distances that we considered. Individual countries may lose up to 100% of arrivals, although this result occurs only in a few of the smallest countries in the world. Gains tend to be smaller, but they tend to occur in countries with larger populations. With regard to questions (2) and (3), the impacts on LDCs follow this same pattern. At the country level, there is no significant difference between the average net change for LDCs and non-LDCs. Regarding question (4), we found that in terms of direct contribution to GDP, in general, LDCs may suffer significantly rather than gain, whereas losses and gains are more in equilibrium for non-LDCs. The total changes in tourism economies vary depending on the cut-off distance but remain below 4% of the global direct tourism GDP. For LDCs, the maximum loss is approximately US$1.4 billion, which is only 0.076% of the global direct GDP of tourism. Therefore, it is plausible that the sector is able to compensate for such losses, for instance, by investing in less carbon-intensive (domestic, short-haul) tourism or by raising a small fee on long-haul travel to contribute to a special poverty alleviation fund, as suggested by Pentelow and Scott (2011).
More generally, this research has demonstrated that the application of a more holistic method that includes non-air and domestic arrivals facilitates assessment of the impacts of a hypothetical restriction in distances on both LDCs and non-LDCs and has demonstrated that countries may both lose and gain. Even if distances per one-way trip are limited to 1500 km, de facto a scenario without rapid transport, such as air transport, the tourism economy does not need to collapse, and LDC tourism economies in particular need not be destroyed. Nevertheless, individual countries, including some LDCs, may suffer heavily. This paradox can be solved either by dismissing any reduction of air transport or by finding measures that may compensate the poorest countries that are negatively affected. The budget for such compensation can easily be found within the tourism industry. For example, a report by the International Monetary Fund and World Bank shows that pricing international aviation emissions is a feasible approach that can be combined with the compensation of adversely affected developing countries (Keen, Perry, & Strand, 2012).

Furthermore, we have shown that a more holistic approach avoids an exaggeration of the problem of negative impacts by balancing both gains and losses and by including the large number of domestic arrivals that form a solid base for the tourism industry in many countries and that may well gain from reduced travel distances.

4.2. Limitations to the research method

We realise that the analysis presented in this paper may be criticised based on a number of assumptions. First, we assume that the number of trips is simply a function of GDP/capita and is essentially independent of travel distances that can be travelled within time and monetary budgets. Travel may exist and be guided by the pure existence of transport infrastructure; in other words, ‘if we can travel we will travel’ (see Urry, 2002). This assumption supports the idea that the number of trips is important for the decision to travel only at a basic level, namely, based on whether

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Fig. 3. The impact on the number of arrivals per country when domestic and international tourism arrivals are considered with the redistribution of trips longer than the cut-off distance. Bubble size represents total arrivals in 2005. Note: income figures are in purchasing power parity (PPP) of 1995 US$. 

Fig. 4. The distribution of LDCs and non-LDCs gaining and suffering from the cut-off distance assumption in Series 3 (domestic plus international and redistribution of all trips).
there is any form of transport. Furthermore, econometric studies have shown income elasticity to be -2.4, whereas average price elasticity is only -0.5 (Witt & Witt, 1995); hence, regarding the decision to travel, income is five times more important than the cost of travel. Another indirect proof of our assumption is that distances have grown more rapidly than the number of trips or guest-nights, primarily because of the increased speed of travel based on the increased share of air transport (see e.g. Mulder et al., 2007). This finding is consistent with reactions to the 2008 financial crisis; the majority of households will still travel but their trips will be marked by a shorter length of stay, shorter distances and bargain hunting (European Travel Commission, 2009, p. 2). In 2009, in the Netherlands, the reaction to the financial crisis was also reflected in a decrease in outbound holiday travel and an increase in domestic holiday travel, a decrease in return distance, and a decrease of holiday travel by air (de Bruin et al., 2012).

