

**London's Ecological Footprint**  
A review

June 2003



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## Foreword

There is increasing interest in developing measures of economic performance which include an assessment of environmental impact and importance. Most recently, Best Foot Forward has produced a *City Limits* report on London's 'footprint'. The ecological footprint analysis used in the report is a relatively new concept and has the attractive characteristic that it can be easily conveyed to a wider audience. A location's ecological footprint is a measure of the land needed to support human activity in a particular area.

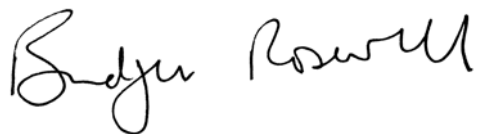
GLA Economics commissioned Brook Lyndhurst to examine how this analysis can be used as a more general measure – to capture how environmental impact is changing and as a guide to prioritising policies in this important field.

This report contributes to the debate on these matters. We have no good tools in this area at present and footprint analysis would be very powerful if it could be shown to be both reliable and practical.

Brook Lyndhurst's report throws doubt on both of these. When using the footprint method, comparability over time is a problem. The report also points out that the footprint method does not take into account the activities of commuters into London and that the service sector, which is so important, is dealt with in a very broad way.

Nonetheless, ecological footprinting is an important milestone for resource accounting and environmental impact for London. The *City Limits* work has created a vital tool for economists and policy makers by providing a large dataset to aid and develop conventional environment-economy analysis. This report should encourage debate on whether the ecological footprint – in its current methodological framework – is best suited as a measuring tool to prioritise sustainable development projects.

We welcome any comments you may have on this report, and your suggestions for developing environmental measures.



**Bridget Rosewell**

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# Introduction

GLA Economics commissioned Brook Lyndhurst to undertake a concise, desk-based research exercise to provide them with a critical context for the *City Limits*<sup>1</sup> report. The brief was to:

- briefly review the current 'state of the art' in mass balance/ecological footprint/resource flow analyses and summarise the methodologies used by such analyses.
- compare and contrast the applications of these different methodologies.
- highlight the issues arising from the review.
- make propositions for further research or enquiry that could be usefully undertaken, either by the GLA or others, to further the application value of footprint analysis.

Our review was conducted in the spirit of the *City Limits* report itself:

'I hope this report stimulates real debate and change.' Oswald A Dobbs MBE,  
Chairman of IWM (EB)

We were mindful of the very broad parameters of such a debate, and the range of potential participants: very different perspectives on environmental footprinting, for example, might characterize 'mainstream' economists compared to environmental campaigners, or environmental policy makers compared to mainstream private enterprises.

Our objective was, as far as possible, to strike a balance between these perspectives. Thus, whilst a detailed, formal technical exposition of footprinting was outside the scope of the research and this report, our report contains a variety of technical elements. (More detail on footprinting can be found on the following websites

<http://www.rprogress.org/programs/sustainability/ef/methods/calculating.html#assumptions>  
or <http://www.bestfootforward.com/>)

This report starts by looking at some of the different types of resource flow analysis and environmental accounting techniques currently used in the UK.

The second section deals with the principles of footprinting in more detail and reviews the findings for London from the *City Limits* report.

The strengths and weaknesses of footprinting both in general and in the London case are highlighted in the third section.

The final section draws out the issues and questions arising as a result of our research.

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<sup>1</sup> 'City Limits: A resource flow and ecological footprint analysis of Greater London', Best Foot Forward Ltd for IWM (EB), 2002

# 1. History and state of the art

## 1.1 Origin

The roots of ecological footprint analysis can be traced back to the 18<sup>th</sup> century when Francois Quesnay published his *Tableau Economique* in which he discussed the relationship between land productivity and wealth creation. Many scholars subsequently tried to conceptualise and to develop accounting techniques to analyse the relationship between people and nature.

Some of these techniques focused on energy flows needed to support human activities while others started to look more explicitly at the human carrying capacity concept. For example, in the early 19<sup>th</sup> century Malthus, with his 'Essay on the Principles of Population as It Affects the Future Improvement of Society', started the debate on the earth-limited capacity to feed an ever-growing population.

The global carrying capacity concept started to gather momentum in the 1960s and 1970s, with the publication of 'Limits to Growth' by the Club of Rome. The think-tank, led by Alexander King and Aurelio Peccei, warned that unless important changes of policy were made, the continuation of existing trends in population growth and resource use would lead to catastrophic events. The conclusions of the report were largely misread by some of the press who put it forward as a plea for zero growth.

At that time, Georg Borgstrom also started analysing resource consumption in terms of 'ghost acreage', ie in terms of imported agricultural carrying capacity while Rees developed the 'regional capsule', a precursor to the ecological footprint, as a teaching tool for multi-disciplinary planning students in the 1970s.

Particular impetus came from the Earth Summit in 1992, which led to the adoption of Agenda 21, a wide-ranging blueprint for action to achieve sustainable development worldwide. Agenda 21 prompted widespread effort to measure sustainable development and kicked off a sprawling process of indicator development around the world at pan-national, national, regional and local levels. It is important to stress that footprinting (so far at least) is just one of the many and varied approaches that have been adopted for monitoring progress on sustainable development and policy-related target setting on environmental issues<sup>2</sup>.

**Ecological footprinting** is part of a family of related methodologies that are concerned with accounting for the entire resource flow within the economy rather than simply measuring the local state of the environment (which is what many cities have chosen to do as part of their LA21 processes). The methodology is outlined in detail in Section 2.

Ecological footprint is a method for accounting for the environmental impact of humanity. Other similar indicators include the environmental space, developed by Weterings and Opschoor

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<sup>2</sup> A survey of practice on Sustainability Indicators in the UK and other locations around the world is provided in J Cox, D Fell and M Thurstain-Goodwin, *Red Man Green Man, Performance Indicators for Urban Sustainability*, RICS Foundation, 2002

in 1997<sup>3</sup>. The concept of environmental space is defined as ‘the space available to humanity as a whole for the utilization of stocks and sinks’. They argue that this idea forces us to confront the fact that resources such as the atmosphere have limits at the global level and therefore have to be allocated between nations and regions in a ‘fair’ way. Environmental space looks at resource consumption and equity where equity is defined as a ‘fair earth share’ of a resource.

The **Environmental Space** concept has however been criticized on a number of grounds. The notion of ‘fair share’ is deemed simplistic by Moffat<sup>4</sup> as it does not take into account the geographical variations in needs. Nations in colder climates do not have the same heating needs as African nations, for example. Also, defining the maximum sustainable use rates of some resources can be tricky. For example, the impacts of CO<sub>2</sub> are global and the environmental limits are relatively well defined. This may not be the case for another resource whose impacts may be at a more local level. Mapping all resource use is, in addition, a very extensive and data intensive task requiring significant human/financial resources.

