A New Carbon Baseline for the Lake District National Park

Methodology Document

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2 Methodology

Whilst the term 'footprint' is used in various ways, we are using it to mean the sum of the direct and indirect emissions that arise throughout supply chains of activities and products. The inclusive treatment of supply chain emissions, as presented here, differs from more standard 'production-based' emissions assessments, but gives a more complete and realistic view of impacts of final consumption.

As an example, emissions resulting from the purchase of goods by residents and visitors would not feature in a production based emissions assessment, since all the emissions take place in the supply chains of the products rather than at the point of purchase. To give another example, in a consumption based assessment, the footprint of travel includes, on top of the direct vehicle emissions, those resulting from the extraction, shipping, refining and distribution of fuel, emissions resulting from the manufacture and maintenance of vehicles, and so on. Thus, in the case of car travel the final figure is typically around double that of the exhaust pipe emissions. In a third example, the footprint of electricity consumption includes components for the emissions associated with fossil fuel extraction, shipping, refining and transport to power stations, as well as those resulting from the electricity generation process itself.

2.1 Boundaries of the study

The following is within the scope of this study:

- all residents personal travel and visitor travel to, from and around the Lake District National Park (LDNP),
- fuel and electricity consumed in homes and places to stay,
- emissions from food and drink and other purchased items,
- the supply chains of all the above (e.g. fuel supply chains and embodied emissions)
- business emissions for businesses operating within the LDNP

The following is specifically excluded:

- Bespoke treatment of impacts of land-use in the specific circumstances of the LDNP.

2.2 Inclusion of the Kyoto Greenhouse Gases

This assessment considers the basket of Greenhouse Gases (GHG) that is covered in the Kyoto Protocol, expressed in terms of carbon dioxide equivalent (CO_2e), the sum of the weights of each gas emitted multiplied by their global warming potential (GWP) relative to carbon dioxide over a 100 year period.

2.3 GHG Protocol guidelines

We have followed the reporting principles of the *'GHG Protocol, a Corporate Accounting and Reporting Standard – Revised Edition'* (GGP) published by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI) (Ranganathan *et al,* 2015).

The GGP defines 3 scopes for emissions reporting. Scope 1 covers direct emissions from company-owned vehicles and facilities. Scope 2 includes net emissions from energy imports and exports, such as electricity. Scope 3 includes other indirect emissions resulting from company activities, as detailed by the boundaries of the study. This report includes all Scope 1 and 2 emissions and comprehensive treatment of Scope 3 emissions throughout supply chains of activities and purchases within the boundaries laid out above.

2.4 Treatment of high-altitude emissions

High-altitude emissions from aircraft are known to have a higher global warming impact than would be caused by burning the equivalent fuel at ground level. Although the science of this is still poorly understood, this study has applied an emissions weighting factor of 1.9 to aircraft emissions, to take this into account. This is in agreement with the figure suggested in Defra (2009) *'Guidelines for Company Reporting on GHG Emissions'*.

The figure can also be inferred from the Intergovernmental Panel on Climate Change's Fourth Assessment Review (IPCC 2007).

2.5 Reporting approach

The start point for this work is a model of GHG emissions per capita from UK consumption. For this we used an environmental input–output model (EIO) based on 2014 ONS combined use tables and UK environmental accounts. The specific model used was developed by Small World Consulting with Lancaster University (see below). The categorisation of emissions into 105 consumption categories was simplified into a 14 category model.

An estimate of the average visitor population was derived from the Cumbria Tourism (2015) 'Visitor Survey' figures for UK and overseas visitor numbers and visitor days.

In the first instance the GHG footprint of consumption by residents and visitors whilst in the LDNP was obtained simply by multiplying average populations of each by the UK per capita consumption footprint estimates.

2.6 Environmental Input–Output analysis (EIO)

EIO combines economic information about the trade between industrial sectors with environmental information about the emissions arising directly from those sectors to produce estimates of the emissions per unit of output from each sector. The central technique is well established and documented (for example: Leontief, 1986; Miller & Blair 1985, 2009; Berners-Lee *et al.* 2010). In the UK, the main data sources are the *'Supply and Use Tables 1997 - 2014'* and the *'Greenhouse gas emissions in the UK, 1990 to 2014'* (ONS, 2016a; ONS, 2016b), both provided by the Office of National Statistics (ONS).

The specific model used for this project was developed by Small World Consulting with Lancaster University. This model takes account of such factors as the impact of high altitude emissions that are not factored into the environmental accounts and the effect of imports. We have also used price indices to take account of changes in the economy between the production of the supply and use tables for 2014 and the baseline year of 2016.

