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Greenhouse gas emissions from flying can offset the gain from reduced driving in dense urban areas

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ABSTRACT

Numerous studies have illustrated how denser urban forms lead to smaller greenhouse gas (GHG) emissions from passenger transport. Many of these studies have excluded aviation since the association between urban structure and air travel is not as intuitive as it is the case of ground travel. However, several recent studies have concluded that air travel is a significant contributor to the GHGs from passenger transport. Furthermore, even air travel habits depend heavily on lifestyles and socio-economic factors that are related to the urban form. Here we analyse the interactions between urban structure and different transportation modes and their GHG impacts in Finland. The study utilises the data from the Finnish Transportation Agency's passenger traffic survey from May 2010 to May 2011, which includes over 12 000 people and over 35 000 trips. The survey is based on one-day travel diaries and also includes additional data on long-distance trips from a longer period. Methodologically, the study takes a traveller's perspective to assess the GHG emissions from passenger transport. We found that (1) air travel breaks the pattern where GHG emissions decrease with increasing density of urban structures, and (2) in the metropolitan region there is a clear trade-off between car-ownership and air travel in the middle income class. The main policy implication of our study is that air travel must be included in GHG assessments and mitigation strategies targeting travel behaviour. In dense urban regions, the emissions of air travel have the potential to offset the gain from reduced private driving.

1. Introduction

Passenger transport is recognised as one of the major causes of greenhouse gas (GHG) emissions and has received wide attention from researchers and policy makers striving for sustainability. Numerous studies have illustrated how denser urban forms lead to smaller GHG emissions (e.g. Newman and Kenworthy, 1989, 1999; Mindali et al., 2004; Norman et al., 2006, see also review by Badoe and Miller (2000)). This has led to GHG mitigation strategies that emphasise densification as an important measure to reduce GHG emissions from transport. However, many of these older studies have excluded aviation and especially the interactions between aviation and other forms of transport, whereas several more recent studies have concluded that the main contributors to the climate change related to passenger transport are private driving and air travel (e.g. Brand and Boardman, 2008; Aamaas et al., 2013; Åkerman et al., 2012).

Currently, aviation causes about 3.1% of the total GHG emissions in the EU and 1.9% globally, but the emissions are rapidly increasing (Hill et al., 2012). Of these, the greatest amount is due to passenger air travel. According to Brand and Preston (2010), passenger air travel has been increasing by about 6% yearly in the UK since the mid-1970s. Åkerman et al. (2012) reported an average rate of increase of 5.5% per year for international passenger air travel during 1980–2007 in Sweden. It has also been predicted, that the share of air travel will increase in the future because the emissions from other sectors are declining, but in the aviation sector the rapid growth of passenger numbers easily overrides any reductions from the technological development (e.g. Hill et al., 2012; Åkerman, 2011). Furthermore, the emissions from air travel have a higher impact on radiative forcing than the emissions from ground transport, though there are some uncertainties involved (e.g. Lee et al., 2010). Moreover, Scott et al. (2010) emphasised that the global tourism sector is unlikely to achieve its share of the GHG emissions reductions targets, mainly due to the emissions from air travel.

The association between urban structure and air travel is not as intuitive as it is in the case of ground travel, but air travel habits do depend heavily on lifestyles and socio-economic factors that are

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related to the urban form. It has been suggested that lifestyles are not only a product of individual's values and personal identity, but that lifestyles, for example consumption and time use, are constrained by the surrounding structure (e.g. Heinonen et al., 2013a,b, Baiocchi et al., 2010; Jalas, 2002). Brand and Preston (2010) found in their case study of Oxfordshire, UK, that when socio-economic, lifestyle or other such factors are not accounted for, the GHG emissions from air travel increase along with the level of urbanisation so that the emissions are lowest in rural and highest in large urban regions. In their study, the increase in the emissions from air travel was found to be significantly higher than the decrease in the emissions from private driving, and thus the total emissions from personal travel were the highest in large urban regions.

