Stepping Forward

A resource flow and ecological footprint analysis of the South West of England

Technical report

The *Stepping Forward* Report Series

This report is one of a series of separate reports produced for the *Stepping Forward* project:

- **Graphic summary** **(printed and web)**
- **Summary report** **(printed and web)**
- **Scenarios report** **(printed and web)**
- **Resource flow report** **(web only)**
- **Ecological footprint report** **(web only)**

  (with Ecological footprint analysis results and sustainability assessment)
- **Tourism report** **(web only)**
- **Technical report** **(web only)**

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Biffaward Programme on Sustainable Resource Use

Objectives

This report forms part of the Biffaward Programme on Sustainable Resource Use. The aim of this programme is to provide accessible, well-researched information about the flows of different resources through the UK economy based either singly, or on a combination of regions, material streams or industry sectors.

Background

Information about material resource flows through the UK economy is of fundamental importance to the cost-effective management of resource flows, especially at the stage when the resources become 'waste'.

In order to maximise the Programme's full potential, data will be generated and classified in ways that are both consistent with each other, and with the methodologies of the other generators of resource flow / waste management data.

In addition to the projects having their own means of dissemination to their own constituencies, their data and information will be gathered together in a common format to facilitate policy making at corporate, regional and national levels.

More than 30 different mass balance projects have been funded by Biffaward. For more information on the Mass Balance UK programme please visit **www.massbalance.org**

Acknowledgements

The South West England Environment Trust (SWEET) is the Entrust approved Environmental Body which commissioned *Stepping Forward,* with work undertaken by Best Foot Forward Ltd. (also project management) and Energy for Sustainable Development (ESD). The project was funded by Biffaward with a contribution from the South West Regional Development Agency.

Advisory group

SWEET wish to acknowledge the generous help and support of the project advisory group.

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Rachel Child & Neil Evans	Energy for Sustainable Development
Peter Jones	Biffa Waste Services Ltd.
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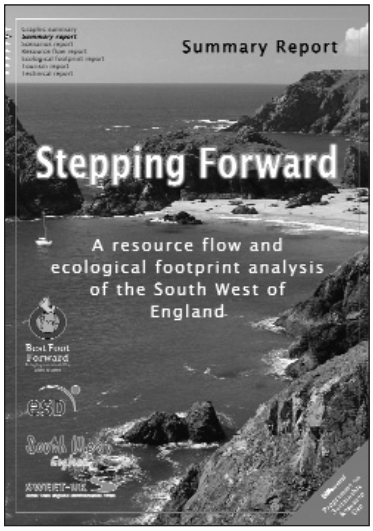

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Foreword

South West Regional Development Agency

Many of us would agree that the South West is England's most compelling region - as much a destination for those who seek a great place to live and work as for the nation's holidaymakers. Indeed, our economy is performing strongly; we enjoy an outstanding natural environment; and levels of unemployment in the region are at historically low levels. Nevertheless and despite its successes, the South West faces significant challenges in maintaining and improving quality of life.

One of the clearest challenges is to balance the role of economic development in raising prosperity with the desire to maintain and enhance the natural environment. Some of the tensions arising from this are easily identifiable, not least congestion and the pressure for green-field development. Other impacts of economic activity are less clear, particularly those associated with not only "importing" resources but also exporting waste and pollution beyond the region's boundary.

The Regional Economic Strategy recognises these issues and by identifying the environment as a key driver for future economic success, they are placed at the heart of the region's work to improve its prosperity. However, the absence of robust regional data and intelligence about environmental impacts have been barriers to delivering more sustained economic activity.

This is where *Stepping Forward* comes in. By providing us for the first time with a clear understanding of the region's resource and material flows, together with good quality data, it represents an important step towards a more sustainable South West. The overall message from the report is stark: the region is living significantly beyond its environmental means. It needs to consider urgently how to improve the sustainability of its economic activity and while this will inevitably present challenges, evidence suggests that such robust consideration will also stimulate significant opportunity.

The South West RDA has been pleased to support the development of *Stepping Forward* and we recognise that it is just a first step along what will be, at times, a challenging road. We look forward to playing a full role in disseminating and stimulating discussion on this report and to considering how we can all adapt our activity to support a more sustainable economic future for the South West.

Juliet Williams
Chairman,
South West Regional Development Agency.

South West Regional Assembly

The South West is a growing region with a wealth of attributes that continue to attract people into the area. The preservation of what makes the South West desirable must be at the forefront of future development in the region. This principle is at the heart of the South West's Integrated Regional Strategy *Just Connect* which sets out a number of key headline aims and objectives for the region which key regional organisations have endorsed as being critical to the region over the next 20 years.

Just Connect recognises the assets of the region - its diversity, its environments, its cultural opportunities, and the balance between its urban and rural parts - and considers them to be key to the South West identity and the attractiveness of the region. But it also acknowledges that many of the environmental assets of the South West are under threat. For this reason, a headline aim of the region is "to enhance our environments and the quality and diversity of our cultural life". The South West Regional Assembly is working with stakeholders from across the region to ensure that this aim, along with the other headline aims of *Just Connect*, are embedded in all future strategies in the region.

Ensuring successful development in the region in the future requires having a clear view of where the region wishes to be and, critically, knowing where we are now. The Regional Assembly welcomes the publication of the Ecological Footprint of the South West, *Stepping Forward,* and considers it to provide some hard-hitting messages for the region about its current resource consumption. This report provides a useful 'back-drop' of information and analysis which is both in-depth and cross-cutting. In making the best use of the available data the report is an important aid in quantifying the likely environmental impacts on the region in the future if our consumption patterns continue at current rates. A welcome key outcome from the report is the identification of the areas that can be most readily addressed in terms of moving towards a more sustainable approach to living in the South West.

The Regional Assembly has been pleased to support the production of this report and will seek to raise its profile amongst the stakeholders of the South West region when undertaking its work and driving forwards the sustainability agenda.

Chanel Stevens
Vice-Chair,
South West Regional Assembly.

Chair's statement

One of the challenges of identifying and implementing policies which reduce society's burden on the environment, has been the lack of tools and approaches to define and quantify what is 'sustainable' consumption and what is 'sustainable' production. This study presents two data sets. The Resource Flow Analysis looks at the movement into, within and out of the South West and the use of all natural resources in the South West. This is a powerful tool for quantifying and tracking the resources required (and wasted!) in the production of the goods and services that we enjoy. The Ecological Footprint Analysis looks at the use of resources by the residents of the South West including resources consumed within the South West and indirectly in other parts of the world. It is a resonant and enlightening indicator of the consequences of our consumption patterns and how sustainable those patterns are.

