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Consumption based Greenhouse Gas Emissions for London

(2001 - 2016)

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1. Introduction

This report was commissioned by the Greater London Authority because of the importance of understanding the total greenhouse gas impact Londoners have, including those emissions that take place outside London's physical boundaries, in order to tackle the climate emergency.

This report documents the Consumption-based Greenhouse Gas Emissions Accounts (CBA) for London for the period of 2001 to 2016. CBA offers a different perspective from the standard approach for assigning GHG emissions to a territory. Instead of purely considering the emissions that are released in the territory of London, CBA considers the emissions that occur due to the consumption activities of London residents, including all the emissions associated with the production of goods and services throughout their complete supply chain (more detailed definitions are provided below).

University of Leeds is responsible for producing the CBA for the UK Government and Scottish Government providing national level figures. The same methodology has been applied to calculate the CBA for London. The predominant methodology is an "Environmentally Extended – Multi Regional Input Output" model (EE-MRIO). This has become the standard approach to assess the consumption based emissions of a country or region. EE-MRIO is the most comprehensive, versatile and compatible approach for consumption-based accounting of greenhouse gas emissions and has already become the norm (Davis and Caldeira, 2010; Peters and Hertwich, 2008; Peters et al., 2011; Wiedmann, 2009; Wiedmann et al, 2011).

The UK has adopted consumption-based emissions as an official government indicator and has undertaken numerous reports that employ the approach to evaluate the effectiveness of climate mitigation measures beyond technological solutions. These include an assessment of the role of resource efficiency in climate change mitigation policy, the role of services and an understanding of drivers of GHG emissions between 1992 and 2004 (Barrett and Scott, 2012; Minx et al, 2009; Baiocchi and Minx, 2010).

In summary, employing the EE-MRIO methodology and ensuring consistency with the national accounting, this report provides consumption based emissions for London for 2001 through to 2016, for both Carbon Dioxide and Greenhouse Gases providing figures in absolute and per capita emissions. This study replaces previous estimates of London's CBA.

2. Definitions

GHG emissions can be allocated to countries and cities in different ways. Three different methods of allocating emissions are now in common use: 1) territorial-based, 2) production-based, and 3) consumption-based.

1) The United Nations Framework Convention on Climate Change (UNFCCC) requires countries to submit annual National Emission Inventories. The UNFCCC follows the Intergovernmental Panel on Climate Change's guidelines in term of the allocation of GHG emissions which is, "emissions and removals taking place within national (including administered) territories and offshore areas over which the country has jurisdiction" (IPCC, 1996, pp.5). According to this definition, however, GHG emissions emitted in international territory, international aviation and shipping, are only reported as a memo and not allocated to individual countries. We call these "territorial-based emission inventories".

2) Some countries and cities also report GHG emissions using the same system boundary as the System of National Accounts (SNA), such as are already done with Gross Domestic Product (GDP). This allocation is necessary to make the emission statistics consistent with economic data used in economic modelling. These inventories are often called "National Accounting Matrices including Environmental Accounts (NAMEAs)". In the EU, NAMEAs are reported to Eurostat, though most other developed countries develop NAMEAs but do not report them internationally. The main difference between NAMEAs and the UNFCCC territorial emissions is the allocation of emissions occurring in international territory, and the allocation of tourist activities. In the SNA, international aviation and shipping are typically allocated to countries based on the operator of the vessel, likewise, international tourists are allocated emissions based on where they are resident and not where they are travelling. We call the NAMEAs "production-based emission inventories".

3) Consumption-based emissions allocate emissions to the consumers in each country or city, usually based on final consumption as in the SNA but also as trade-adjusted emissions (Peters, 2008). Conceptually, consumption-based inventories can be thought of as consumption equals production-based emissions minus the emissions from the production of exports plus the emissions from the production of imports (Consumption = Production – Exports + Imports). We call these "consumption-based emission inventories".

3. Methodology

3.1 EE-MRIO

EE-MRIO is a peer-reviewed method having applications in the calculation and reporting of consumption-based emissions accounts and in climate change policy (Minx et al., 2009; Wiedmann and Barrett, 2013).

Input-output models (IOM) make the link between the environmental impacts associated with production processes and the consumers of products. The IOM is constructed from observed economic data and shows the monetary transactions between industrial sectors (intermediate consumers) and final consumers[1]. Economic sectors purchase goods and services from other sectors; pay wages; pay taxes and potentially receive subsidies in the process of making their own product. Final consumers demand goods and services such as food, energy, transport, domestic appliances, leisure activities and so forth. Government sectors are recognised as both a final consumer with an annual budget to spend, and an intermediate sector providing public services (e.g. health care and education).

EE-MRIO allows analysts to consider the impact of traded goods. Essentially, an MRIO model for *n* countries each with *m* sectors generates a matrix of dimensions '*m x n*' rows by '*m x n*' columns and rather than considering a single nations' economy it treats the entire global economy as a single system. The MRIO table is constructed by placing the domestic IO tables from every region along the diagonal of a large composite matrix and filling in the off diagonal matrices to show the sectoral requirements from non-domestic regions in the production of domestic products. This assumes IO tables are available for all nations, there is a degree of harmonisation in sectors described and trade linked data can be determined.

The methodology employed in this study is consistent with the approach adopted by both the UK and Scottish Government that employs an EE-MRIO model. For more details on the model please refer to Barrett et al (2013) or the official Defra site where the national CBA results are available (https://www.gov.uk/government/statistics/uks-carbon-footprint).

3.2 National to sub-national accounts

The methodology described above allows national consumption-based accounts to be produced. Additional steps are required to produce CBA at the sub-national level (London for example).

We use a hierarchical hybrid methodology for estimating final consumption of London (Minx et al, 2013). This approach integrates data from multiple sources and prioritizes the most robust information. Our methodology also prefers physical over monetary data, as far as possible, to avoid quantity estimates being biased by inhomogeneous or volatile prices (Weisz and Duchin 2004).