Three main advantages of EIO over more traditional process-based life-cycle analysis (LCA) approaches to GHG footprinting are worth noting:

1) EIO attributes all the emissions in the economy to final consumption. Although, as with process-based LCA, there may be inaccuracies in the ways in which it does this, it does not suffer from the systematic underestimation (truncation error) that process-based LCAs incur through their inability to trace every pathway in the supply chains (Lenzen, 2001; Nässén *et al,* 2007).
2) EIO is an analytical and therefore impartial process for the calculation of emissions factors per unit of expenditure, whereas process-based LCA approaches entail subjective judgements over the setting of boundaries and the selection of secondary conversion factors.
3) Through EIO, it is possible to make estimates of the footprints resulting from complex activities such as the purchase of intangible services that LCAs struggle to take into account.

One of the limitations of EIO in its most basic form is that it assumes that the demands placed upon (and therefore the direct emissions from) other sectors by a unit of output within one sector are homogeneous. As an example, a basic EIO model does not take account of the carbon efficiencies that may arise from switching the expenditure on paper from a virgin source to a renewable source without reducing the actual spend. In this report, the carbon intensity per unit turnover of, for example, the hotels, pubs and catering establishments of the LDNP are assumed to be 'UK typical'. It is possible, with additional resource, to make

bespoke adjustments to these generalities given relevant local data and a defendable basis for relating that data to emissions. A further assumption in the model used here is that goods from overseas are produced with the same carbon efficiency as they would have been in the UK. Overall, this assumption usually results in an underestimation of the footprint of purchased goods. A further omission for this and all EIO models that we are aware of is that the impact of land-use change around the world has not been taken into account. This would be likely to result in an increased assessment of the footprint of foods, especially animal products[1].

2.7 Adjustments based on bespoke national and local data

The result based on EIO and UK averages was adjusted to take account of key differences in consumption patterns for both visitors and residents from the UK average, wherever available data provided a reasonable basis for doing so. Estimates were also added for visitor travel to and from the LDNP. Specifically, the following adjustments were made.

2.7.1 Visitors

Travel to and from the LDNP was estimated using data from Cumbria Tourism's 2015 *'Visitor Survey'* and 2010 *'International Visitor Survey'*. They gave the following data:

- Travel modes to and from the LDNP by overseas visitors, day visitors and UK staying visitors
- Proportions of overseas visitors from different countries and sufficient information about the split between travel modes getting to and from the LDNP to allow a tolerable estimation of the all overseas visitor miles by different modes to and from the LDNP. (Distances from each country from Webflyer.com)
- Proportions of UK visitors from each UK region (allowing journey miles to be plotted using data from AA journey planner website).

In the case of overseas visitors, estimates of time spend in the LDNP were divided by estimates of the length of overseas visitor trips to give the proportion of each journey to the UK that should be allocated to the LDNP visit. ONS Travel and Tourism data (ONS 2016b) gave information leading to estimates of the average length of stay in the UK by visitors from each of the countries and regions being analysed and estimates of the lengths of stay in the LDNP came from the Cumbria Tourism visitor surveys.

Travel around the LDNP was estimated by combining data on visitor spend per person on transport from the STEAM report (LDNP, 2016) and primary modes of transport used (*'Cumbria Tourism Visitor Survey',* 2015) to achieve an estimate of the spend on different transport modes. This combined with data on visitor numbers enabled the calculation of adjustment factors for the EIO model. Assuming UK typical car efficiency and an average fuel price of £1.13 per litre in 2016 a bespoke calculation was made for car use based on Small World Consulting's hybrid "Defra plus EIO methodology" and this was used in place of adjusting the existing EIO estimate. This directly calculated the emissions based on the expected number of litres consumed based on the expenditure and then factors in the additional emissions from supply chains. The embodied emissions of car use are then added into this based on a typical ratio of embodied emissions to fuel consumption.

Other expenditure **areas** were adjusted using STEAM (LDNP, 2016) data on total spend to estimate the average spend per capita based on visitor full time equivalents. These were compared to the UK typical spend per capita to obtain an adjustment factor. Where no data was available on visitor spend it was assumed to be the same as UK typical.

[1] 'How Low Can We Go?', WWF, (2010) estimates that emissions from red meat production outside Europe rises by a factor around five when land-use change is taken into account.

Visitors were not buying certain items. Some types of goods were assumed not to be bought or directly depreciated by LDNP visitors. These included, for example, domestic appliances and power tools.

2.7.2 Residents

The basis for adjustment of resident data was taken mainly from information from the 2011 UK Census (ONS 2011). The data from the census is described in geographical areas known as output areas (OAs). Each OA is given a specific code and describes a specific part of the country thus using a map and information on where these OAs are located it was possible to identify which specific OAs fell within the boundary of the LDNP. This knowledge then allows further analysis of census and other data to establish facts about the resident population of the LNDP.