**Life-cycle analysis** is also a powerful tool that provides detailed accounts of all the energy, resources and waste materials associated with a product over its entire life cycle. However, the results are not usually aggregated across product classes for whole economies and are more usually used to demonstrate environmental impact for specific products.

Stemming from life-cycle analyses is the **mass balance** concept whose purpose is to ‘follow and quantify the flow of a material or materials in a defined situation and over a period of time. This allows the identification of the points in the life cycle where resource use is most inefficient and tracks the types and quantities of waste produced’<sup>5</sup>. This method allows better management of resources and the development of policies to maximise resource efficiency. It is developed in more detail in the next section.

**Resource efficiency** is taken one step further by Ernst von Weizsäcker, Amory Lovins, and Hunter Lovins in their book *Factor Four: Doubling Wealth, Halving Resource Use* published in 1997. The ‘Factor 4’ proposition states that global eco-efficiency must increase fourfold – ie quadrupling resource productivity over the next 30 to 50 years – through a process of doubling outputs whilst halving inputs.

This approach was used by the Nordic Council of Ministers in 1998 to assess whether it would be possible to improve eco-efficiency by Factor 4 (and ‘Factor 10’) in different sectors in Denmark, Norway, Sweden and Finland<sup>6</sup>. The general conclusion was that it was feasible to head in the right direction but that many changes in social and individual values as well as in the regulatory mechanisms would be required to reach the targets of Factor 4 and Factor 10 by 2030 and 2050 respectively.

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<sup>3</sup> *Sharing Nature’s Interest*, N Chambers, C Simmons and M Wackernagel, 2000

<sup>4</sup> *Sustainable Prosperity: Measuring Resource Efficiency*, I Moffat, N Hanley, S Allen and M Fundingsland, DETR, 2001

<sup>5</sup> *Mass Balance UK*, C Linstead and P Ekins, RSNC, 2001

<sup>6</sup> *Sustainable Prosperity: Measuring Resource Efficiency*, I Moffat, N Hanley, S Allen and M Fundingsland, DETR, 2001

## 1.2 'State of the art' – footprinting and resource flow analysis

In 1996, Wackernagel and Rees published *Our Ecological Footprint – Reducing Human Impact on Earth*. Compared to the environmental space and mass balance approaches, ecological footprint analysis is a comprehensive indicator of the biologically productive land and water areas required to produce the resources consumed by a defined human population or economy.

Very simply, footprinting approaches relate human consumption of environmental resources (demand) to the carrying capacity of ecological systems (supply). This tool was developed to measure whether a given country or region was using resources at a rate faster than nature can regenerate them.

The use of ecological footprint analysis has spread quickly and the method is being constantly refined. In 2000, WWF International published the first *Living Planet Report*, using ecological footprinting as a way to measure human pressure on Earth and how this pressure is distributed among countries. The WWF use these reports to make recommendations to governments, businesses and consumers on what they can do to slow down and, eventually, to halt the slow degradation of the world's natural environments.

### The Mass Balance UK Programme – Sectors and areas

In the UK, Biffaward<sup>7</sup> is funding a major research stream to develop mass balance databases for the UK. Biffaward has so far provided funding of £5.5 million to the various projects under the umbrella *Mass Balance UK*.

The Sustainable Economy Programme of Forum for the Future, under contract to the Royal Society for Nature Conservation (RSNC), is co-ordinating this area of research to ensure that all the data generated are consistent with each other and compatible with the systems of the Environment Agency, DEFRA and the ONS. The reports funded by this programme are available on the Mass Balance web site<sup>8</sup>, which also includes a mass balance database.

Mass balance studies seek to account for the flows of materials in the economy in order to understand resource requirements and the possible impacts of resource depletion on economic security. Once resource requirements are better understood, two steps can be taken to minimize these requirements:

- increase resource productivity
- improve waste management to ensure that a greater proportion of materials can be recovered and recycled or re-used.

The Mass Balance programme includes several **sectoral mass balance** studies and (currently) two **sector footprint** studies, one for Public Services and one for Financial Services (which will be of particular interest to London policy makers). In the event, the Public Services study,

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<sup>7</sup> Biffaward is the environmental fund created via landfill tax credits from Biffa Waste Services, managed by the RSNC

<sup>8</sup> <http://www.massbalance.org/>



recently published by Wastewatch, turned out to be an account of resources used by the public sector rather than a fully-fledged footprint analysis.

A number of **local footprint** studies are also part of this programme:

- the 'Island State', the ecological footprint of the Isle of Wight
- *City Limits*, the ecological footprint of London.

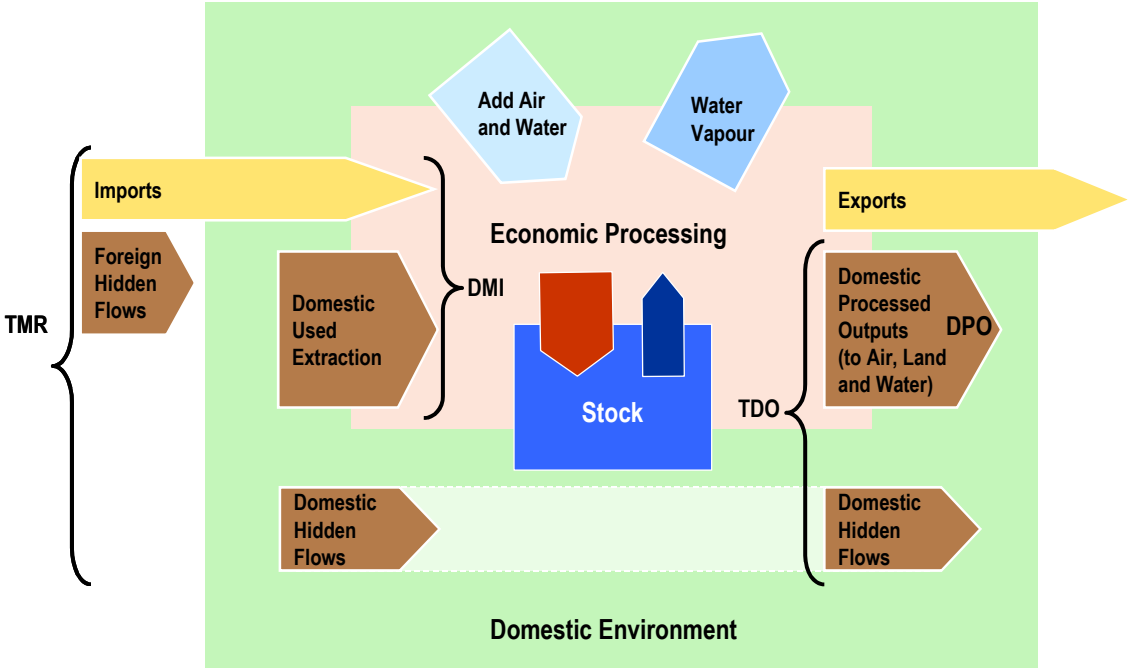
Follow-up work on these studies are either underway or planned (see Biffaward website).