[1] Represented as Households, Government, Non-Profit Institutions and Capital Investment in IO tables

At the local level we update household spending on domestic energy consumption with data measured in energy units (kWh) and further adjust local consumer expenditure matrices by matching them with regional spending estimates derived from the expenditure survey across all consumption activities, in this case the Family Spending Survey produced by the Office of National Statistics. Accordingly, we match the sum of all regional matrices with national level data.

Household consumption contributes 70% of the UK's carbon footprint (Minx, Wiedmann et al. 2009). The remainder is attributable to government services and capital investments. We downscale the national accounts for those to the local level on an equal per capita basis. This means we assume that every citizen in the UK enjoys the benefits from government expenditures and capital investments in the same way. In summary, the proposed approach goes beyond mere geo-demographics and adjusts consumption patterns according to local conditions (Minx et al, 2013).

4. Results

4.1 Overall results

Figure 1 shows the consumption-based GHG emissions for London between 2001 and 2016 on an absolute basis. This is broken down by the high level categories of government, capital, households and other. It is important to note that "Government" is not the scope 1,2 and 3 emissions of the Greater London Authority. It is the average per capita emissions of all UK Government (national and local).

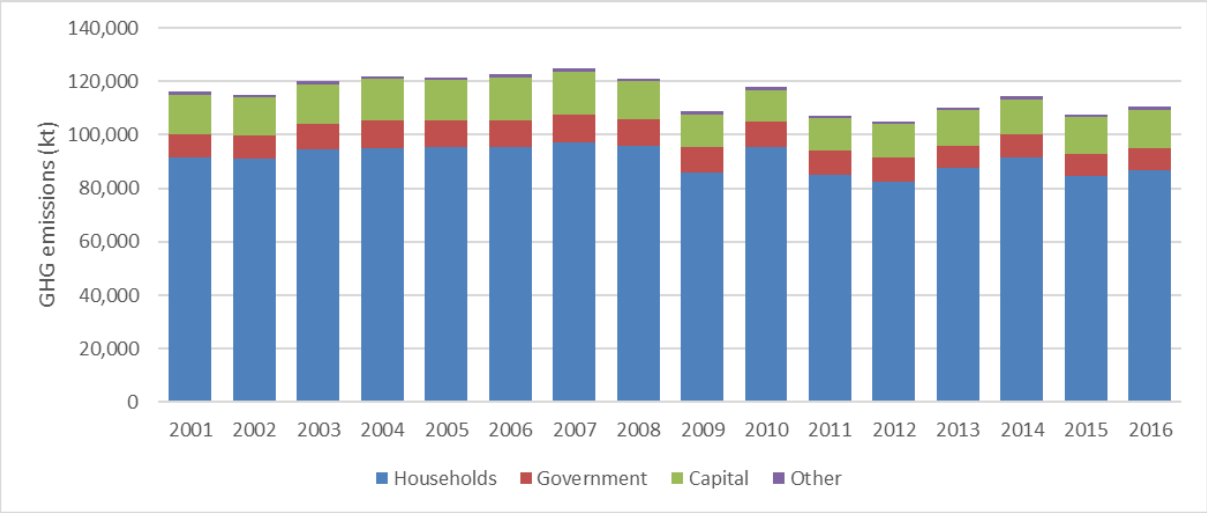

Figure 1: London total GHG footprint broken down by final demand type (2001-2016)

The total GHG footprint of London has declined by 4% over the 16-year period. From a per capita perspective, the reduction is higher due to population growth with a total reduction of 21%. The majority of this reduction occurred between 2008 and 2009, during the global financial crisis which had profound effect on household expenditure.

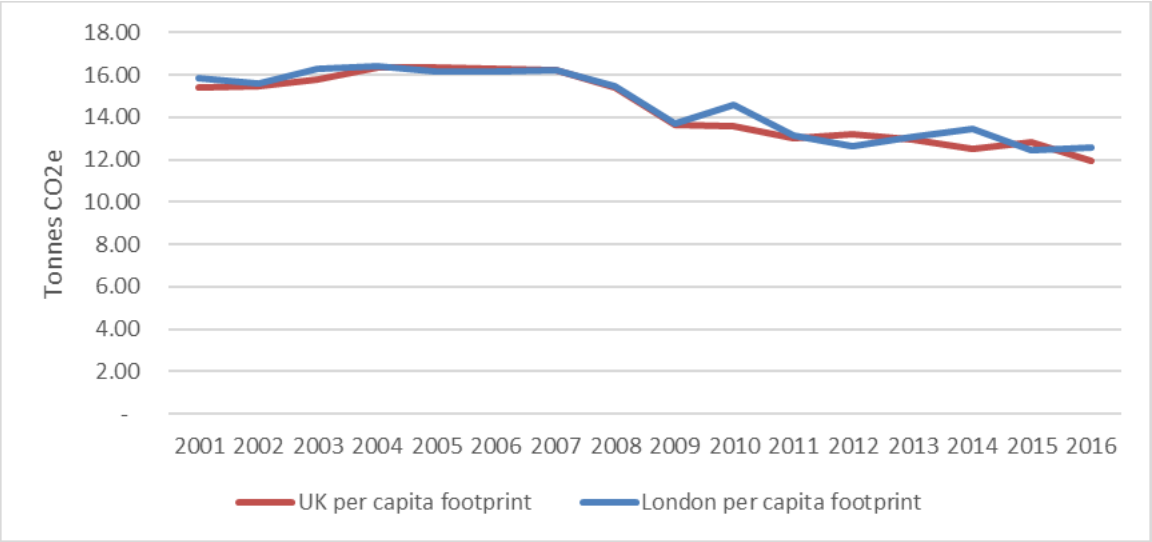

Figure 2: UK and London per capita footprints (2001-2016)

The per capita footprint for London is very similar to the average footprint for the UK and follows a similar trajectory.

The following analysis provides a high-level breakdown of the GHG footprint by consumption categories (figure 3).