As in several previous studies, these two methodologies have been applied to a region to investigate the ecological aspects of sustainable consumption and production. This study makes a significant step forward by combining these ecological aspects with economic indicators of productivity, costs and savings, and social aspects such as creation of jobs. The scenario work done in this study gives a powerful insight into how these sort of analyses can be used to appraise and provide evidence for local regional and even national policy making.

While there is still a shortage of robust data on which to carry out these analyses, particularly for materials, products and wastes, data sources do appear to be improving. The data we have gives a serious indication that we are already living beyond our means. What we need now are information, data and knowledge to enable us to find effective and efficient ways of living sustainable lifestyles, in terms of both production and consumption. I believe this study makes a useful contribution.

On behalf of the project team I would like to thank those who funded this work and all those who contributed their time and data.

Sally Campbell

South West England
Environment Trust.

Chair of the Stepping Forward Advisory Group.

About the *Stepping Forward* project

The main objectives of the *Stepping Forward* project were to collect data on the South West region of England and its residents, in order to:

- Carry out a resource flow analysis.
- Calculate an ecological footprint.
- Carry out a sustainability assessment.
- Develop improvement scenarios.
- Assess data quality and availability for a project of this nature.

The Resource Flow Analysis illustrates the flow of resources through the region's boundaries and economy and is a vital tool for sustainable resource management. The Ecological Footprint Analysis illustrates the environmental impacts associated with the consumption patterns of the residents of the region.

The Ecological Footprint concept enables the comparison between resources consumed and resources available and therefore illustrates how ecologically sustainable those consumption patterns are. The scenarios illustrate how changes in policy and practice can affect the nature and scale of the resident's ecological footprint.

We believe that the combination of these analyses make the results compelling reading for a wide range of audiences and should lead to a better understanding of the environmental impacts associated with activities in the South West.

This approach has been used before and methodologies tried and tested in similar projects for the Isle of Wight, Greater London, South East England, Scotland, Wales and Northern Ireland. One of the key objectives of this study was to go further than previous studies in illustrating how this approach can be useful in evidence-based policy-making. We believe the extensive and detailed work on scenarios will be of great interest to policy makers and for this reason, a report dedicated to the scenario work has also been produced.

Key findings: *Stepping Forward* Project

In 2001, the South West residents' ecological footprint was 27.4 million gha (global hectares) or 5.56 gha per person.

If everyone on the planet consumed as much as an average South West resident, we would need three Earths to support global resource consumption sustainably.

Ecological footprint analysis

- Materials and waste were 10.4 million gha - 38% of the total ecological footprint.
- Food was 8.0 million gha - 29% of the total ecological footprint - of which 77% was animal-based food.
- Direct energy was 5.0 million gha - 18% of the total ecological footprint - of which 71% was domestic energy use.
- Personal transport was 2.6 million gha - 10% of the total ecological footprint - of which 79% was car travel.
- Built land was 1.3 million gha - 5% of the total ecological footprint.
- Water had the smallest ecological footprint, 0.05 million gha, (<1% of the total).

Resource flow analysis

In 2001, the South West:

- Consumed 93,760 GWh of energy (including renewable energy).
- Consumed 48 million tonnes of materials and products.
- Manufactured over 17 million tonnes of finished products and consumed approximately 26 million tonnes of products.
- Produced 6.9 million tonnes of food and consumed 3.4 million tonnes of food.
- Generated 20.3 million tonnes of waste, nearly half a tonne of waste for every tonne of resources consumed by the economy.
- Consumed an estimated 3 million megalitres (Ml) of water
- Total physical land area was 2.3 million hectares (ha), of which 50% was grassland.
- Residents travelled an estimated 56 billion passenger kilometres (pass-km), 82% by car and 5% by air.
- Generated 27 million tonnes of emissions to air, of which:
  - 98% was carbon dioxide
  - 45% was associated with road transport.

Scenarios

Energy

- Domestic energy consumption in the South West was 46,931 GWh with associated CO_2 emissions of 12.6 million tonnes. The majority of this energy was for space heating and water heating.
- It is not possible to reduce CO_2 emissions from housing stock through new building strategies, but significant energy efficiency improvements to existing housing stock could reduce CO_2 emissions by 4.4 million tonnes (35%) by 2015.
- A person leading a low-impact lifestyle in a ZED standard housing development would produce 3.2 tonnes of CO_2 per year, compared with the UK average of 11.1 tonnes.

Waste

- Municipal Solid Waste (MSW) arisings in the South West in 2001 were 522 kg per person, and Commercial and Industrial waste arisings were 1030 kg per person.
- To bring the waste ecological footprint to within the per capita earthshare would require a 56% reduction in arisings to 227 kg per person for MSW and 447 kg per person for C&I waste, combined with significant diversion of the waste currently going to landfill.

Transport

- The transport ecological footprint of the South West could be reduced by 26% by halving air travel and reducing car travel by 25%.
- If all cars operated at the best fuel efficiency currently available, while still travelling current distances, the transport ecological footprint of the South West would be reduced by 50% and CO_2 emissions would be reduced from 1083 kg to 392 kg per person per year.
- A sustainable level of transport could be achieved by reducing car and air travel by 25% and 50% respectively, and switching all vehicles to hydrogen fuel cells, powered by short crop rotation biomass.

Tourism

In 2001, in the South West:

- Tourists spent an estimated £4,535 million.
- Domestic tourists made 24.4 million trips to the region, and overseas tourists made 1.9 million trips, travelling 9.8 billion kilometres to and from the region.
- Over 16,000 accommodation establishments were in operation, of which 60% were Bed & Breakfasts.
- Tourist accommodation consumed 4,512 GWh of energy and 26,109 million litres of water, and generated an estimated 120,000 tonnes of waste

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Resource flow analysis methodology

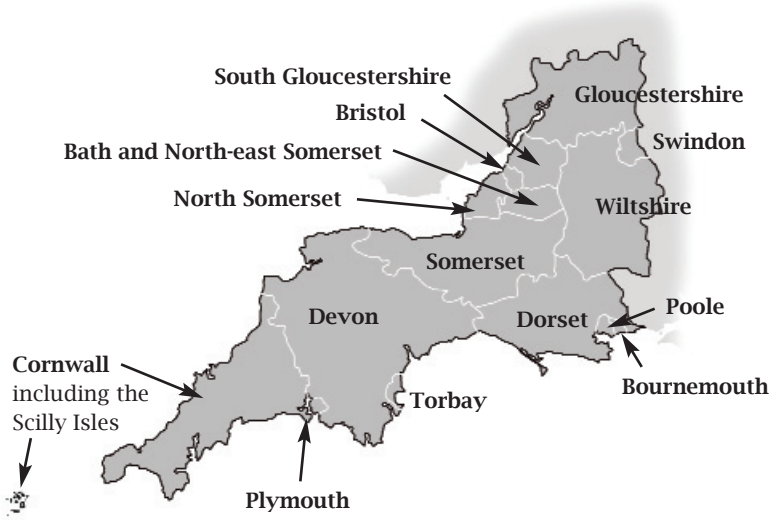
The South West of England: A definition

This study examines the South West region of England as defined by the South West Regional Development Agency's (SWRDA) geographical boundaries, which includes the Isles of Scilly and Lundy, the mainland and inshore waters. The region is composed of six counties and nine unitary authorities (See Figure 1).