**The UK government approach – resource use in the UK economy**

The need for an indicator on resource use was advocated in both the 'Quality of Life Counts' (1999) report and in the PIU report on Resource Productivity (2001). The UK government is actively investigating the route of the Total Material Requirement (TMR) index to measure the scale of resource use at the national level. One advantage of this index is that it is calculated relative to economic indicators such as Gross Domestic Product (GDP). The TMR indicator thus corresponds to the material use of an economy or a sector per unit of GDP.

Unlike the ecological footprint, the TMR indicator, developed in 1997 by Adriaanse, does not attempt to relate the levels of resource use to ecological sustainability (or environmental carrying capacity). It only quantifies changes in resource use over time. Thus, whilst it allows international comparisons to take place, it also offers fewer challenges to a 'business as usual' mindset.

**Figure 1: Economy-wide materials flows**



Source: *Resource Use and Efficiency of the UK Economy*, Wuppertal Institute, 2002

TMR measures the total flow of materials going into the economy, ie the primary resources for all the production and consumption activities. This includes both the direct and indirect uses of resources. Indirect flows are also termed 'hidden flows' and are those resources that do not enter the economy but that are moved to obtain the material that enter the economy. For example, the biomass (eg leaves, twigs) that is removed from forests to obtain wood and excavated materials are part of hidden flows. Direct Material Input (DMI) is the flow of resources entering the economy for further processing.

Material flow accounts, the analysis of resource flows, are the physical counterpart to the main National Accounts. Linking both sets of accounts provides the basis for resource productivity indicators.

In 2002, DEFRA published *Resource Use and Efficiency of the UK Economy*, a report by the Wuppertal Institute identifying the resource requirements of the UK economy using the TMR indicator and measuring how internationally competitive the UK is in using those resources.

The report warned that although TMR is widely favoured as a resource use indicator, the estimates of indirect flows are less reliable than those of direct flows, and therefore, this indicator needs to be considered alongside other indicators.

One finding of this report is the fact that economic growth in the UK is becoming de-coupled from the total use of materials (though total resource use continues to increase). This is not surprising in a sense, as UK growth is mostly concentrated in services. Services, by definition, use fewer environmental resources than manufacturing industries per unit of output. Estimates of whole-economy resource-efficiency are therefore influenced by sectoral mix.

Another finding is that UK resource productivity, defined as GDP per capita divided by DMI per capita, is within the top five of the European Union (ie the UK economy is one of the least material intensive in the EU). It would be somehow more meaningful to do such an analysis on a sector-by-sector basis, as international comparisons would not be distorted by the overall structure of the different economies (eg London's financial sector compared to New York or Frankfurt, if the methodology could be applied to cities).

One weakness of this report is that it focuses on DMI (resource productivity) rather than having a whole cradle-to-grave approach (resource efficiency). For example, it highlights the good performance of the UK in terms of resource productivity but fails to look at waste recycling rates. Proportions of waste landfilled in the UK are higher than most European countries and it is likely that the UK would not fare so well if indicators of resource efficiency were calculated.

This approach also fails to take account of the possible ecological limits to current patterns of production and consumption.

### **Practical application of footprint analysis to policy making in the UK**

It would be fair to say that the use of resource flow or footprint analysis is still in its infancy as regards policy making or target setting.

Much of the effort so far, in the UK at least, has focused on data collection since little of the information required for such analysis exists in official statistics, or is not designed for the purpose of mass balance accounting. The Biffaward project is making an important contribution in this regard and will provide a platform from which practical interventions can be developed (though it may remain limited to certain sectors/places in the immediate future).

The following are two examples in the UK where footprinting has been used to **explore the issues** relating to resource use and to **identify priority areas for further attention/policy development**. In neither case does the footprint analysis indicate specifically what needs to be done.

#### **(a) Scotland**

In Scotland, the Scottish Executive commissioned the ecological footprint of five Scottish cities (Aberdeen, Dundee, Edinburgh, Glasgow and Inverness) as part of the larger Scottish Cities Review. The footprint analysis was used to benchmark the Scottish cities' performance against each other and against other regions/areas both in the UK and internationally.

The footprint analysis was used there to identify areas where the cities perform particularly well or poorly and thus, where action was needed. For example, passenger transport was identified as being a greater challenge for Edinburgh and Aberdeen than for Dundee and Glasgow, where greater availability of public transport and lower levels of car ownership translate into a lower transport footprint. The Review also underlines the role of the land-use planning system in planning for and controlling future development to ensure Scottish cities become more sustainable. The Scottish Executive has now launched a more comprehensive footprint analysis for Scotland as a whole.

#### **(b) Isle of Wight**

In the Isle of Wight, the ecological footprint (part of the Biffaward programme) helped identify areas in need of action. For example, the largest contributors to the footprint were respectively Materials, Transport and Energy.

In the footprint analysis, a range of options was explored to reduce energy use on the Island. This finding was instrumental in the development of the Renewable Energy Strategy, which sets a target for renewable energy to account for 10 per cent of energy use by 2010. A Footprint Waste Trust is also being set up to consider an appropriate waste strategy for the Island.

## 2. Ecological footprint<sup>9</sup>

In this section of the report we outline, firstly, some of the general principles behind ecological footprinting before, secondly, turning to consider the *City Limits* report itself.

### 2.1 General principles

Footprint analysis is an integrated tool that ‘...measures how much nature, expressed in the common unit of “bioproductive space with world average productivity”, is used exclusively for producing all the resources a given population consumes and absorbing the waste they produce, using prevailing technology.’

Ecological sustainability is achieved when the ecological footprint equals carrying capacity.

#### Carrying capacity or ecological supply

The main strand of the theory underlying ecological footprinting is the concept of carrying capacity, a term used to identify the number of individuals from a given species that a defined habitat can support indefinitely.