Second, another main assumption is that the total number of arrivals (domestic plus international) is a fair proxy of the tourism economy in a specific country/destination. This assumption could be challenged, as both tourism revenues and the length of stay (LOS) are generally higher for international long-haul trips than for domestic short-haul trips (European Travel Commission, 2009; Expedia, 2010; OTTI, 2007; Schmidt, 2002; TRCNZ, 2001). For example, Dutch holiday travellers stay an average of 5.2 days on domestic trips and 10.0 days on international trips (based on de Bruin et al., 2012). Furthermore, according to the same source, expenditures differ for domestic and international travel, both for the entire trip (€155 versus €669, respectively) and per day (€30 versus €67, respectively). However, these differences are static and cannot predict what would occur if people are somehow forced to change their destination choices. Would a tourist who is accustomed to taking a long-haul trip for three weeks and spending $1000 for travel and accommodations actually reduce his or her length of stay (LOS) to one week and his or her spending to $250 when forced to stay within 1500 km of home? Expenditure per day is often found to be a function of LOS, such that expenditure per day may decrease with longer stays (Thrane & Farstad, 2011). This scenario could cause some loss of ‘economy’ if people choose to stay for shorter durations when forced to stay closer to home. However, the ‘length of stay is largely explained by the socio-demographic profile of the tourist’ (Barros & Machado, 2010, p. 692); therefore, with the tourist population assumed to be constant, the average LOS is not dependent on the distribution over distance classes and can also be expected to be more or less constant. Furthermore, LOS may logically be most related to the availability of annual leave days and income to spend, which indicates that shifts in the distance class do not have any impact on the total tourism economy.

Our economic assessment using the WTTC data also showed that, at least with regard to the non-LDCs, the assumption to use arrivals as a proxy for tourism revenues is valid. However, because the WTTC data are destination-centred, we were unable to maintain LOS and spending per trip based on the departing tourist. Furthermore, the WTTC data include domestic spending on outbound tourism, which is attributed to the destination country according to our method of using the data, causing an overestimation primarily for non-LDC countries. Additionally, it is not entirely clear whether domestic arrivals are consistently included. For instance, combining WTTC tourism employment figures with total international and domestic arrivals in GTTD results in ratios that vary from one employee per nine arrivals (Cambodia) to 2360 arrivals (Macedonia). This large variance could not easily be explained.

A third objection against the analysis could be that the cut-off distance assumption is hypothetical and is not covered by policies or concrete measures. Indeed, further research into the most effective and efficient ways to change habitual long-haul travel is clearly recommended by this study (see e.g. Cohen, Higham, & Cavaliere, 2011). One main recommendation is to begin conducting research on policies that accommodate reduced distances. However, the aim of our study was not to identify policies that could reduce distances; rather, we sought to indicate that the general objection to limiting air travel as being unethical with respect to poor people is much weaker than it appears.

A final point of discussion concerns the method of redistributing trips. We have chosen to redistribute trips proportional to the distribution of remaining departures per country. To understand the manner in which tourists might react to a restriction in distance, we distinguished between the short and long terms. In the short term, tourists who have already planned a long-haul trip, for instance, from the UK to Australia, may react to a reduction to 10,000 km by choosing the longest equivalent trip that is still available within this limit. However, that reaction demonstrates behaviour in a transition based on individual choices only. On a longer time scale, such as four or five years, the social valuation of travel is likely to change. Distance restrictions will most likely increase the value of distance as distance becomes scarcer. This result indicates that people will find the same value at a shorter distance. This speculation assumes distance distribution to be a constant in relative terms, with respect to the longest distance available, which is the scenario that we attempted to model.

Research recommendations derived from the model’s shortcomings include the development of a more advanced model for both economic impacts and redistribution (e.g., based on global equilibrium models, gravitation models, or input–output analyses). Furthermore, the role of specific policies in achieving reduced distances and the consequences of such policies should be studied in detail. Finally, further research with regard to the constant departures hypothesis is recommended.