The study covered all activities within these boundaries, such as production, imports and exports of goods and materials within the region.

Source: SWRDA, 2004.

Figure 1: The counties and unitary authorities in the South West



What is a resource flow analysis?

A resource flow analysis aims to quantify the flow of resources, in terms of mass, within a defined geographical area or industry sector over a set period of time. The generic model shown in Figure 2 illustrates the main flows of resources through a defined boundary. A resource flow analysis can point to opportunities for understanding and managing materials consumption and minimisation (Griffiths & Lewis, 2004 & Linstead & Ekins, 2001).

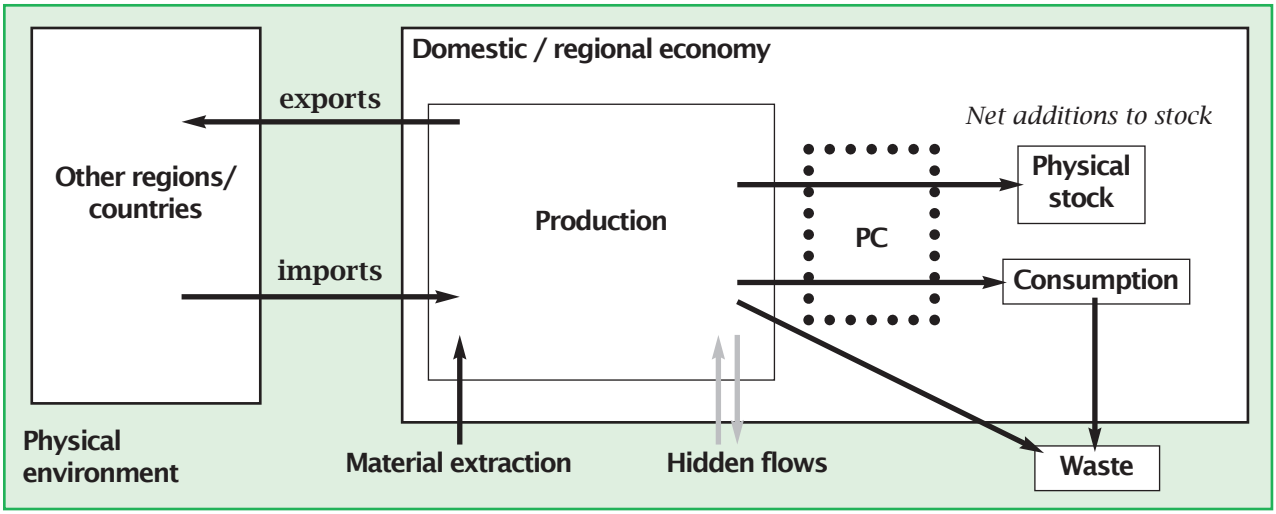
Resources can be defined as materials or products. Raw materials are extracted from nature and consumed as they are or combined with other materials to produce finished products (Linstead & Ekins, 2001 and Linstead *et al.*, 2003). The consumption of materials and products creates waste and emissions as by-products.

Resource flows also identify hidden flows, which are materials extracted from nature but not consumed or incorporated into final materials and products (Bringezu & Shutz, 2001; Rodrigues & Giljum, 2004). Therefore, to complete a resource flow analysis of a geographical area it is necessary to quantify:

- Material imports, production and exports.
- Product imports, production and exports.
- Waste production.
- Hidden flows.
- Water consumption, and waste water production.
- Emissions to air.

Resource flow analysis guidelines presented in the *Mass Balance UK: Mapping UK resources and material flows* (Linstead & Ekins, 2001) were adopted for this project, making the findings comparable to previous mass balance studies. These guidelines were supplemented by mass balance accounting principles agreed on during a Biffaward meeting in April 2003 (Biffaward, 2003).

Figure 2: The generic structure of a resource flow analysis



PC = Total physical consumption, where certain materials and products are perishable within a year (such as food) and their byproducts are returned to the environment in the form of waste, while the remaining consumption concerns goods and materials likely to remain within the economy for longer periods (such as buildings).

Source: Rodrigues & Giljum, 2004.

Calculating stock: Resources remaining in the economy

Stock is materials and products which remain in a region's economy beyond the period of study. Analysis and identification of stock makes a resource flow analysis more complete. To calculate stock changes from one year to another, the volume of stock at the beginning of the study period needs to be known. Unfortunately there is no method of measuring initial stock for a geographical region, other than doing a full resource flow analysis. Therefore, this study did not measure initial stock, but did calculate the change in stock over the reporting period. Stock was calculated as the difference between the input and output of resource flows, and is reported as resources remaining in the economy.

Data identification and collection

The base year for data collection was 2001, and the common reporting unit was tonnes. Ideally, all data used in the study would have been primary data reported in tonnes, by South West or national government sources. Unfortunately, not all data was available, and not all available data was in the required format. Consequently a proportion of data was calculated using assumptions and proxy factors, which are documented in the relevant sections below. Where 2001 data was not available, data was used from other years. Where data was not available in tonnes, conversion factors were applied.

The application of proxy measures

It was sometimes necessary to 'proxy' data from a number of sources to derive appropriate consumption figures for the South West. In most cases a number of proxying methods were considered, often the most appropriate one being adopted with the advice of the Advisory Group. Proxy measures applied to individual data sets are described in the relevant sections of the methodology below.

What is a proxy?

A proxy is a factor applied to available data to approximate the required level of data, for example applied to national data to scale it down to regional level. Proxy factors used can include economic data such as employment by sector or Gross Domestic Product (GDP), population, waste or expenditure data. A proxy is selected according to its relevance to the data being manipulated. Figures derived from a proxy will not be as accurate as primary data.