Although it is accepted that humans can extend the carrying capacity of their habitat (by technological innovation), the ecological footprint concept assumes that the regenerative process of the planet is limited. Chambers, Simmons and Wackernagel use the open-topped water barrel analogy<sup>10</sup>. Imagine the water represents our resources. The barrel can only be refilled by the steady dripping of resources from solar energy. To avoid running the barrel dry and depleting our natural capital<sup>11</sup>, we must live off the overflow.

Figure 2



<sup>9</sup> A glossary of terms used in this section is given in Appendix 1

<sup>10</sup> Sharing Nature's Interest, N Chambers, C Simmons and M Wackernagel, 2000

<sup>11</sup> For discussion of economy models of Natural Capital see various works by Professor Paul Ekins of Policy Study Institute and Keele University (eg *Economic Growth and Environmental Sustainability*, *The Prospects for Growth*, Routledge, 2000)

The carrying capacity of each area on earth constantly changes, reflecting either greater yields due to technological improvements or the depletion of natural resources.

Ecological footprint analysis distinguishes between different land types. There are seven main land categories:

- Arable land: biologically the most productive type of land. Used for the main crops
- Pasture land: used for grazing animals
- Forested land: can be harvested for timber products
- Sea: used as fishing grounds
- Built land: also called degraded land, as its productive capacity has been lost to human developments
- Energy land: this is forest land set aside to absorb CO<sub>2</sub> emissions
- Biodiversity land: land needed to insure the protection of the planet's non-human species.

To estimate the carrying capacity of an area/region/country, the area under consideration is divided into the various land categories. Yield factors, which show the extent to which the local biocapacity of a given land use is greater/smaller than the global biocapacity in that land use, are then applied to the various areas.

To allow comparison with other countries, it is then necessary to convert these results into global hectares using equivalence factors. For example, the *Living Planet Report 2002*<sup>12</sup> estimates arable land to be 2.11 times more productive than world average land. Pasture land is less than 50 per cent as productive as this average while forest land is 35 per cent above average productivity.

$$\text{Carrying capacity} = \sum ((\text{land area}_{(x)} * \text{yield}_{(x)}) * \text{equivalence factor}_{(x)})$$

### **Ecological footprint or ecological demand**

Going back to the water barrel analogy, calculating the ecological footprint means accounting for the use of the overflow, ie accounting for the use of the planet's renewable resources (its 'interest' rather than its 'capital'). Non-renewable resources are accounted for only by their impact on, or use of, renewable, bioproductive capacity.

There are two complementary methods to calculate ecological footprints: the compound and component method.

The *compound method* is the most robust and inclusive. It calculates total consumption using trade flows (production + imports – exports) for a large number of biotic resources. It also looks at the energy balance, which includes both locally generated energy and energy embodied in traded goods.

The *component method* is more useful as a PR tool to calculate local or regional footprints provided sufficiently detailed data is available at this geographical level. With this type of

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<sup>12</sup> Living Planet Report 2002, WWF International

analysis, the footprints of different types of travel, food, materials waste and energy can be shown separately, hence a definite appeal as a publicizing or educational tool.

Originally, both these methods omitted some uses of nature for resource production (like fresh water) and waste absorption. The *City Limits* report addressed both these issues by accounting for Londoners' use of water and adding landfilled waste in the ecological footprint as an element of consumption.

Consumption of the various elements (food, transport, materials consumption, energy, degraded land and water in the component method) is first calculated using *tonnes* as the unit of measurement. It is then translated into a footprint using a conversion factor. Footprints are usually expressed in terms of global hectares per person. These are difficult to calculate and vary greatly geographically. In the *City Limits* report, UK conversion factors were applied to London data.

Conversion factors take into account all the activities necessary to the production of a particular resource. For example, calculating the banana footprint will involve converting local consumption using global yield and adjusting the result by making allowance for transport, processing, and agriculture energy.

The calculation is even more complicated for materials and transport elements of the analysis as conversion factors for these elements need to convey the amount of embodied energy, the potential for land degradation, the area of productive land used and the area of energy land needed for CO<sub>2</sub> absorption.

The total footprint is the sum of all the appropriated land areas.

$$\text{Ecological Footprint} = \sum ((\text{production}_{(x)} + \text{imports}_{(x)} - \text{exports}_{(x)} - \text{stocks}_{(x)} + \text{landfilled waste}_{(x)} - \text{recycled waste}_{(x)}) * \text{conversion factor}_{(x)})$$

## 2.2 City Limits

The *City Limits* report used the components approach and expressed the ecological footprint for London in terms of the following building blocks<sup>13</sup>:

- materials and waste
- food
- energy
- transport
- water
- degraded (built) land.

The London footprint is estimated to be 48,868,000 gha<sup>14</sup> or 6.63 gha per capita while the biocapacity of London is estimated to be 1,210,000 gha or 0.16 gha per capita. London's ecological footprint is also compared to the average 'earthshare', which represents the area to which the global population is entitled assuming everyone receives an equal share of the Earth. This average 'earthshare' stands at 2.18 gha per capita. The London footprint is therefore greater than both London's biocapacity and the average 'earthshare'.

**Table 1. The ecological sustainability of Londoners**

	<b>Ecological footprint (gha per capita)</b>	<b>Biocapacity (gha per capita)</b>
London	6.63	0.16
UK	6.3	
World average	2.8	2.18
<i>Source: City Limits</i>		

In terms of components, materials and waste account for 44 per cent of the footprint, food for another 41 per cent, energy for 10 per cent, transport for 5 per cent, and water and degraded land for the remaining 1 per cent (see Figure 3 in section 4.3)

Given that the global 'earthshare' is expected to drop to 1.44 gha per capita by 2050<sup>15</sup>, the authors conclude that 'for Londoners to be sustainable by 2050, their ecological footprint will need a 35 per cent reduction by 2020 and 80 per cent by 2050'.

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<sup>13</sup> Data used in the *City Limits* analysis can be accessed in spreadsheet form from [www.citylimits.com](http://www.citylimits.com)

<sup>14</sup> gha stands for global hectares. A global hectare is 1 hectare of biologically productive land with world-average productivity (see Appendix 1)

<sup>15</sup> No source is given for this estimate, which is quoted in the *City Limits* summary

The authors then make *suggestions* for reducing the ecological footprint by 35 per cent. These include, for **every Londoner**<sup>16</sup>:

- ‘reduced gas consumption from 9.5MWh to 6.2MWh AND
- installed 11 m<sup>2</sup> of solar panel AND
- travelled 3,000 km less per year OR switched 3,500 km of car travel to bicycle AND
- consumed 70% less meat, reducing food waste by 100 kg AND
- ate more than 40% local seasonal unprocessed food AND
- produced over 1 tonne less waste.’