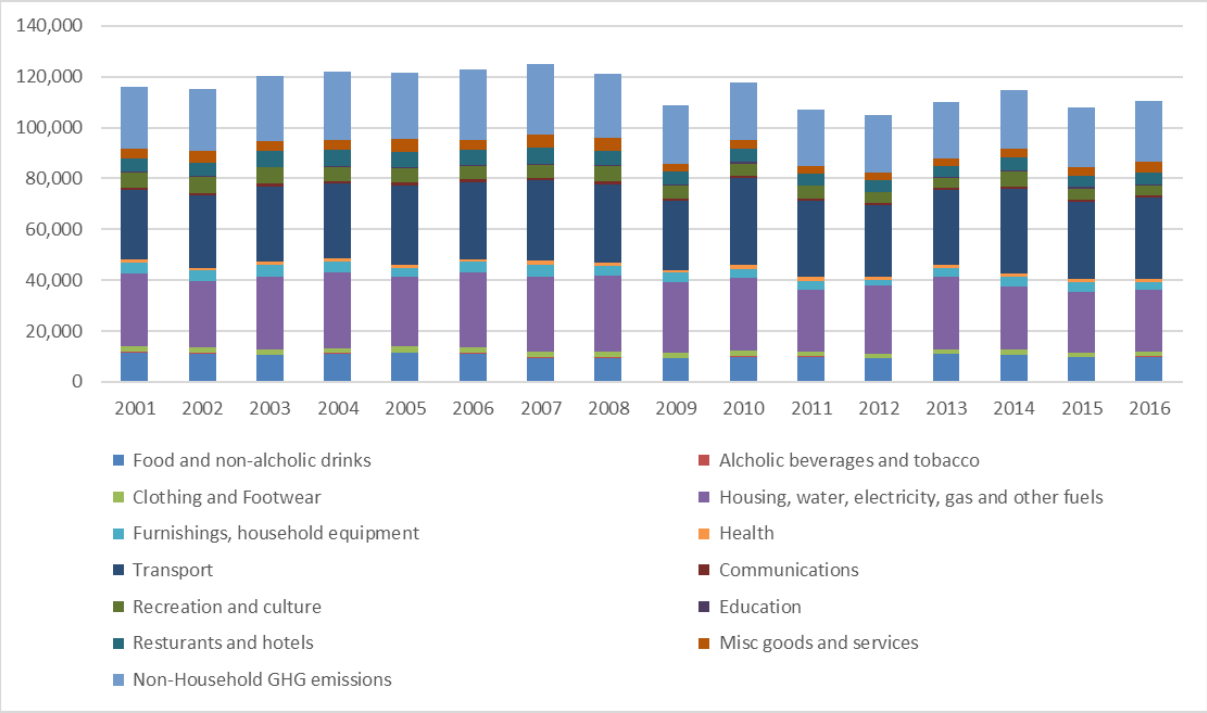

Figure 3: Household GHG footprint by COICOP category (2001-2016)

The three categories of food, housing and transport are responsible for 76% of the household footprint in London in 2016 (with households being responsible for 78% of the total footprint). The remaining 24% relate to goods and services. The most notable decline has been the GHG emissions from housing. Transport emissions have remained similar as has food. Goods and services has also reduced.

5. Sectoral comparisons with the UK

This section compares the average per capita footprint of a London resident with the per capita footprint of the average UK resident for a number of different consumption items.

5.1 Food and non-alcoholic drinks

The food and non-alcoholic drinks footprint includes all spend on food consumed in the home. The average London resident has a lower than average impact for spends on this category but higher than average impact for spends on food and drink purchased outside the home, see section 5.11 below.

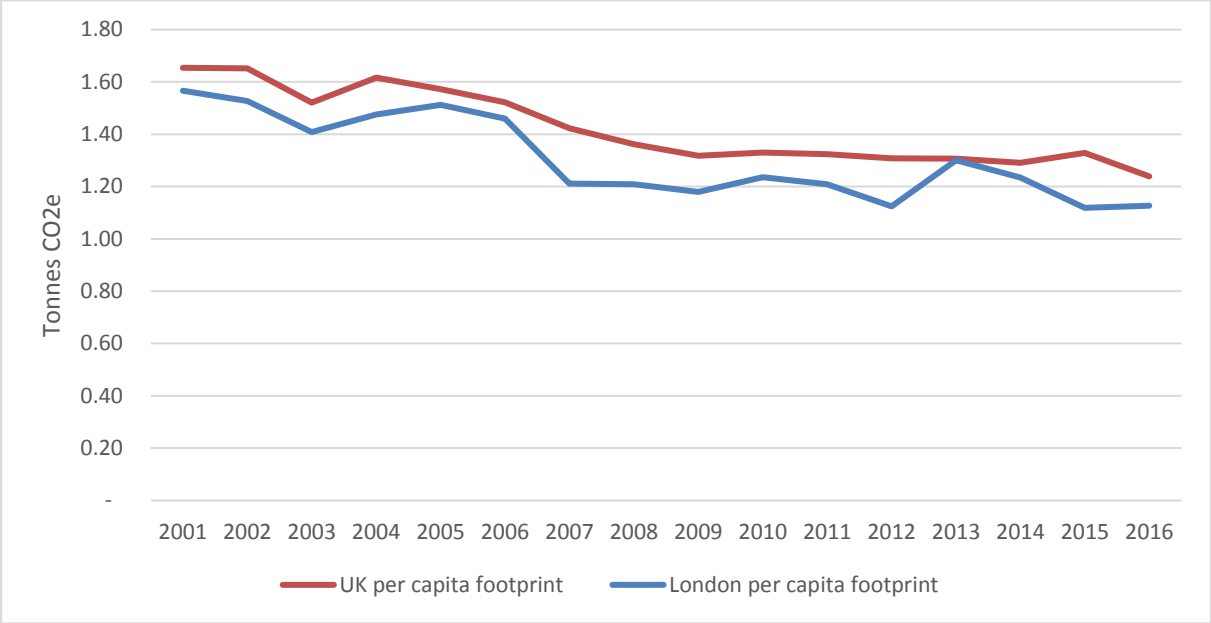

Figure 4: UK and London per capita footprints for food and non-alcoholic drinks (2001 -2016)

5.2 Alcoholic drinks and tobacco

The alcoholic drinks footprint includes all spend on alcohol and tobacco consumed in the home. The average London resident has a lower than average impact for spends on this category.