This section identifies the main data sources used for the resource flow analysis and discusses how data gaps were addressed and how results were derived.

Main data sources

South West-specific data was used wherever possible. Key data providers were identified, such as the South West Regional Assembly and Regional Development Agency, South West Observatory and Environment Agency. However, where regional data was unavailable, UK data was used to derive figures for the South West. Below is a brief description of the main data sources.

Direct energy

There was no single source of energy data for the South West. The Department of Trade & Industry (DTI) was the main source for electricity and gas consumption. Data on solid fuel and petroleum had to be proxied from UK data, also obtained from DTI. Other sources included the Office for National Statistics (ONS) and AEA Technology.

Materials

Data on UK imports, exports, production and consumption of agricultural materials was obtained from the Food and Agricultural Organisation (FAO). South West-specific agricultural information, provided by the Department for Environment, Food and Rural Affairs (DEFRA) was used to proxy this data to South West level. Minerals data was mostly South West-specific and obtained from the British Geological Survey (BGS).

Products

No South West-specific information on the volume of products consumed was available. ONS UK ProdCom data was proxied using South West-specific economic data supplied by the University of Plymouth.

Waste

Most waste data was South West-specific, and obtained from the Environment Agency and the South West Regional Technical Advisory Board (RTAB).

Hidden flows

Hidden flow data was obtained from the Wuppertal Institute's study on resource flows in the UK (Bringezu & Shutz, 2001).

Transport

Data on personal transport in the South West was mainly obtained from the Department for Transport and the National Travel Survey.

Water

Five of the main water companies based in the South West supplied information on the volume of water supplied, delivered and lost through leakage. Water UK supplied further information on water abstraction in the region by sector. All data was available at regional level.

Land use

Land use data was obtained from the Office for National Statistics *Regional Trends* 37 (2001a) report.

Emissions to air

Data on emissions to air was not available at regional level. UK data from the *National Air Emissions Inventory Data Warehouse* (NAEI) was proxied to the South West using economic data from the University of Plymouth. Levels of emissions by industrial sector were obtained from Biffa.

Due to differences in accessibility and quality of the data for each component, the methodology used to collect and calculate final consumption figures varied greatly. For this reason, components have been described in greater detail below.

Direct energy

Energy consumption data was collected by fuel type - gas, electricity, petroleum, solid fuel (coal) and renewables, and by sector - domestic, industrial and commercial.

Main data sources

- Department of Trade & Industry:
  - *Digest of Energy Statistics* (DTI, 2002).
  - *Energy Consumption in the UK* (DTI, 2003).
  - *Energy Trends* (DTI, 2003a).
  - *Oil and Gas* (DTI, 2004).
- Office of National Statistics:
  - *Regional Gross Value Added* (ONS, 2003a).
  - *Region in Figures: South West* (ONS, 2003b).
- AEA Technology *Regional Renewable Energy Statistics* (AEAT, 2001).

Data availability and quality

In general, data was of good quality. Regional data was available for all fuel types except solid fuel and petroleum. Breaking down energy use by sector was also possible.

Calculations and proxy measures used

All data was collected for the base year (2001) and converted to a standard unit of gigawatt hours (GWh). Figures were also converted to tonnes of oil equivalent and tonnes of CO_2 using standard emission factors (DEFRA, 2003b).

Electricity consumption

Total electricity distributed in the South West region in 2001 was 32,710 GWh (DTI, 2003). This figure was based on Grid Supply Point (GSP) data supplied by National Grid Transco and was broken down into domestic and non-domestic electricity consumption using ratios derived from figures supplied by Western Power Distribution (Western Power, 2003).

It is likely that the DTI figure for total electricity distributed is not completely accurate, although at this stage the DTI are not able to estimate the scale of the inaccuracy. GSPs have been attributed to a Regional Development Agency (RDA) region by postcode and other locational information, but where GSPs are located near a regional boundary, they may supply electricity on both sides of the boundary. No attempt was made to adjust for this.

In addition, there will be a number of differences between figures for electricity distributed and electricity consumption for reasons such as:

- The GSP figure does not include electricity sold directly to large generators via high voltage grids (without passing through the distribution network), or electricity consumed by the generating company.
- There are losses between GSPs and customer meters.
- There are losses due to theft, meter fraud and accounting differences.

No attempt has been made to adjust for these differences here.

For comparison, Western Power Distribution (WPD) also provided a figure for total electricity consumed in the South West. This was proxied up (to account for the difference between the WPD area and the regional boundaries adopted for this project (see Figure 1) which produced a figure of 26,110 GWh.

Gas consumption

Figures for domestic and non-domestic gas consumption in the South West were obtained from the Department for Trade and Industry (DTI, 2003). These figures were based on data supplied by Transco. No data was available for bottled gas consumed in the South West region.

In the UK, gas sold via the Transco network is about 70% of total gas consumption. The remaining 30% is gas supplied to power stations or large industrial consumers through the National Transmissions System or other transmission systems. For the purposes of this study, gas supplied to power stations in the South West was not included because its CO_2 emissions are accounted for in the electricity consumed in the region. Data relating to gas supplied to large industrial consumers, not through the Transco network, was unavailable for the South West, due to its commercially sensitive nature.

As an additional check, a figure for South West gas consumption was calculated using 'gas consumption by postcode' data available from Transco. These two figures corresponded closely.

Solid fuel and petroleum consumption

Figures for solid fuel and petroleum consumption were not available for the South West region. As a result, UK data was obtained from *Energy Consumption in the UK* (DTI 2003). UK figures were scaled to South West level using GVA as a proxy factor.

It was not possible to break petroleum figures down into different fuel types, such as diesel. It is important to note that the petroleum consumption figure does not include consumption used for transport.

Renewable energy consumption

Data on energy generated from renewable sources in the South West was obtained from AEA Technology (2001), and could be further split into electricity use and use for heating (space and water).

The figure for electricity included both grid and off-grid electricity. No breakdown of this data was identified. However, it is likely that most electricity produced by renewables is grid electricity, and was 'hidden' in the overall electricity consumption figure. For this study, all electricity produced from renewables was assumed to be grid electricity.

There was no adequate regional data on renewable electricity consumed for heating. It was assumed that the amount of renewable energy used to generate heat was approximately one third of that used to generate electricity. This is likely to consist of:

- Biomass including energy crops, logs, forestry wastes, waste wood, agricultural wastes including animal slurry, poultry litter and straw.
- Solar water heating.
- Landfill gas/waste CHP schemes.