Electricity and domestic fuel consumption data were obtained from the ONS broken down by middle super output areas (MSOA) (ONS, 2015). These cover larger areas than the OAs but the ONS provides a mapping to correlate the areas. Using this and the population of the OAs the proportion of each of the relevant MSOAs that fell within the boundary of the LDNP was calculated. This proportion was then used to estimate gas and electricity consumption within the LDNP. This was then compared to the UK gas and electricity consumption per capita, to obtain an adjustment factor for the EIO model.

Car fuel use and embodied emissions of driving were calculated based on ONS transport energy statistics (ONS, 2017). These were available at local authority level so they were apportioned to the LDNP based on the proportion of the population that falls within the LDNP in each local authority. They were then compared to the UK emissions per capita to arrive at an adjustment factor for the EIO model. The same adjustment factor was used for embodied emissions of driving.

Other expenditure. Based on 2011 census data, similar OAs across the country have been grouped together and described by their shared social and physical demographics in a so called “output area classification” (OAC) (Gale *et al*, 2016). Thus, each OA within the LDNP is nominated an OAC name (ONS, 2011a). The family spending survey publishes estimates of typical spending profiles of each OAC group (ONS, 2016d). By combining these datasets it is possible to arrive at an estimate of the typical spending profiles of the OAs within the LDNP and thus the typical spending of the LDNP. This is then compared to the typical UK spending to establish adjustment factors for typical household goods such as food, clothing, transport accommodation, which is then mapped onto the EIO model to adjust the UK model to reflect the typical spending of households within the LDNP. In areas of the economy not covered by the family spending survey it was assumed that the LDNP did not differ from typical UK spending.

2.7.3 Industry

Average emissions intensities for 105 UK industries, broken down by direct emissions (scope 1) emissions from power generation (scope 2) and supply chain (upstream scope 3) were taken from the EEIO model. These were multiplied by industry turnover within the LDNP in 18 broad industrial sectors from the Lake District Economy Topic Paper (LDNP, 2017).

2.8 Other Emissions Factors.

Where consumption estimates were based upon expenditure, the carbon intensity of activities and purchases have been taken from the EIO model.

Where emissions estimates have been based upon physical consumption, the direct components associated with fuel combustion, from electricity generation and from most transport have been calculated using conversion factors provided by department for Business, Energy and Industrial Strategy (BEIS) in their *‘Greenhouse gas reporting: conversion factors 2016’ ’* (2016). However, the BEIS figures do not take account

of supply chain emissions other than those produced at the point of electricity generation, and these need to be considered separately and we have referred, again to the EIO model.

2.9 Data Sources

The main sources are listed in Appendix A.

2.10 Uncertainties

The complexity of supply chains and the difficulties in obtaining accurate data dictate that footprinting can only offer an estimate rather than an exact measure, and the figures in this report should be viewed in that context. We have operated from the principle that it is more informative to make best estimates of even the most poorly understood components of the footprint, and to discuss the uncertainty openly, than to omit them from the analysis.

Overall, the results in this report should be viewed as offering a broad guide to the size and relative significance of different components.

2.10.1 Uncertainties over data

Sources of error were numerous, but the largest are thought to be as follows. Much of the data was drawn from visitor surveys, in which responses may have been systematically inaccurate, the sample group not fully representative and sample sizes were not always ideal.

2.10.2 Uncertainties over conversion factors

The areas in which the relationship between consumption and footprints is best understood are gas and electricity consumption. There is relatively good consensus over conversion factors to within around 5% in these areas. The next most certain group of conversion factors are those for travel and transport. In this category, there is uncertainty over the impact of high altitude emissions and the embodied emissions in the manufacture and maintenance of vehicles, roads and other infrastructure.

Supplies and services are the areas of greatest uncertainty. As an example, credible process based life cycle analyses of a particular specification of paper typically differ by factors of around 50% depending on the specific practices employed in the particular mill in which it was manufactured. It would also be possible for two detailed studies of exactly the same process to arrive at significantly different estimates, depending on the precise assumptions made. The EIO approach that we have adopted overcomes the truncation error that process-based approaches incur, but does suffers its own series of problems, most notably errors of aggregation – the failure to look at the particular circumstances of a supply chain by using an industry average.

3 Appendix A: Main data sources and references

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Office of National Statistics (2016a). Input Output Supply and Use tables, 1997 - 2014. UK supply and use tables. Link: https://www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/datasets/inputoutputsupplyandusetables

Office of National Statistics (2016b). Leisure and Tourism 2016 Overseas Residents visits to the UK, Section 4. Table 4.Lengths of stay in the UK of visitors from different countries of origin. Used to determine proportion of international travel attributable to the Park visit. Link: https://www.ons.gov.uk/peoplepopulationandcommunity/leisureandtourism/datasets/overseasresidentsvisitstotheuk

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