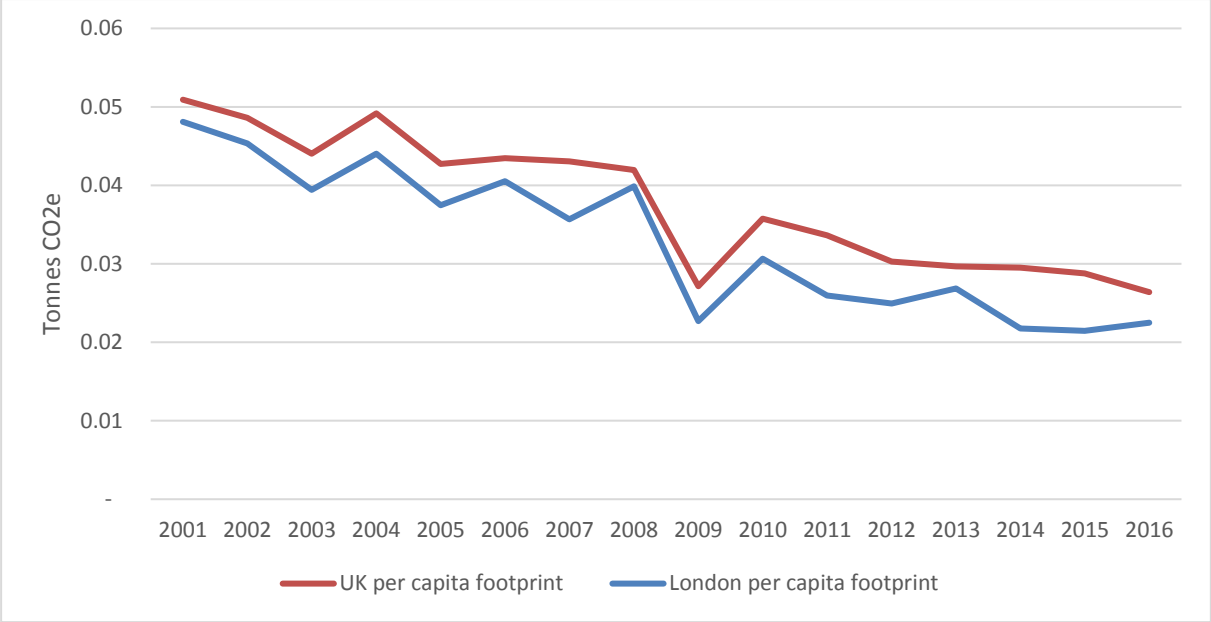

Figure 5: UK and London per capita footprints for alcoholic drinks and tobacco (2001-2016)

5.3 Clothing and footwear

The clothing and footwear footprint includes all spend on adult and children's clothes and shoes. The average London resident had a higher than average impact for spends on this category but recently the levels are quite similar.

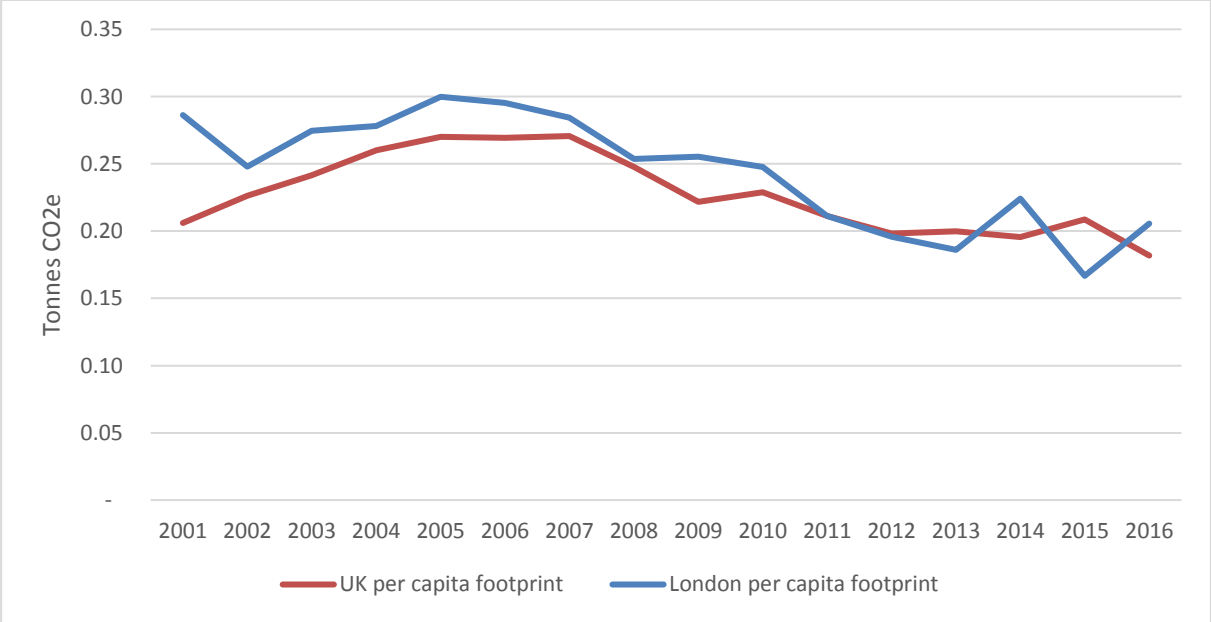

Figure 6: UK and London per capita footprints for clothing and footwear (2001-2016)

5.4 Housing, water, electricity, gas and other fuels

The clothing and footwear footprint includes all spend on home repairs, heating, water and power. The average London resident had a lower than average impact for spends on this category but recently the levels are quite similar.