Domestic energy

Domestic energy consumption was broken down, by fuel type, into energy used for space and water heating, and cooking, lighting and appliances. Figures for UK consumption in these categories were obtained from the DTI's *Energy Consumption in the UK: Tables* (DTI, 2003). The proportions of UK consumption in each of these categories were applied to the South West figures for domestic energy consumption.

Non-domestic energy

The figure for non-domestic energy consumption was also broken down further by fuel type, and was based on South West GVA figures by sector. Ratios of the GVA for particular sectors compared with UK GVA (ONS, 2002) were applied to the figures for total non-domestic electricity consumption by fuel, for example:

South West non-domestic gas consumption = 18,061 GWh (2001)
South West GVA = £56,064m (1998)
South West GVA (Hotels & Restaurants) = £2,105m (1998)
South West Hotels & Restaurants' gas consumption = (2105/56064)*18061 = 678 GWh

Data recommendations

- **The DTI recently published regional gas and electricity figures for the first time. It would be useful if this data extended to cover other fuels such as solid fuel and petroleum.**
- **Further breakdowns of the regional consumption figures would have been useful, for example electricity and gas figures for industrial sectors.**
- **More data on renewables would be useful, for example information on grid and off-grid. Most renewable energy data is reported in MWh installed rather than GWh generated and consumed, but the latter is more useful for this type of analysis.**

Materials

Materials are anything that can be classed as primary production, such as agricultural crops, fishing, forestry or minerals extraction. These materials are identified by the UK Total Material Resource Flows (TMR) study (Bringezu & Shutz, 2001). Materials, as defined in the TMR study, are included under Standard Industrial Classifications 1, 2, 5, 10, 11, 13 and 14 (see Appendix 2).

Main data sources

- British Geological Survey *United Kingdom Minerals Yearbook 2001* (BGS, 2002)
- British Geological Survey *Collation of the results of the 2001 Aggregate Minerals Survey for England and Wales* (Highley et al., 2003).
- Office for National Statistics *Regional Trends 37* (ONS, 2001a).
- Food & Agriculture Organisation United Kingdom *Food Balance Sheet 2001* (FAO, 2002).

Data availability and quality

Overall data availability and quality for materials was surprisingly good. Most data was available in the appropriate unit (tonnes) and year (2001). Only forestry data was presented in thousands of cubic metres of over-bark standing, or in Wood of Raw Materials Equivalent (WRME). This data was converted to tonnes using conversion factors from ONS (Forestry Statistics 2003).

The main difficulty with materials data was its inconsistency in terms of regional boundaries. Most of the data was available on a national scale, but regional data for the South West was sparse. Data on agriculture, fishing and forestry was only available at national level, while mining and quarrying data was mostly available at regional level.

Calculations and proxy measures used

Total material consumption in the South West was estimated by combining agriculture, fishing, forestry, mining and quarrying. Due to varying sources and data consistency issues, different methods and proxies were applied.

Agriculture including fish

Detailed agricultural data was available from the *United Kingdom Food Balance Sheets* (FAO, 2002). Appendix 3 lists the categories of agricultural materials covered by the FAO. As the FAO does not provide data for agricultural consumption by UK sub-region, UK figures were proxied to derive figures for the South West.

To make this more reliable, different proxies were used for different agricultural materials. Different proxies were also applied to production, imports and exports of agricultural materials, because production levels do not necessarily reflect import or exports.

The FAO calculation for total supplies of food was the same as that adopted by Best Foot Forward, and is the standard methodology agreed by the Biffaward Mass Balance programme (Biffaward, 2003). This is the formula for flow of materials:

Net supply (N) = Production (P) + Imports (I) + Stock changes (SK) - Exports (E)

$$N = P + I + SK - E$$

This example shows the calculation for Oats under the Cereals category of food materials provided by the FAO (2002):

Production UK (P_{UK}) = 616 ('000 tonnes)
Imports UK (I_{UK}) = 16 ('000 tonnes)
Stock changes UK (SK_{UK}) = 59 ('000 tonnes)
Exports UK (E_{UK}) = 171 ('000 tonnes)

$$N_{UK} = P_{UK} + I_{UK} + SK_{UK} - E_{UK}$$
$$= 616 + 16 + 59 - 171$$
$$= 520 \text{ ('000 tonnes)}$$

This data was UK-specific and proxies were applied to scale the figures down to the South West. DEFRA's (2003c) agricultural survey indicated that of all cereal agricultural holdings (2,491,890 hectares) in the UK, 13% (332,823 hectares) were in the South West. This factor of 13% was applied to the UK's total production of cereal to give production in the South West (PSW):

$$P_{SW} = P_{UK} * \text{Proxy}$$
$$= 616 * 13.36\%$$
$$= 82 \text{ ('000 tonnes)}$$

Imports, stock and exports were proxied using economic data from the *Integrated Economic Information System for the South West (Econ-I)* (University of Plymouth, 2003), which allowed for a comparison of economic data (GVA and employment) between the South West and Great Britain. According to *Econ-I,* 495 people were employed by the grain milling and starch industry (SIC sector 15.6) in the South West in 2001, 3.6% of all UK employees in this sector. This factor was applied as a proxy to imports, stock and exports:

$I_{SW} = I_{UK} * Proxy = 16 * 3.6\% = 1$
$SK_{SW} = SK_{UK} * Proxy = 59 * 3.6\% = 2$
$E_{SW} = E_{UK} * Proxy = 171 * 3.6\% = 6$

Net supply in the South West (N_{SW}) is calculated from these figures:

$$N_{SW} = P_{SW} + I_{SW} + SK_{SW} - E_{SW}$$
$$= 82 + 1 + 2 - 6$$
$$= 79 \text{ ('000 tonnes)}$$

The same proxying calculations were applied to all the FAO agricultural and fish materials. Appendix 4 gives the factors applied to each agricultural material. Fish data was extracted from agricultural materials and presented separately in the results section.

Forestry

Data on forestry was obtained from the *Compendium of Statistics About Woodland, Forestry and Primary Wood Processing in the United Kingdom* (Forestry Statistics, 2003). Production data was available for softwood and hardwood in thousands of cubic metres of over-bark standing. Data was further broken down between Forestry Commission (FC) and non-FC woodland. Imports and exports of forestry materials were split between softwood and hardwood, in thousands of cubic metres of WRME (Wood of Raw Materials Equivalent) under bark.