(No distinction is made between consumption by individuals and by businesses. And yet, waste generated and energy needed by businesses is, in part at least, conditional on the number of people employed in London and, therefore, is also conditional on those who commute to London. Consumption by businesses should therefore not be entirely attributed to Londoners.)

Having made these suggestions, the *City Limits* report does not go on to set out any further detail. To build on such suggestions, however, it is clearly necessary to consider specific policy recommendations (particularly in the context of the draft London Plan) and, in turn, to consider the relative costs of such policies (and who should bear these costs).

A set of scenarios was developed and presented in the *City Limits* report, to reflect existing policy targets and how these would affect the ecological footprint. Three different scenarios were worked out (for each component of the footprint):

- a ‘business as usual’ scenario
- an ‘evolutionary’ scenario based on existing policy targets
- a ‘revolutionary’ scenario based on the requirement of a 35 per cent reduction in the ecological footprint by 2020 (to be on target to decrease the ecological footprint by 80 per cent by 2050).

No overall conclusion is, or indeed can be drawn from these scenarios, as they treat each element (household waste, passenger transport, transportation of food, electricity, household water consumption) in isolation. The report acknowledges that there is no interaction between components but refers to an interactive spreadsheet on the *City Limits* website where different reductions in footprint can be applied to the components and an overall footprint reduction is calculated. This spreadsheet does not, however, calculate the impact of the reduction in one element’s footprint on the other elements.

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<sup>16</sup> Source: *City Limits* summary report



### **3. Strengths and weaknesses of ecological footprints**

This section presents an assessment of the strengths and weaknesses of the ecological footprint methodology. It also looks at issues raised in the *City Limits* report that are particular to London.

#### **3.1 Strengths**

##### **Good visualising tool**

The use of land as an aggregate unit makes it a powerful and resonant means of measuring and communicating environmental impact and sustainability. The ecological footprint is a clear and understandable indicator that can be used with Local Agenda 21 processes, as a benchmarking tool and for public relations, information, or for motivation of public opinion. It clearly shows how much of the Earth London is consuming.

##### **Hazard warning indicator**

It is also a tool warning that humanity is currently exceeding the Earth's carrying capacity. This indicator recognises that there are biophysical limits and that current consumption patterns are not sustainable in the long-term. Expansion at all levels cannot continue to be an end in itself. The Living Planet Report 2002 clearly shows that at the global level, the total ecological footprint (2.28) is greater than the biocapacity (1.90), meaning that humanity is depleting its natural capital.

##### **Make ecological trade imbalances visible**

Another major asset of the indicator is that it clearly addresses the issue of import and export of sustainability. Footprint studies show to what extent nations depend on net imports of ecological services. Since it has to be a zero-sum game at the global level, not all countries can be net-importers if global overshoot is to be avoided.

A net importer of ecological services does not experience first-hand the consequences of wasteful or destructive agricultural, forestry or fishery systems but nevertheless consumes the production derived from these systems. The *Living Planet 2002* report suggests using the tax system to internalise the environmental costs of production to correct this imbalance. Revenues could then be turned into subsidies to encourage sustainable production systems.

##### **Use of the indicator is increasingly widespread**

At the European level, experts on the urban environment are working on a European Common Indicator Project (ECIP), to identify indicators reflecting the interactions between environmental, economic and social aspects. The aim of this project is to support local authorities in their work towards sustainability. Ecological footprinting is being considered as an indicator. However, the main barrier for ecological footprinting to be included in the ECIP is the difficulty to move from the identification of the footprint to progress and decisions.

A relatively large number of academics and organisations are also involved in ecological footprint calculations. The results in the WWF's *Living Planet Report 2002* were widely reported in the media. It is therefore increasingly important for all ecological footprint practitioners to adopt a common methodology to allow comparisons between countries and local areas.

At present, the use of footprint/mass balance analysis in (general) policy development appears limited but this may reflect the relative novelty of the approach as much as lack of interest or applicability. An important first stage is the development of the Mass Balance UK databases in the UK which could spin out policy debates once the initial work is completed. Moreover, it is clear that UK government will continue to promote Material Flow Accounts as a parallel to the standard National Accounts.

### **Highlights the problem areas**

One common criticism of the ecological footprint is that the indicator shows the mismatch between biocapacity and ecological demand but does not say anything on how to reduce that mismatch. However, the value of the indicator resides in the detail of the approach.

While the accuracy of the numbers can be questioned, the ecological footprint gives us an indication of the relative size of the transport footprint versus the energy footprint versus the food footprint, for example, and shows which sector fares better or worse than the other. Policy priorities can be deduced on the basis that, for example, the energy footprint is the largest and needs action most urgently. The effectiveness of policy changes can then be measured at a later date when the indicator is updated.

## **3.2 Weaknesses**

### **Only an indicator of environmental sustainability**

One criticism levelled at the ecological footprint is that it only looks at demands placed on the environment and that no attempts are made to consider the social or economic dimensions of sustainability. For example, trade effects also have a social dimension. Ecological footprinting is therefore an indicator of environmental sustainability, not an overall indicator of sustainability.

This is where TMR is useful since, whilst it is also an indicator of resource use, it is possible to relate it to economic indicators such as GDP. Ecological footprinting and TMR are somewhat complementary, the former showing the ecological sustainability of a place and the latter showing material productivity in pounds by relating output to resource use.

### **Questions of distribution**

At the heart of pure footprint approaches lies the idea of fair 'earthshares' – that is, that every person on the planet is entitled to an exactly equal share of ecological resources, wherever they live, or however economically productive they are, or whatever social needs they have.

This is clearly a very radical political proposition which, in our view, could undermine buy-in from important stakeholders if the analysis were to be used for policy development. In our view, important questions that need to be asked in relation to footprinting are: 'What is a fair share for global cities like London?' 'How much does the footprint have to be reduced to be acceptable?' An analogous question in conventional economic analysis would be, 'should all cities have equal GDP per head?'

### **Lack of transparency**

The calculations involved in putting together the indicator are complex and often not fully explained and available to those who will use the results, hence there is a certain lack of transparency.

More research needs to be done, perhaps at the national, rather than at the global level, to determine the sources of data or the possible proxies that could be used by all those wishing to develop ecological footprinting in an area in the UK. Similarly, if the use of ecological footprinting is to become widespread, the same national conversion factors need to be used by all those involved. The details of the methodology used to develop these factors also need to be made widely available.

At the same time, more work has to be done to clarify what the footprint does tell us and what its limits are.