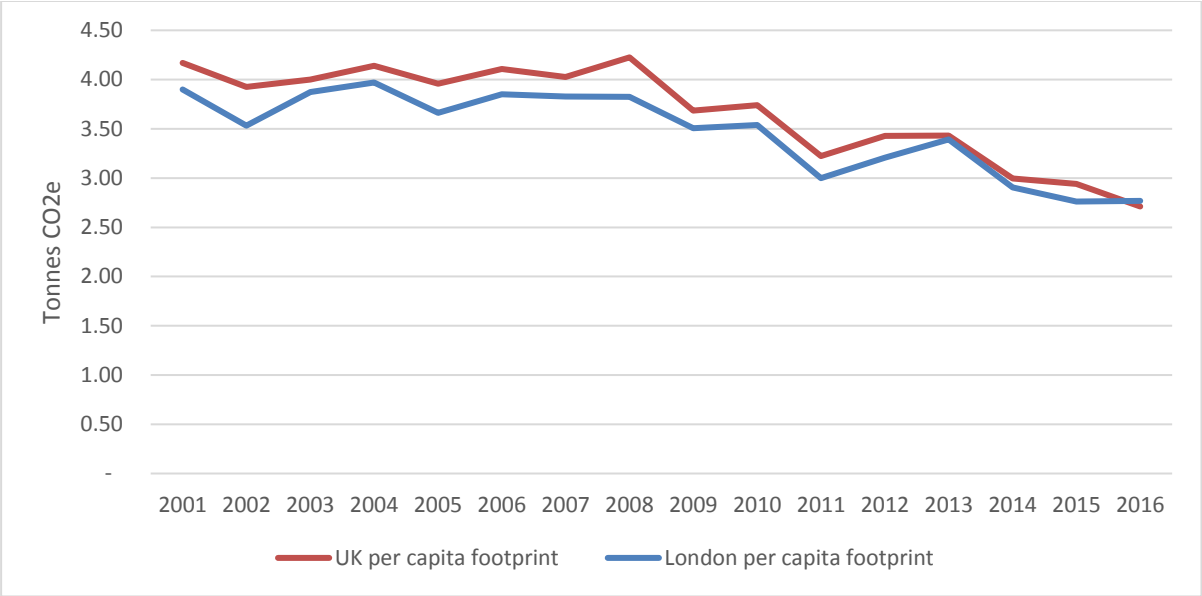

Figure 7: UK and London per capita footprints for housing, water, electricity, gas and other fuels (2001-2016)

5.5 Furnishings and household equipment

The furnishings and household equipment footprint includes all spend on furniture, carpets, kitchen equipment and kitchen appliances. The average London resident has a similar level of impact in this category to the rest of the UK.

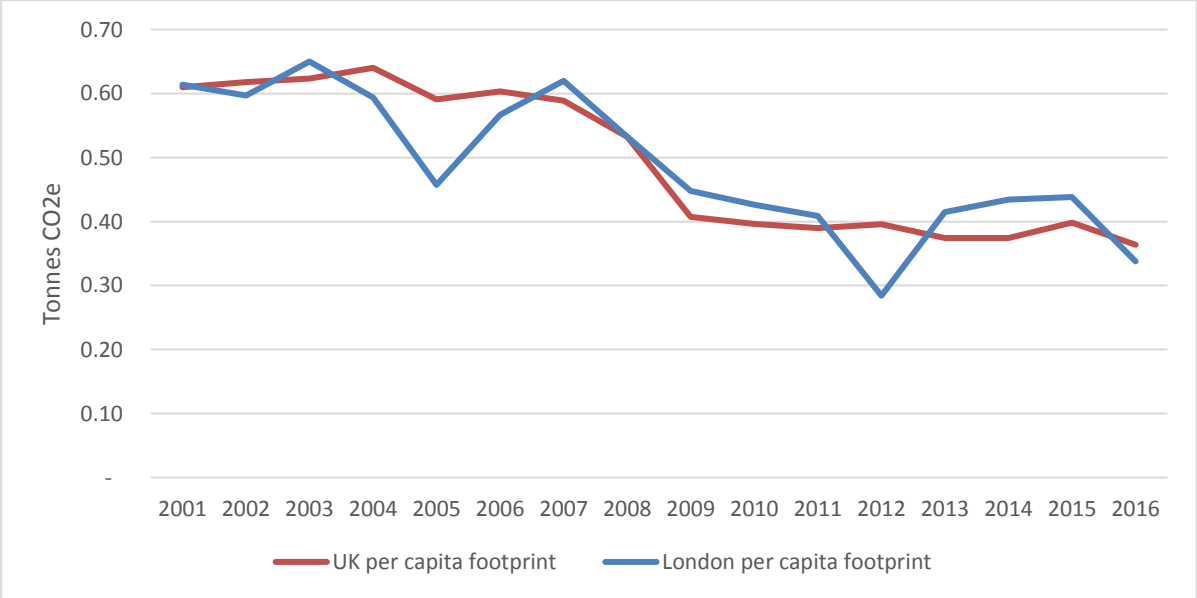

Figure 8: UK and London per capita footprints for furnishings and household equipment (2001-2016)

5.6 Health

The health footprint includes all spend on pharmaceutical products and hospital services. The average London resident has a similar level of impact in this category to the rest of the UK.