Cubic metres of forestry materials were converted to tonnes (Forestry Statistics, 2003). UK data was proxied to South West level using employment factors (University of Plymouth, 2003). Approximately 5% of UK employees in the forestry industry are based in the South West, so this percentage was applied to the total amount of forestry materials consumed in the UK in 2001to give an estimate of wood materials produced in the South West.

Mining and quarrying

Two main sources supplied mining and quarrying data: the ONS (2001a) and the British Geological Survey (BGS, 2002 and Highley et al., 2003). Production, imports and exports data were available for the South West region. There were only a few cases where regional data was not available, including coal, lignite & peat, petroleum & natural gas, metal ores and other mining and quarrying.

Proxies were derived using employment and GVA data from the University of Plymouth (2003).

Data recommendations

- **Improved consistency of reporting regional figures: overall, materials data was easily accessible, but in some cases regional breakdowns were not consistently reported, for example the consumption of potash.**
- **Due to the lack of primary data for the South West, particularly in the agricultural sector, this study had to rely on UK data sets and proxy measures. Primary regional data would be preferable.**

Products

Main data source

- Office for National Statistics *Product Sales and Trade* (ProdCom) reports, (ONS, 2001).

What is ProdCom?

ProdCom (Products of the European Community) is a survey of manufactured products regulated by the European Union (EU). The names and descriptions of the products covered are standardised to enable comparability between member states. Data is collected on value (sales) and volume (units) for over 4,800 products assigned to 200 industries. Over 3,000 companies and 200 industries are surveyed yearly and others are surveyed on a quarterly basis. The Office for National Statistics collects this information for the UK (ONS, 2001).

Data availability and quality

There was little primary data available on product manufacturing in the South West, so UK ProdCom data was proxied to derive an estimate of product flows in the South West.

Calculation and proxy measures used

In its published format, ProdCom data could not be used directly, but needed manipulation before it could be used to estimate product flows through the South West. The two main stages were:

1. The production of a standardised UK data set.
2. The application of proxy factors to scale UK figures to the South West.

Sales data from Prodcom was used to represent production data for the products in this section.

Production and validation of UK ProdCom sheets

ProdCom is primarily economic data tracking the value of products throughout different stages of the manufacturing process. When taking actual tonnage of these products, double counting is likely to occur. Resources flow between different industries, so that a final product of one stage could go on to be used in the manufacturing process of another product. For example, iron can be used in the manufacturing of automotive parts, which in turn are incorporated into cars. ProdCom would report this iron twice, once in a vehicle part and once in the car, thus double counting its weight. This issue was overcome by labelling all products as either intermediate (vehicle parts) or final product (car). Only final products were included in the total volume to avoid double counting.

Due to data gaps in ProdCom, there were instances where net supply figures were negative. This could occur if sales data was unavailable or suppressed, giving a larger volume of exported products than imports (see example 1). Clearly it is impossible to consume a negative volume of products, but because sales and import data gaps balance export data gaps in ProdCom, the total net supply figures were accurate. SIC 19: 'Leather luggage, handbags & footwear' was the only sector where the total consumption figure calculation gave a negative result. This was because a large amount of production data was suppressed or unavailable, leading to an underestimate of supply. Because SIC 19 represented only a small fraction of consumption in the South West (around 3%), the negative figure was included in the total products figure for the South West.

'Weight per item' conversion factors were researched and applied to convert Prodcom data into tonnes where it was originally supplied in other units.

Example 1:

PRA 33.101739: Orthopaedic appliances and other fracture appliances INCLUDING - parts and accessories - orthopaedic made to measure footwear - orthopaedic appliances for animals

The Sales figure for this sector is not available.

Net supply (N) = Sales (SL) + Imports (I) - Exports (E)
= N/A + 1,187 - 1,551
= -364 tonnes

The application of proxy factors to scale UK figures to South West level

After calculating the total UK mass of products sold, imported, exported and consumed (net supply) for each sector, each one was scaled to South West level using economic conversion factors. The *ECON-I* tool (University of Plymouth, 2003) provided detailed economic data for all SIC sectors (1-36) including GVA and full time employees (FTE). Example 2 demonstrates this method of proxying.

Example 2:

PRA 34.102230: Motor vehicles with a petrol engine greater than 1500cc

$$N_{UK} = SL_{UK} + I_{UK} - E_{UK}$$
$$= 932,104 + 1,181,465 - 545,664$$
$$= 1,567,905 \text{ (tonnes)}$$

Therefore, 1,567,905 tonnes of motor vehicles were supplied in the UK in 2001. The motor vehicle manufacturing industry (SIC 34.1) in Great Britain and the South West employed 221,773 and 12,401 workers respectively (University of Plymouth, 2003). Therefore 5.59% of full time employees in this sector are based in the South West. This percentage was used as a proxy to calculate South West motor vehicle production:

$$N_{SW} = N_{UK} * \text{Proxy}$$
$$= 1,567,905 * 5.59\%$$
$$= 87,645 \text{ (tonnes)}$$

Net supply was derived using economic factors appropriate to the sector, for production, imports, exports and net supplies for all products listed in ProdCom. The results were used to derive a total resource flow of products for the South West.

Data recommendations

- **ProdCom data is presented in PDF and MS Word format. It would be easier to extract and manipulate this data if it were published in Excel.**
- **ProdCom only presents data for the UK as a whole. Regional data would be more appropriate for a study of this kind.**

Food

Main data source

- DEFRA's *Expenditure and Food Survey* (DEFRA, 2003) and *National Food Survey* (DEFRA, 2000).

Data availability and quality

Food consumption data was available in reports on DEFRA's website. Data was extensive and complete for the South West and in useful units (grammes per person per week).

DEFRA effectively recorded the amount of food consumed per resident in the South West (excluding tourists) for 2001, although the *Expenditure and Food Survey* (DEFRA, 2003) did not cover food eaten out. Data for food eaten out was sourced from the *National Food Survey* (DEFRA, 2000).

Calculations and proxy measures used

DEFRA reported data in grammes per person per week. This data was scaled up to tonnes of food consumed in the South West in 2001 (see example 3), and categorised into food eaten out or food consumed at home.

Example 3:

According to DEFRA, the average South West resident consumed 108 grammes of sugar (Code 15001) per week in 2001.

Sugar consumption (g/person/week) (S)	**= 108**
South West population (Pop)	**= 4,934,000**
Weeks in a Year (W)	**= 52**
Grammes in 1 tonne	**= 1,000,000**
Total sugar consumption	**= Pop*W*S / 1,000,000**
	= 4,934,000 * 52
	*** 108 / 1,000,000**
	= 27,709 tonnes

Data recommendations

Although the quality and quantity of the food data reported by DEFRA was high, there is one recommendation for further improvement.