### **Data intensity and availability**

A huge amount of data is needed to calculate an area's footprint. The data needed may not exist in the format required or for the area under consideration. The use of proxy data is therefore widespread, which inevitably raises questions about the accuracy of derived results. Moreover, it is important to bear in mind the cost of collecting data for individual sectors as well as that of building, storing and maintaining the necessary databases.

### **Not a dynamic indicator**

The footprint is a 'snapshot' estimate of biocapacity demand and supply, usually based on data from a single year.

Both sides of the equation can change over time, which is why it is not practical to forecast or 'backcast' footprints from current data. The indicator can, however, be used as a tool to devise scenarios by making assumptions about future consumption and bio-capacity.

It is possible to update an ecological footprint, of course, but it is a time-consuming exercise as the conversion and equivalence factors have to be re-calculated every year both on a global basis and at the national level. The biocapacity also has to be re-worked every year. Although footprint accounts make no distinction between land uses that are sustainable and those that are not, changes in productivity due to unsustainable land use will affect future estimates of biocapacity.

Comparison between years becomes hazardous in terms of determining where the changes originate. It is analogous to having a time-series for consumption at current prices and converting it to constant prices using a deflator with varying base years.

### **Land can only have one function**

Another negative aspect of the methodology is that each unit of land is assumed to have only one function. This is obviously not true in the case of a forest, which can both assimilate CO<sub>2</sub> and provide timber. Moreover, ecological footprinting also assumes that CO<sub>2</sub> can only be sequestered by land even though agricultural crops and oceans also play an important role in CO<sub>2</sub> absorption.

### **Less reliable at the local/regional level**

Lack of access to local data makes the use of ecological footprinting at the regional/local level far less accurate than at the global or national level. Not only would it be impractical to estimate conversion factors at the regional level but the availability of data at such a local level is often difficult to gather. The TMR approach has similar drawbacks at the sub-national level (eg estimating local imports and exports) and additionally requires accurate local economic output data.

### **3.3 Issues surrounding *City Limits***

The *City Limits* report has provided an important and valuable contribution to the consideration of how London is monitored and managed. Its publication raises many questions, both methodological and political. In addition to the strengths and weaknesses referred to above, three further issues are of particular relevance.

#### **‘Geographical’ or ‘responsibility’ principle**

The authors of the *City Limits* report have decided to footprint the consumption for which the London population is responsible rather than to measure the footprint of London itself. This is mainly to be able to apportion consumption impacts to the *individual* so that comparisons with the available earthshare can be made (gha per capita).

The report recognises the ‘fundamental’ nature of this decision (p46) since the two approaches can lead to ‘very different answers’.

The decision means that the impacts of features such as commuting, Heathrow airport and London’s industry (since its outputs are assumed to be consumed elsewhere) are not fully included in the published analysis. Since many of London’s current policies and strategies are either concerned with or affected by these features, it might be appropriate to evaluate their footprint.

#### **Use of global, national or local yields**

On the positive side, the *City Limits* report used ‘actual’ yields, ie UK yields rather than global yields. For full consistency, the ecological footprint of each component of the resource flow equation should be calculated, applying national yields to domestic goods and local yields on imported goods. It appears however that UK yields were applied on total consumption rather than on the domestically produced part of total consumption. This may be due to the difficulty of obtaining local yields for all imported products.

#### **Local versus national consumption data**

Regional consumption data is difficult, if not impossible to obtain, and many studies have had to adjust national data for local population size.

In the *City Limits* report, little regional data was available for the materials component and London data had to be proxied. Gaps were also identified in the availability of detailed data on waste and food consumption. For example, data on food consumption, including exports and

imports, was proxied by applying the London population share to national food consumption. The availability of local data was better for energy, transport, water and land.

The absence of official statistics on resource consumption means that the local data issue would apply to *any* attempt to account for London's environmental impact, whether a footprint, resource flow or TMR methodology.

## 4. Conclusions – issues and questions

### Footprint analysis is important...

- It appears that a **new paradigm** is developing for measuring and accounting for environmental impact.

The Biffaward Mass Balance programme, a variety of initiatives underway by Government in relation to material flow accounting and resource efficiency, and a range of international studies are part of this shift.

As a relatively novel discipline, methodologies are still evolving and the relationship to conventional economic accounts remains to be fully explored.

It will be increasingly important for both economists and policy makers to keep abreast of these developments and become fluent in the use of such data alongside conventional economic analysis.

- The ecological footprint concept is part of this new paradigm and is an **excellent instrument** to make complex problems understandable to a broader public and diverse policy stakeholders.

It evaluates the resources we are currently using and compares the total resources used to the long-term carrying capacity of the planet. As such, the *City Limits* report is a valuable tool to kick-start and focus the debate on London's environmental impact and ecological efficiency.

- Another important aspect of ecological footprinting is that it makes explicit the link between human activity and land.

While the majority of economic indicators are expressed in prices, both demand and supply in ecological footprint accounts are expressed in global hectares/person.

### ...and the *City Limits* report has played an important role...

- In relation to London, the *City Limits* report is an important milestone in accounting for resource use and environmental impact of the capital.

It has led to the development of new indicators of resource use in London and provided a publicly accessible database. Although we have highlighted a number of technical questions that remain (and it is important to note here, that these may not relate just to *City Limits* but are also a more general reflection of the 'state of the art' of footprinting as a relatively novel technique) the *City Limits* report makes a significant contribution to a more rounded consideration of London's sustainability.

- The most useful feature of footprinting may be in drawing attention to the issues that need to be tackled amongst a broad stakeholder constituency.

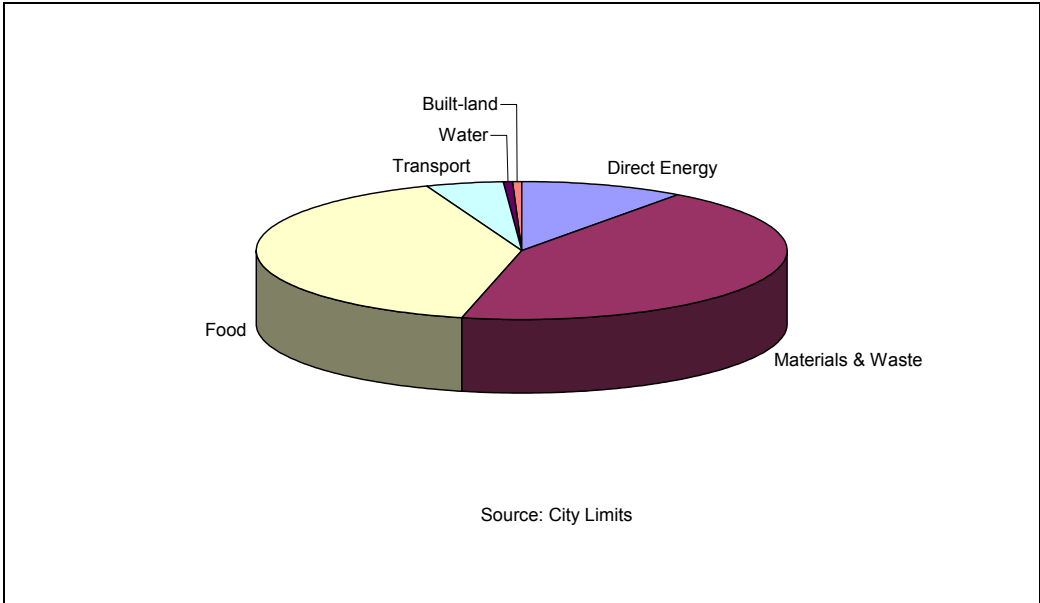
In particular, *City Limits* provides a valuable tool for showing the relative contribution of each component to London’s environmental impact, which helps to support existing Mayoral priorities and to identify other areas that might be prioritised in future.