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**Fig. 5.** Potential tourism economy (GDP) impacts of reduced distances for LDCs (lower graph) and non-LDCs (upper graph). Note 1: Between the two graphs, the y-axis scales differ by two orders of magnitude. Note 2: The potential loss (gain) is defined as the sum of all losses (gains) below (above) the percentage losses (gains) in arrivals given by the x-axis.
4.3. Consequences for tourism and poverty policies

Because of the uncertainty of success and the slow implementation of most technological mitigation options, measures that curb rapid transport growth appear to be inevitable. In the medium to long term, we anticipate that air transport may be likely to witness some restriction in growth. Measures that may reduce distances in travel could include significant taxes on kerosene or carbon (Wit et al., 2002), a personal carbon budget (Defra, 2008), highly capped emission trading (Scheelhaase et al., 2010), or capacity restrictions on airports (CATE, 2002). LDCs will be affected by these measures, but such effects do not constitute a sufficient reason to avoid discussing such measures, as the amount of funds associated with effective measures is large and allows for sufficient compensatory measures (see e.g. Keen et al., 2012). However, such taxes or policies meet strong resistance and are dismissed as 'retaliatory levies ... killing the goose which lays the golden egg' (Lysle, 2012, p. 103), with the egg being tourism exports.

Meanwhile, mitigating climate change is difficult to achieve without a significant contribution from tourism (Gössling et al., 2010; Scott et al., 2010). Failing to mitigate climate change may cause a wide range of international political instabilities, weather-related disasters, and socio-economic crises in the medium to long term (Barnett & Adger, 2007; Campbell, 2008; Ibarrarán, Ruth, Ahmad, & London, 2009; Oh & Reuveny, 2010), causing more far-reaching impacts than the maximum of US$1.4 billion losses that we found in the LDC tourism economy associated with an extreme reduction in travel distances. The cost of the average climate-related disaster has increased from US$12 billion in 1970 to US$83 billion in 2000 (Oh & Reuveny, 2010). Even if measures to mitigate air transport related emissions prevented only one of the 400 disasters occurring in 2000, such measures would save an amount of economic loss which is an order of magnitude larger than the net tourism sector losses identified. Finally, climate-related impacts caused by a lack of sufficient mitigation efforts may negatively affect international long-haul tourism (see Hall, 2010). This impact would result in a redistribution from long- to short-haul tourism similar to that shown in this analysis or even a reduction in all tourism volumes and economies (but without the possibility of compensatory measures). Hence, even if viewed purely as a precautionary measure, reduced air transport growth should be accepted as one of several possible futures and should be integrated into tourism and aviation policy scenarios. The financing of compensatory measures for LDCs must be part of this debate.

4.4. Conclusions

Employing a more holistic method, we have shown that a reduction in tourist travel distances, the growth of which is the main cause of the tourism industry's on-going and rapidly increasing contribution to climate change, has significantly less severe impacts than previously envisioned. Our results departed from the usual expectations primarily because we did not adopt an approach that considered only the destination scale or international tourism; rather, we also chose to include domestic tourism and considered the global geography of tourism, including shifting flows amid hypothetical restrictions on travel distances. At the global level, the number of arrivals does not necessarily change as a result of measures that reduce travel distances, as redistribution is likely to occur. In terms of arrivals, the impacts on LDCs do not differ from those on non-LDCs, but in terms of tourism's contribution to GDP, there may be a less favourable situation for all LDCs, particularly in the most severe scenario. Further economic research may provide insight as to whether such impacts exist and, if so, to what extent. Nevertheless, it is certain that some LDCs will encounter negative economic impacts from reduced travel distances, but for these countries, a range of policy designs aimed at compensation would be available. Therefore, it is strongly recommended that future research examine the impacts of specific policies aimed at reducing the growth of tourism transport demand for long- and medium-haul travel based on the adoption of a more holistic approach and the inclusion of economic aspects in a more systematic manner. Specifically, there is a need for a more complete origin-destination table at the global level or ideally at the level of smaller, more unified geographical units, including domestic trips. Another important line of research that is absent in the existing literature concerns the negative impacts of the current growth of air transport on the tourism economies in both poor and wealthy countries. As the GTTD showed, countries may attract additional tourists by reducing the distances that people travel; therefore, there is reason to suspect that current increases in average distances could negatively affect the tourism economies of certain other countries.

Finally, we hope to have provided the ‘much-needed input for an important policy discussion’ to bridge the gap between the two extreme scenarios. We believe that this paper has at least strongly nuanced the poverty and tourism discourse, which has thus far discouraged discussing the desirability of reducing growth in air transport.

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