- **Food eaten out should be included in the *Expenditure and Food Survey.* Apparently future reports will contain this information.**

Waste

Main data sources

- Municipal Solid Waste (MSW): *South West Waste Audit 2000/01* (EA & RTAB, 2004).
- Commercial & Industrial (C&I): *Strategic Waste Management Assessment 2000: South West* (EA, 2000).
- Construction & Demolition (C&D): *Survey of Arisings and Use of Construction and Demolition Waste 2001* (Symonds Group, 2003).

Data availability and quality

South West Waste Audit 2000/01 (EA & RTAB, 2004) data was the most reliable for the region. The study not only looked at waste generated by source, but also reviewed waste management by waste type.

Up-to-date Commercial & Industrial waste (C&I) data was difficult to obtain. Some recent reports published by the Environment Agency covered C&I waste management volumes by region, but did not report arisings. For this reason, 2001 data was incomplete, so C&I data reported in *Strategic Waste Management Assessment 2000: South West* (EA, 2000) was used even though it only covered 1998/99. The decision to use older data was approved by the project Advisory Group.

Construction & Demolition waste (C&D) was extremely inconsistent. Figures reported by different studies varied significantly. The Symonds Group (2003) study was used because it contained the most detailed data at a regional level, covering waste arisings and management methods.

Overall, waste data for the South West was reliable. Furthermore, it was encouraging to find that data was available regionally rather than nationally, avoiding the need for proxies and assumptions on waste arisings.

Data recommendations

- **Waste surveys tend to be carried out by many different organisations. As a result data is reported at different levels and often does not correspond. For a more unified or simplified approach to reporting, it would help if a single agency such as DEFRA reported on all three main categories of waste.**
- **C&I waste is no longer recorded at a regional level, and this gap in information will hinder understanding and better management of this sector.**

Hidden Flows

What are hidden flows?

Hidden flows are resources associated with material extraction, and in this study are excluded from the resource flow analysis, as they do not enter the economy. An example of a hidden flow would be the large quantities of materials disturbed during quarrying. Hidden flows have been identified and quantified here as they have environmental impacts associated with them, and may be important when considering resource management in the South West.

Main source of data

- The Wuppertal Institute's TMR study *Total Material Resource Flows of the United Kingdom* (Bringezu & Shutz, 2001).

Data availability and quality

Hidden flow data was limited. Bringezu & Shutz's 2001 TMR study was the most complete study available, yet data quality varied. Coefficients were available for 16 different materials produced and 25 materials imported and exported. The coefficients were based on averages for the world or other nations. These coefficients were applied to the South West, in the absence of UK- or South West-specific data on hidden flows. As a result, the results should be used with caution. The geographical and geological makeup of a nation influence mineral extraction, and hidden flow coefficients vary significantly between countries due to different mining and quarrying techniques. For example, these are the hidden flow coefficients of imported hard coal from four major producing countries:

- Australia - 10.64 tonnes of hidden flows per tonne of hard coal.
- Russia - 5.13 tonnes per tonne.
- Canada - 18.87 tonnes per tonne.
- South Africa - 3.84 tonnes per tonne.

In such cases averages were used, except where available information suggested that UK imports or exports were predominantly from one country or group of countries.

Calculation and proxy measures used

Proxying was not necessary as material production, imports and exports had already been calculated (see Materials section). Wherever possible, Bringezu & Shutz's hidden flow coefficients were applied to the corresponding materials data to quantify hidden flows. This was done for production, imports and exports although a total hidden flow figure could not be estimated due to significant data gaps.

Data recommendations

More research needs to be carried out on hidden flows, particularly in the UK, similar to studies such as the *Industrial Ecology of the Metal Sector: Metal Material Flows in Finland* (Juutinen & Viitanen, 2000) which managed to calculate hidden flows associated with household goods.

Transport

Main data sources

- *Regional Transport Statistics: 2002* (Espineira & Haslam, 2002)
- *National Travel Survey* (Salathiel, D. 2003), both for Department for Transport.

Data availability and quality

Regional Transport Statistics (Espineira, J. & Haslam, M. 2002) reported average distance travelled, in miles, per person, by mode, in the South West. The modes included walking, cycling, driving (car & passenger), other private modes and local bus. It did not cover rail, taxi/minicab or other public modes such as water transport and air travel. However figures for these three modes did exist but had been omitted from the final report for statistical reasons. As this was the only data available on rail and taxi travel for the South West, it was used. In this report, air and water transport were combined, but for the present study it was necessary to separate them.

Through personal contacts, further detailed information on water transport for the South West was obtained from the Department for Transport (Pathan, 2004). Further air travel data was obtained from *Transport Trends: 2002* (DfT 2002a), and used to calculate the average distance travelled by UK residents abroad.

Calculations and proxy measures used

Regional Transport Statistics (Espineira & Haslam, 2002) figures were converted to kilometres.

Data on all ferry routes from South West ports to other UK and international ports was available. DfT (Pathan, 2004) provided information on the distance between ports, the number of journeys and the number of passengers travelling on these journeys. It was therefore possible to calculate total waterborne passenger kilometres for the South West.

Regional Transport Statistics (Espineira & Haslam, 2002) reported only UK internal air travel. DfT's (2002) *Transport Statistics Great Britain* published information on total international air miles travelled out of the UK as well as the total number of passengers. A total UK air travel figure was derived from these two sources.

ONS (2002a) overseas travel and tourism report states that only around 62% of all UK air travel is done by UK residents, so this factor was applied to the total UK air travel to derive a figure for air travel by UK residents, and this was scaled down to South West level based on population.

Data recommendations

- **Most air travel data looks at passenger numbers and flight numbers. It would be more appropriate if data was reported as distances travelled.**

Water

Main data sources

Data on water consumption and supply for the South West was gathered from 17 different sources, including the five main water companies in the South West: Bournemouth & West Hampshire Water, Bristol Water, Cholderton & District Water, South West Water and Wessex Water.

Water abstraction and leakage data was obtained from OFWAT (2001) and Water UK (2003).

Data availability and quality

All water companies were able to provide detailed information. Key statistics, such as the volume of water supplied (million litres per day), were often reported on the water companies' websites and environmental reports. Further details, such as the proportion of water supplied to households and non-households, or the amount lost via leakage, were obtained through personal communications with individuals in the water companies.