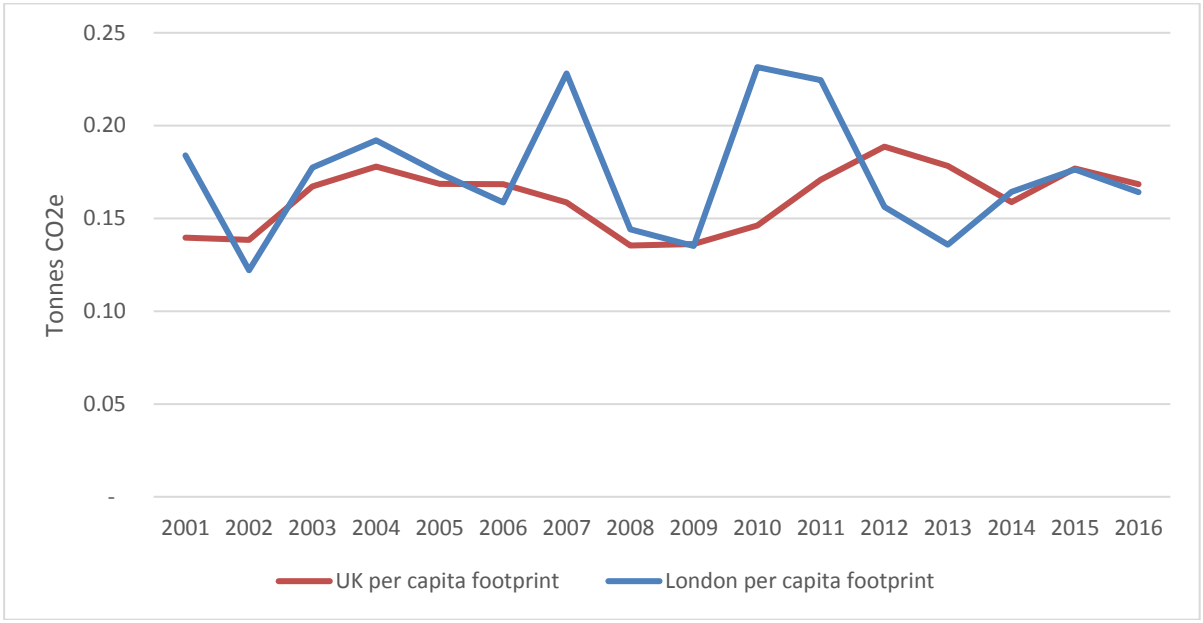

Figure 9: UK and London per capita footprints for health (2001-2016)

5.7 Transport

The transport footprint includes all spend on vehicles, operating private transport, public transport and air fares. The average London resident has a higher than average impact for spends on this category. This includes air travel, with Londoners spending more on international air travel than the average UK resident, which significantly increases per capita emissions.

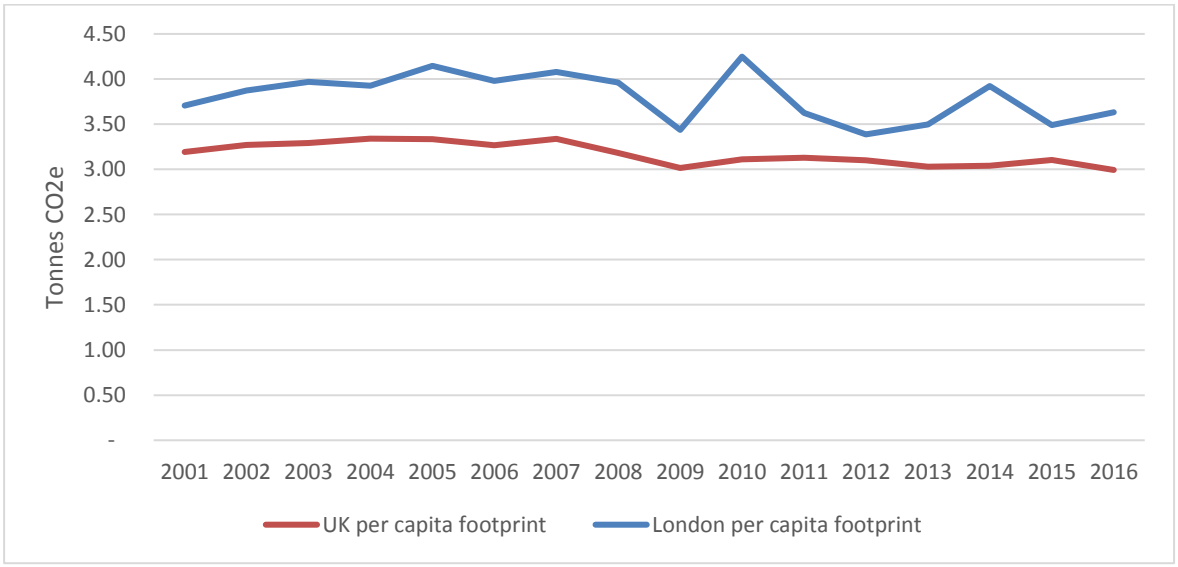

Figure 10: UK and London per capita footprints for transport (2001-2016)

5.8 Communication

The communication footprint includes all spend on post, mobile phones, internet and telephone services. The average London resident has a higher than average impact for spends on this category.

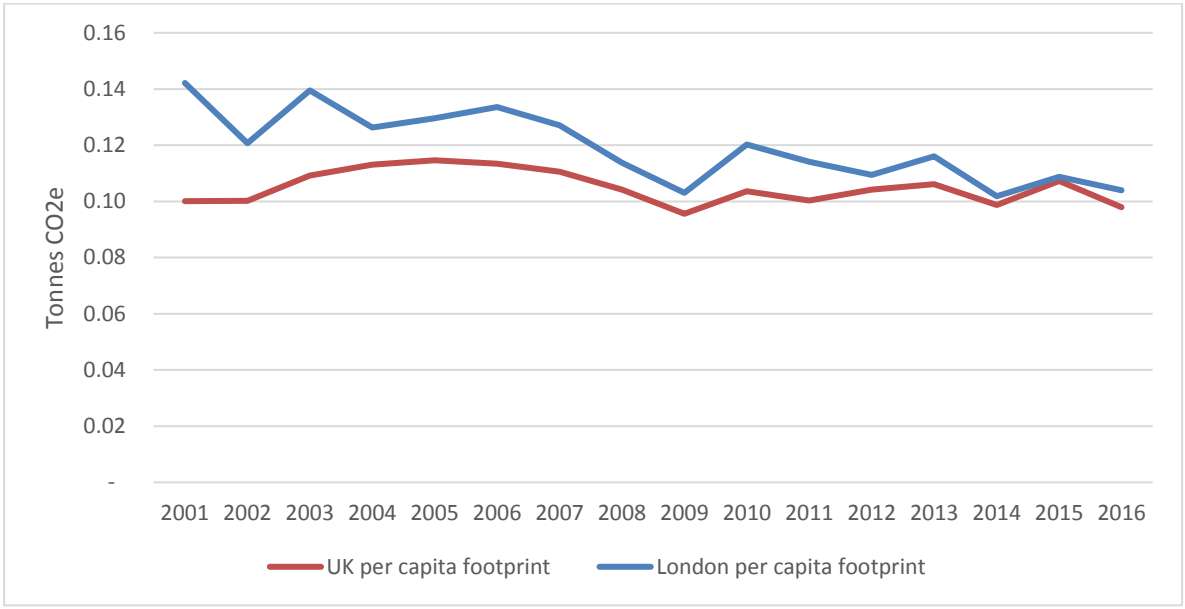

Figure 11: UK and London per capita footprints for communication (2001-2016)

5.9 Recreation and culture

The recreation and culture footprint includes all spend on books, games, sports, cinema, pets, gardening and theatre. The average London resident has a lower than average impact for spends on this category.

