

Estimating CO₂ emissions of European city tourism

Research Article

Estimating transportation-related CO₂ emissions of European city tourism

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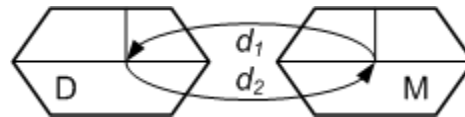
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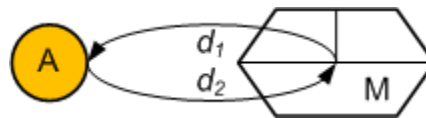
Objectives and motivation

Stefan Gössling, Daniel Scott, Michael Hall 2015: *Inter-market variability in CO2 emission-intensities in tourism: Implications for destination marketing and carbon management*, *Tourism Management*, 46, pp. 203-212

CO2 emissions in tourism calculated based on the distances flown of all tourists from a specific **source market** to a specific **destination** times CO2 emission factors per flight distance



The primary objective of the TourMIS project is to create **more precise estimates** of CO2 emissions of European **city tourism**

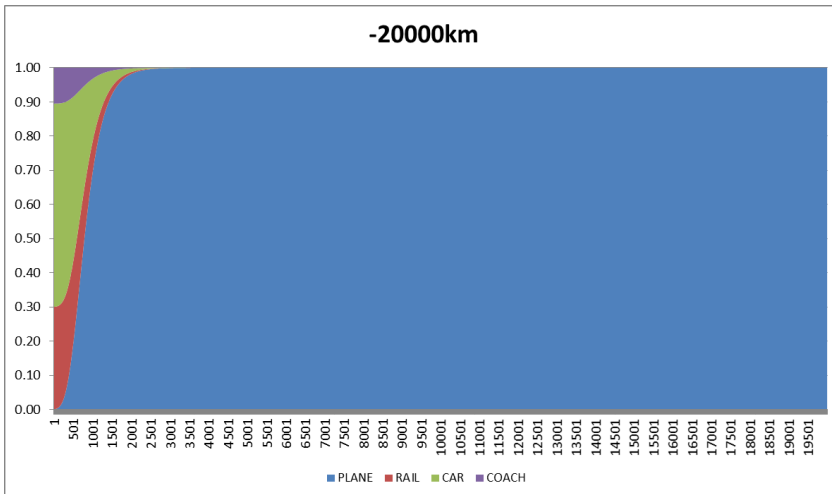
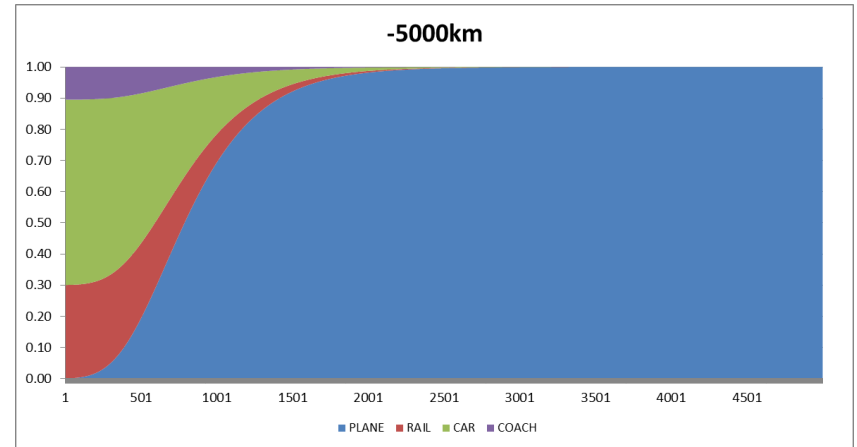
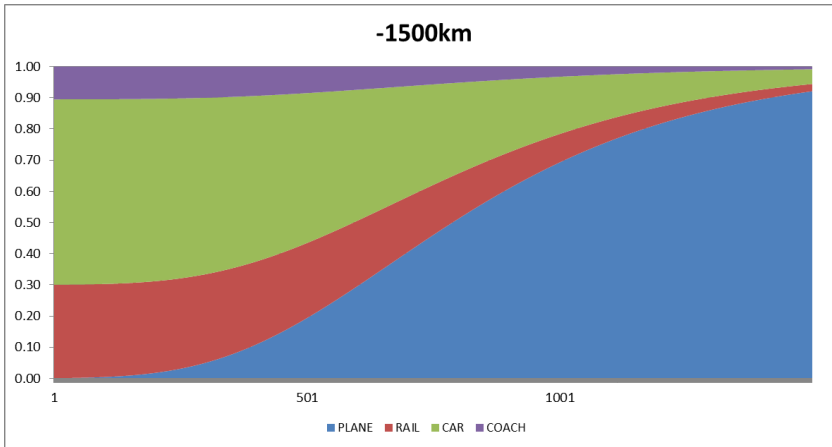


In order to achieve this objective, **not only the travel distance** (as typically done) but also the **chosen transportation mode(s)** and the particularities of the different cities' **source markets** are taken into account

Four steps

1. Calculation of travel distances in km between European cities and their source markets based on their geographical coordinates (population centers) as reported by the Socioeconomic Data and Applications Center (SEDAC) by NASA
2. Calculation of share of travel mode (air, rail, car, coach)
 - a) Entered by TourMIS inputter (information from guest surveys)
or
 - b) Estimated (by TourMIS)*New feature!*
3. Calculation of CO2 emissions by multiplying distance by travel mode with average CO2 emissions by travel mode
4. Incorporating multiple trips and average length of stay

Estimating travel mode by travel distance



The probability of choosing a certain transportation mode is approximated by a Gompertz function in travel distance (PLANE) and a growth function in travel distance (RAIL), with the remaining probability (i.e., $100\% - \text{Pr}(\text{PLANE}) - \text{Pr}(\text{RAIL})$) being distributed on CAR (85%) and COACH (15%), respectively

Estimating CO2 emissions

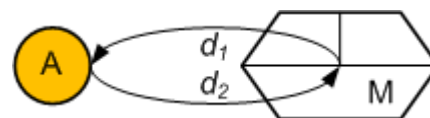
- Travel distances per transportation mode are calculated by multiplying the travel distance in km per destination and source market by Pr(PLANE), Pr(RAIL), Pr(CAR), and Pr(COACH), respectively
- CO2 emissions per tourist arrival are calculated by multiplying the travel distances per transportation mode by the average CO2 emissions per transportation mode according to Peeters et al. (2007):

Table 11.2 Emission factors for tourism transport modes in the EU context

Mode	CO ₂ factor (kg/pkm)	Occupancy rate/load factor (%)
Air < 500 km	0.206	-
500-1,000 km	0.154	-
1,000-1,500 km	0.130	-
1,500-2,000 km	0.121	-
> 2,000 km	0.111	-
Air world average ^(a)	0.129	75
Rail	0.027	60
Car	0.133	50
Coach	0.022	90

(a) This value is calculated in Section 11.1.2.1.

Source: Peeters, P. et al. (2007b)



$$CO_2 = \sum f^T(d_1) * kg/pkm^T + \sum f^T(d_2) * kg/pkm^T$$

Limitations and future research

- Differences in transportation mode preferences across European countries have not been considered
 - Eurostat data on the terrestrial modal split of passenger transport as well on passenger flights could be incorporated in the future
- Only (direct) CO₂ emissions from transportation from the source markets to the destinations are considered
 - More information is needed on the other (indirect and induced) CO₂ emissions of tourists to and within European cities