Viewed from the perspective of consumption research, e.g. Ornetzeder et al. (2008) have shown that not owning a car may lead to increased consumption in other consumption categories, e.g. holiday travel. Heinonen et al. (2013a,b) have presented similar findings. This interesting issue has been given little attention in the field of transport research and was the main inspiration for this study. People who give up a car may consider that as an environmentally friendly choice. However, e.g. Hares et al. (2010) and Miller et al. (2010) showed in their focus group studies that tourists are often unaware of the climate change impact of holiday travel. Davison and Ryley (2010) found in their case study from East Midlands, UK, that only 8% of travellers were trying to reduce air travel for environmental reasons, whereas for example price sensitivity had much more effect. Some studies (e.g. Davison et al., 2014; Barr et al., 2010) have also highlighted that particularly for air travel there is a cognitive dissonance between attitudes and behaviour, i.e. those who recognise the environmental impacts of aviation actually fly more than average and possibly justify this to themselves by environmental friendly choices in other areas of life (Dickinson et al., 2010). Moreover, Frändberg and Vilhelmson (2011) found that even though there is a trend of reducing everyday travel and car-dependency among young Swedish adults, the international long-distance travel of these same people is increasing. They suggested that this is due to their more globalised lifestyles. Furthermore, Holz-Rau et al. (2014) found that while socioeconomic issues affect long-distance trips and daily trips much the same way, the urban form affects mostly in different directions. They found that residents of low-density neighbourhoods make less and shorter long-distance trips than those living in large urban areas and high-density neighbourhoods, but the latter travel less in their daily lives.

In this study, we analyse the interactions between urban structure and different transport modes and their GHG impacts in Finland. The particular aim is to investigate the role of aviation in the composition of the total GHG emissions from passenger transport in different urban structures. The analysis is based on descriptive statistics and mean value comparisons. The study depicts how urban form, household characteristics, travel behaviour and GHG emissions from transport are interconnected and how, depending on the situation, flying can act as a substitute or as a complement to private driving. The study utilises the data from the Finnish Transportation Agency's passenger traffic survey from May 2010 to May 2011. That data includes one-day travel diaries of 12 000 people and additional information about long-distance trips during 2–4 weeks depending on the transport mode.

This paper contributes to the literature by providing a new case study that simultaneously studies daily trips and long-distance travel from a perspective of sustainability (here GHG emissions) and includes a measure for urban structure. Our results give support to the earlier findings of e.g. Brand and Preston (2010), who found that the emissions of air travel are highest in large urban regions. Our results also show that the emissions of air travel differ between urban forms within Helsinki Metropolitan Region (HMR). Furthermore, we found a clear trade-off between car-owning and holiday air travel in the middle income class in HMR.

The paper begins by presenting the research material, data processing and method of analysis. In the next section, we show the results of our analysis: (1) How the profile of GHG emissions from personal travel varies in different urban structures and (2) How the profile differs in motorized and non-motorized, i.e. car-owning and car-free, households. In the discussion section, we interpret our results, analyse the uncertainties and give some policy implications. The paper ends with a short conclusion.

2. Research design

2.1. Research material

The main data source of the study is the latest National Travel Survey from May 2010 to May 2011 (Finnish Transport Agency, 2012). The traditional survey is conducted by the Finnish Transportation Agency every six years, and it gives an overall picture of passenger transport in Finland. The survey is based on one-day travel diaries and phone-interviews of over 12 000 people and includes over 35 000 trips. There is detailed information about the trips, such as travel distance, destination and modes of transport as well as demographic information about the respondent. The survey was executed so that the test days varied among the respondents, and the whole survey covers every day of the year including weekends and holidays. In addition to the one-day travel diaries, additional data on long-distance trips was collected. The respondents reported their over 100 km car trips during two weeks before the test day and their over 100 km trips with other transport modes during four weeks before the test day.

In practice, the data is divided into three datasets: background information, one-day travel diaries and long-distance trips. We utilised all three datasets in our study. The same background information was combined with the one-day diary dataset and long-distance trips dataset. It should be noted that about 17.6% of the respondents did not travel at all – they did not even walk during the test day – according to the travel diaries and phone interviews. Still, these respondents are included in the background information dataset and in this study. This is a relatively high amount: e.g. Madre et al. (2007) concluded in their review about immobility in travel surveys that the share of immobiles should be around 8–12% for the standard one-day, weekday only travel diary. However, the Finnish National Travel Survey includes also weekends and holidays. Furthermore, the seasons affect travel behaviour in Finland so that people travel less in winter. If only spring and autumn weekdays are included, the immobility is about 12.7%, according to the survey. The National Travel Survey provides also analytic weights to correct the biases in the demographics of the sample, and we employed these in our study.

We utilised the same research material in our earlier conference paper (Ottelin and Heinonen, 2014), which was presented in the CIB International Conference on Construction in a Changing World, 4th–7th May 2014 in Sri Lanka. In the conference paper, we presented some preliminary and unrefined results of our study.

2.2. Data processing

2.2.1. One-day travel diaries and long-distance trips

For private driving and public transport we utilised both one-day travel data and data on long-distance trips. To avoid double counting, we excluded over 100-km-long trips from the one-day travel diary dataset. Flights and boat trips, of which there are very few observations in the one-day diary dataset, are much less