Figure 3 shows that food and materials and waste are the biggest contributors to London’s footprint. This suggests that the waste strategy is timely but that further work needs to be done on increasing resource efficiency.

The fact that the food footprint is the second largest footprint in London is a significant finding – no other indicator has ever shown the environmental impact of our diet in such a striking way. At the moment, food is not included in any of the Mayor’s policies and it may be worth considering whether London needs a sustainable food strategy.

The other two large components, energy and transport, are also the subject of specific strategies in London.

**Figure 3: The ecological footprint of Londoners – by component**



**...But there are weaknesses...**

- The methodology underlying footprinting is still being refined with each new project, raising questions about the reliability and comparability of different studies.

For example, in the mid-1990s, Herbert Girardet produced a simplified version of the ecological footprint of London. He estimated the footprint of London to be around 15,000,000 ha. This is a third of the *City Limits* report’s footprint, which stands at 48,868,000 gha.

The Biffaward initiative is an important step forward in this regard. The ultimate aim is to build national resource flow datasets, which once complete, will give a comprehensive picture of the **mass balance** of the UK. Footprint studies are part of this programme as these studies comprise resource flow analysis for several materials.

- One weakness of the footprint approach is that it does not balance ecological demand and supply against economic (or social welfare) contributions.

A deeper green perspective might say that this does not matter because we cannot have economic development that undermines global environmental security; while a more mainstream perspective might find the primacy of ecological 'capital' in footprint-type approaches hard to come to terms with.

This is why approaches such as TMR/resource efficiency are attractive, since they set the debate within the currency of conventional economic language while still accounting for ecological impacts and resource efficiency. From an ecological point of view, however, TMR type approaches suffer from the weakness that they do not assume, nor relate consumption to, finite limits on ecological consumption.

- A second, and in our view potentially more serious issue is the underlying assumption in footprint analysis that everyone is entitled to exactly an equal share of global resources.

Clearly, this is at odds with conventional welfare economics, and the thinking of all major UK political parties. If a *City Limits*-type analysis were to be adopted as the basis for environmental target setting then the question of 'fair shares' would need to be addressed.

- It is also necessary to ask whether the 'responsibility principle' is the best basis for identifying policy priorities in London.

From a policy making perspective, the rationale for accounting for residents' footprint (the responsibility principle) rather than the city's footprint (the geographical principle) is questionable due, amongst other things, to the sheer size of commuting into London. The current estimate of the footprint does not account for the footprint of thousands of commuters who spend most of their week in the capital.

- And is the impact of the business sector sufficiently transparent?

The partial accounting of industrial and commercial activities in footprinting through material resource flows is also an issue in a place like London where most activity is service-based and, therefore, intangible. The contribution of large sectors such as the public or financial sectors to the footprint is also unclear.

- If the contribution of the commercial sector cannot be distinguished from that of residents, policy development could be misdirected.



For example, all the suggestions to reduce the footprint in the *City Limits* summary specify reduced consumption by EVERY Londoner – but what about businesses?

- Finally, the footprint figures *on their own* cannot be used to prioritise policy.

At present, the results cannot be used – for example – to decide between encouraging the retail sector to reduce its transport use or encouraging the construction sector to cut its transport use; nor can they be used to evaluate social, economic and financial trade-offs that might be implied by any specific attempt to reduce footprint.

### ...Nevertheless, pointers to action clearly emerge...

- There are innumerable different ways in which London's footprint could, in principle at least, be reduced.
- **On the demand side**, options include trying to curb the consumption of one or several components and/or increasing resource efficiency. Better waste management, increased re-use and recycling will also boost resource efficiency.

Sustainable demand management has not really been addressed yet in policy terms and many of the indicative 'solutions' presented in *City Limits* would be deeply unpopular with consumers, residents and politicians. That said, following commitments made at the World Summit on Sustainable Development in Johannesburg, EU governments will begin to turn their attention to Sustainable Production and Consumption over the next few years (details can be found on the UK Sustainable Development portal hosted by DEFRA). It is possible that sustainable demand management will (albeit slowly) begin rising up the policy agenda; an existing example is initiatives on domestic and commercial waste minimization.

- **On the supply side**, an area's carrying capacity can be increased through technological change.

This option is not considered at all in *City Limits*. Once again, there may be a link between changes in ecological supply and demand but it is not explicit. For example, boosting composting rates may not only reduce food waste and be a substitute for peat, but may also boost the use of compost on land that previously did not receive any. Land productivity, as accounted for in footprint analysis, may consequently increase, raising the overall ecological supply. This highlights the importance of considering the costs and benefits involved – the costs involved in reducing the footprint may be indirectly offset through increased carrying capacity.

### ...And some further work is required

- In the **short term**, the *City Limits* report has made the case for greater resource efficiency in London and has identified the major contributors to London's footprint. There is a mix of further analytical and policy development work to be done.