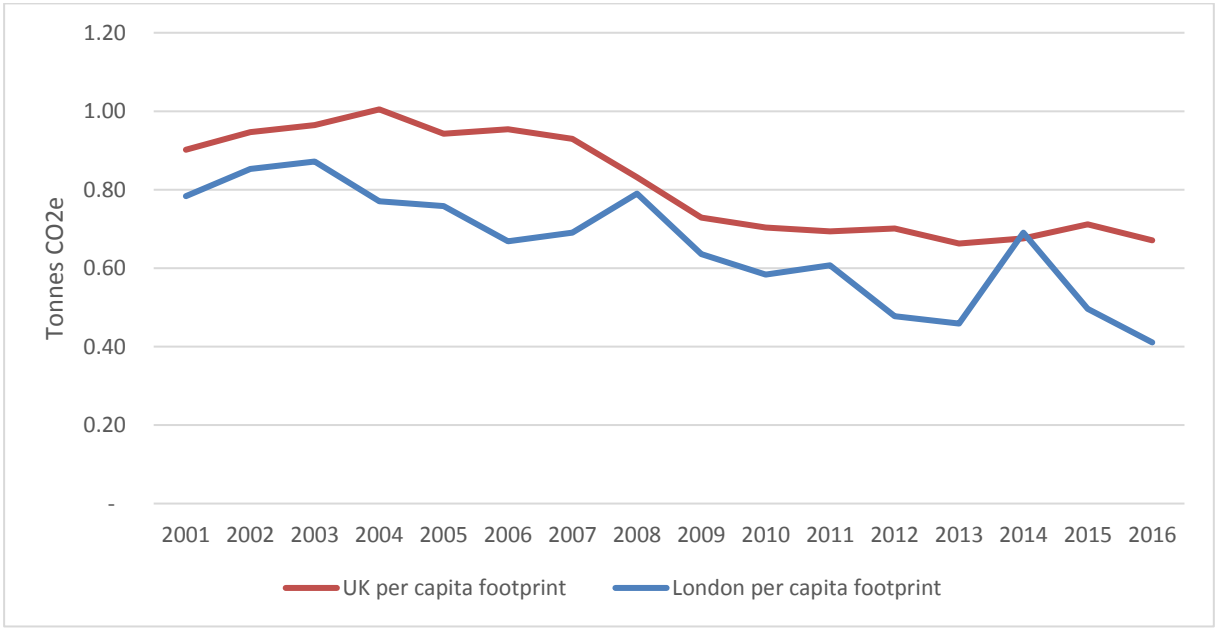

Figure 12: UK and London per capita footprints for recreation and culture (2001-2016)

5.10 Education

The education footprint is estimated from household spend on primary to university education. There is little or no footprint associated with state school education in this category because state education is paid for through household tax payments and is therefore accounted for in another category. The average London resident has a higher than average impact for spend on this category. This may be due to reasons such as a higher proportion of children going to private schools, a higher proportion of adults with university age children or higher a proportion of adults whose children do not get loans for university education and so the parental contribution is high.

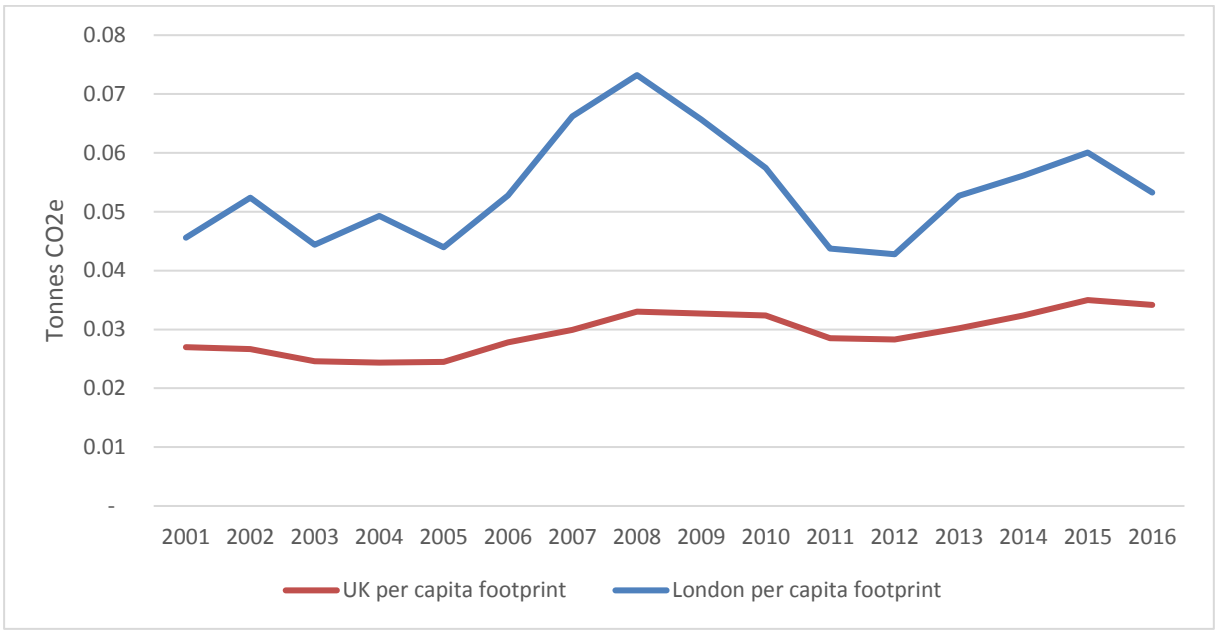

Figure 13: UK and London per capita footprints for education (2001-2016)

5.11 Restaurants and hotels

The restaurants and hotels footprint includes all spend on catered food and drinks including canteens and pubs and accommodation services. The average London resident has a higher than average impact for spends on this category.