- As shown earlier, materials and waste account for more than 40 per cent of London’s footprint, suggesting that the next steps could be:
  - Focusing on the analysis of **different materials** and researching the relative costs and benefits of different courses of (policy) action.
  - Deriving from this analysis, identifying the **key sectors** in which improving resource productivity is paramount to decreasing London’s environmental impact (again, taking wider social, economic and financial costs and benefits into account).
  - Consider using the concepts of Factor 4 in the medium term and Factor 10 in the long term as targets for the sectors identified. These have wide academic and policy-making currency and the same attention grabbing potential as ‘earthshares’.
- Candidates for particular attention in the short term could be:
  - The planned physical developments in the Thames Gateway and other locations identified in the draft London Plan:
 

These developments could provide an ideal opportunity to introduce requirements aiming at improving resource efficiency via the invitations to tender for building projects. Bidders could be asked to guarantee that they will use a proportion of building materials made with recycled and/or local materials, or to demonstrate how energy efficient the buildings will be. Use of Factor 4 or even Factor 10 analyses could help to send a clear signal that London is committed to reducing its ecological footprint.
  - London’s food sector:
 

Food is a significant contributor to the London footprint (40 per cent) and an area where no policy exists at the moment in London. It may be worth developing a food strategy for London that incorporates footprint-related issues. Analysis of the food component of the footprint could be the springboard to begin thinking about sustainable consumption and what this means for the economy of a global city like London. A number of cities around the world have already done this<sup>17</sup>.
- In the longer term, the *City Limits* report may be part of a paradigm shift that will, in turn, require new approaches to the monitoring and management of London. It is impossible to say how quickly or how far such a shift will take place – but a wide variety of stakeholders will undoubtedly need to ‘keep up to speed’ with developments and, indeed, to contribute to them.

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<sup>17</sup> For example, Toronto has its own Food Policy Council, concerned with public health initiatives and food security research. This Council has no statutory powers but is a forum for discussing and integrating policy issues that are not in any Government Department’s direct remit. For example, one of the Council’s areas of interest is Urban Agriculture and Food Waste Recovery. Projects in this area included working with the green community movement to propose using compost and specified crops to remediate certain brownfield sites. The Council also has an active public education role and has published discussion papers ranging from looking at the City’s food economy to the impact of the Canadian diet on health.

- Finally, whilst there is much further work to be done, both in analytical and policy-development terms, it remains the case that gathering and processing the data required for Footprinting analysis (or, indeed, any of the alternative methods referred to in this report) is difficult, time-consuming, expensive – and important.

Given its data and resource intensiveness, footprinting is a difficult methodology to use for time-series monitoring and is probably not best suited to *monitoring* policy performance – though it does have some appeal for initial identification of priorities.

In relation to London, it would be difficult to justify frequent updates to the *City Limits* report. The ecological footprint is a ‘snapshot’ indicator. Updating the data every five years, for example, would probably be sufficient to assess the evolution of London’s footprint (as is the case with Census of Population, for example).

Whichever route is taken, it would seem that partnership options, at national and regional level, need to be developed to ensure appropriate maintenance and development of the base data over time.

## Appendix 1. Glossary

<b>Biocapacity:</b>	the total biological capacity per year of a biologically productive space such as a country, a region or a town <sup>18</sup> .
<b>Biotic:</b>	relating to or resulting from living things, especially in their ecological relations
<b>Ecological footprint:</b>	a measure of how much productive land and water an individual, a city a country or humanity requires to produce the resources it consumes and to absorb the waste it generates, using prevailing technology <sup>12</sup> .
<b>Equivalence factor:</b>	a factor which translates a specific land-use area (eg hectares of world-average cropland) into global hectares, representing biologically productive hectares with world average productivity <sup>12</sup> .
<b>Global hectare or gha:</b>	1 hectare of biologically productive space with world average productivity <sup>12</sup> .
<b>Mass balance:</b>	the mass balance concept is based on the fundamental physical principal that matter can neither be created nor destroyed. Therefore the mass of inputs to a process, industry or region equals the mass of outputs as products, emissions and wastes, plus any changes in stocks <sup>19</sup> .
<b>Total material requirement or TMR:</b>	Sum of the Direct Material Input and the Hidden Flow and thus represents the total amount of material that is mobilised to provide resources for the economy.
<b>Yield factor:</b>	a factor which describes the extent to which a land-use category of a given country (eg German cropland) is more productive than the world average in the same category (ie world average cropland). Each country has its own set of yield factors <sup>12</sup> .

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<sup>18</sup> Living Planet Report 2002, WWF

<sup>19</sup> Mass Balance UK, C Linstead and P Ekins, RSNC, 2001, p4

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<http://www.bestfootforward.com>

Biffaward

<http://www.biffaward.org/>

City Limits

<http://www.citylimitslondon.com>

Mass Balance UK Project website

<http://www.massbalance.org/>

Sustainability Program Ecological Footprint Accounts – Redefining Progress

<http://www.rprogress.org/programs/sustainability/ecological-footprint/methods/calculating.html#assumptions>

Toronto Food Policy Council

[http://www.city.toronto.on.ca/health/tfpc\\_index.htm](http://www.city.toronto.on.ca/health/tfpc_index.htm)

Wuppertal Institute

<http://www.wupperinst.org/>

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Nếu bạn muốn bản sao của tài liệu này bằng  
ngôn ngữ của bạn, hãy gọi điện theo số hoặc  
liên lạc với địa chỉ dưới đây.

### Greek

Αν θα θέλατε ένα αντίγραφο του  
παρόντος εγγράφου στη γλώσσα  
σας, παρακαλώ να τηλεφωνήσετε  
στον αριθμό ή να επικοινωνήσετε  
στην παρακάτω διεύθυνση.

### Turkish

Bize telefon ederek ya da yukarıdaki  
adrese başvurarak bu belgenin  
Türkçe'sini isteyebilirsiniz.

### Punjabi

ਜੇ ਤੁਹਾਨੂੰ ਇਸ ਦਸਤਾਵੇਜ਼ ਦੀ ਕਾਪੀ ਤੁਹਾਡੀ ਆਪਣੀ ਭਾਸ਼ਾ  
ਵਿਚ ਚਾਹੀਦੀ ਹੈ, ਤਾਂ ਹੇਠ ਲਿਖੇ ਨੰਬਰ 'ਤੇ ਫੋਨ ਕਰੋ ਜਾਂ ਹੇਠ  
ਲਿਖੇ ਪਤੇ 'ਤੇ ਰਾਬਤਾ ਕਰੋ:

### Hindi

यदि आप इस दस्तावेज़ की प्रति अपनी भाषा में चाहते हैं,  
तो कृपया निम्नलिखित नम्बर पर फोन करें अथवा दिये  
गये पता पर सम्पर्क करें।

### Bengali

আপনি যদি আপনার ভাষায় এই দলিলের প্রতিলিপি  
(কপি) চান, তা হলে নীচের ফোন নম্বরে  
বা ঠিকানায় অনুগ্রহ করে যোগাযোগ করুন।

### Urdu

اگر آپ اس دستاویز کی نقل اپنی زبان میں چاہتے  
ہیں، تو براہ کرم نیچے دیئے گئے نمبر پر فون کریں  
یا دیئے گئے پتہ پر رابطہ قائم کریں۔

### Arabic

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