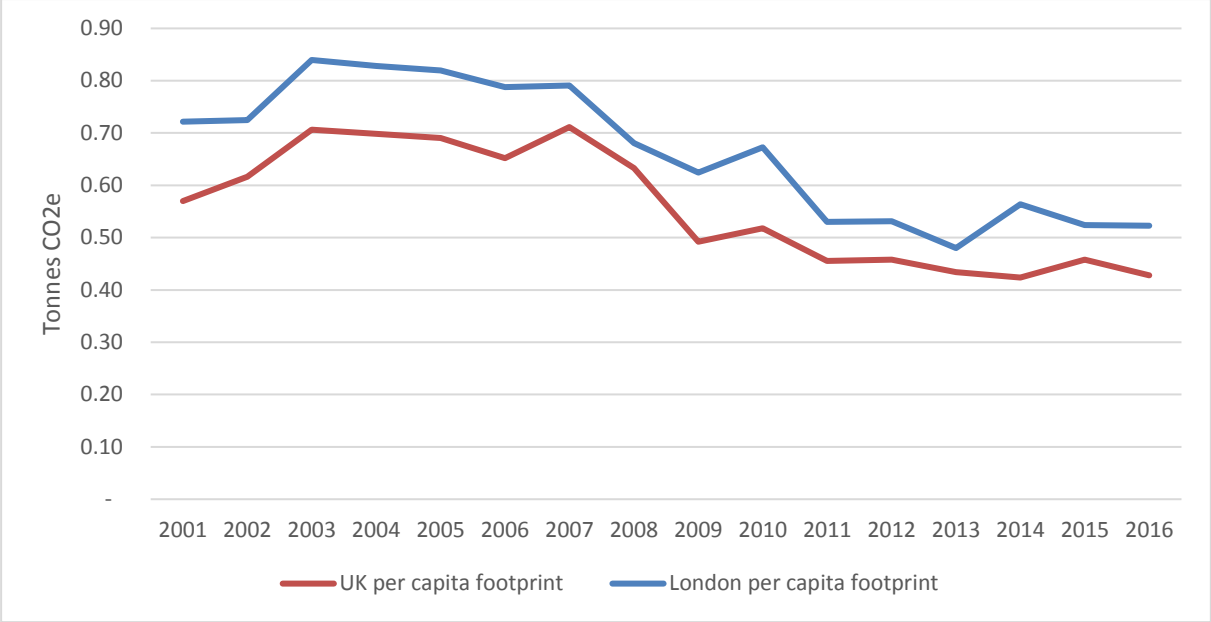

Figure 14: UK and London per capita footprints for restaurants and hotels (2001-2016)

5.12 Miscellaneous other services

The miscellaneous other services footprint includes all spend on hairdressing, babysitting, business and financial services. The average London resident has a similar impact to the rest of the UK.

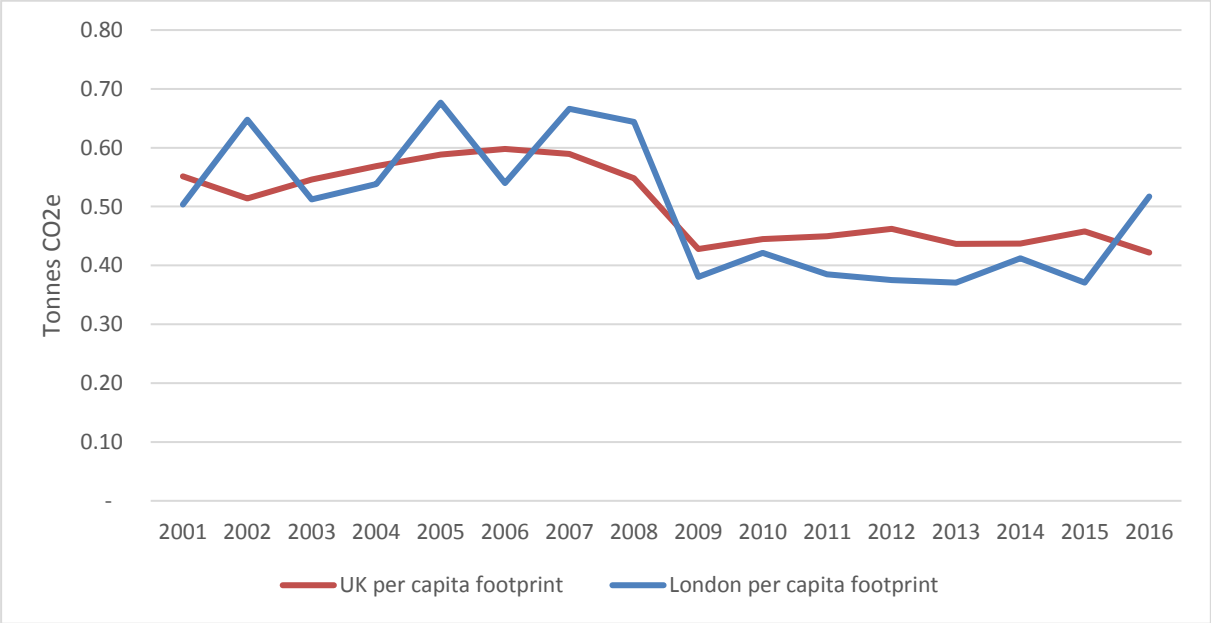

Figure 15: UK and London per capita footprints for miscellaneous other services (2001-2016)

6. Conclusions and research gaps

University of Leeds will continue to improve the underlying data. There have been substantial improvements in relation to previous estimates. Our suggestions for further analysis being:

- Capital and infrastructure – National average are applied and a detailed assessment of the embodied emissions of national infrastructure would help identify additional mitigation option.
- Government – instead of proportioning the national average, an additional study could consider the GHG emissions of the GLA.

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