Data quality was not a problem. The information provided by the water companies covered the year requested (2001) and was in the appropriate unit (million litres per day). Some water companies were able to supply information on public water consumption by industrial sector.

Bournemouth & West Hampshire Water supplied data for Dorset and West Hampshire. As West Hampshire is not within the South West's geographical boundaries, it was removed from the data set.

The only inconsistency encountered in researching water data was that some of the companies reported data in terms of the volume of water supplied, and others reported on water delivered. Water delivered means the amount of water reaching homes, while water supplied includes water likely to be lost through leakage which must be subtracted from the total. It was agreed to take water delivered as the amount of water consumed in the South West. This inconsistency could be resolved with water leakage data provided by all water companies.

Calculation and proxy measures used

Total water consumption in the region was calculated by adding together the volume of water delivered by all the South West water companies. If necessary one of the following calculations was applied:

Water supplied (S) - Water leakage (L)
= Total water delivered (D)

or

Water delivered (D) + Water leakage (L)
= Water supplied (S)

Figures from the water companies covered public water only, and did not include private water abstractions, spray irrigation or fish farming for example. Information about private water was obtained from Water UK (2003), which reported on water abstractions in the South West for all industries and uses.

Non-household water consumption was broken down by industrial sector, based on figures supplied by South West Water and Wessex Water. It was believed that these two companies, being the two largest water suppliers in the South West, would adequately reflect water use by sector in the region.

Data recommendations

- **If possible, it would be useful for water consumption data to be reported as a whole, for the region. This data should also include water abstraction.**

Land use

Data on land use was reported in *Regional Trends 37* (ONS, 2001a). All data was reported in square kilometres and converted to hectares. No proxying was required, as the data was provided at the appropriate level and considered reliable.

Emissions to air

Main data sources

- AEA Technology *UK Emissions of Air Pollutants 1970 to 2001* (Dore et. al., 2003)
- *National Air Emissions Inventory Data Warehouse* website (NAEI)
- Biffa *Great Britain Plc: The Environmental Balance Sheet* (Biffa, 1997)

Data availability and quality

UK Emissions of Air Pollutants 1970 to 2001 (Dore et. al., 2003) reported 25 different kinds of emissions for England, Scotland, Northern Ireland, Wales and Great Britain. Further regional breakdowns were not available.

Great Britain Plc (Biffa, 1997) provided information on the different sources (sectors) of emissions to air in the South West. Emissions were attributed to agriculture, domestic activities, landfilling, other industries, industrial activities, transport and other sources.

Calculation and proxy measures used

Regional emissions were factored using economic data for domestic and industrial activity. For example, according to *Econ-I* (University of Plymouth, 2003), the South West had 16% of Great Britain's primary industrial activities such as mining and quarrying, and 14% of GB's employees in these industries. Using *Econ-I* as a source for proxy factors for all SIC industries, NAEI's emissions data was scaled to South West level. Biffa data for emissions by sector (Biffa, 1997) was scaled down using similar proxy factors.

Data recommendations

- **NAEI data would be valuable reported at a regional as well as national level.**
- **Some of the data presented on emissions by source was outdated. It would be useful if this could be updated, especially as emissions to air are becoming more important in sustainability reporting.**

Ecological footprint analysis methodology

This section includes an abridged version of the methodology described in *The Ecological Footprint of the UK* (Barrett & Simmons, 2003). The methodology used for *Stepping Forward* further develops this general approach, and is wholly compatible with the *National Footprint Accounts*, as calculated by Wackernagel *et al.* (Redefining Progress, 2002) and published in the *Living Planet Report 2002* (Loh, 2002) - see below.

What is an ecological footprint?

An ecological footprint is the area required to provide the goods and services consumed by individuals, communities or organisations. It can also be derived for products or for particular activities. Using an 'area equivalence' expressed as 'global hectares', the ecological footprint expresses how much of nature's renewable bioproductive capacity (or 'interest') we are currently appropriating. If more of nature's interest is consumed than is available (i.e. nature's 'capital' is being reduced), then it is possible to assume that the rate of consumption is not sustainable (Chambers *et al.*, 2000).

A snapshot approach

An ecological footprint is a 'snapshot' methodology. It is based on a year-specific data set - 2001 for *Stepping Forward*. An ecological footprint tells us how much bioproductive area would be required to support current consumption, and does not attempt to predict future or measure past impacts. It is likely that, due to technological changes and variations in material flows through the economy (consumption of resources), the ecological footprint (and biocapacity) will change over time, hence the need to focus on one year.

Bioproductivity

The capacity to produce biomass such as crops, grass or timber.

Biocapacity

The total bioproductive area of a country or region.

Equivalence factors

The ecological footprint (as measured using global average yields) is normalised by applying equivalence factors. These are multipliers which adjust different area and sea types according to their relative bioproductivity.

Yield factors

When calculating the biocapacity of an area, the land types and sea available are normalised to world average equivalents using locally derived yield factors. These are multipliers which express the extent to which local bioproductivity is more or less than the world average for that land or sea type.

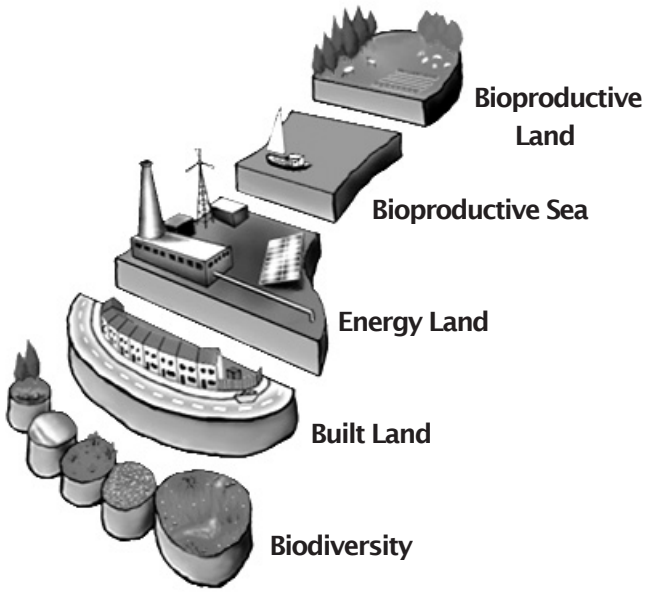
Source: Lewan & Simmons, 2001.

Area types

For the purposes of calculating an ecological footprint, bioproductive land and sea is categorised into four basic types (see Figure 3):

- **Bioproductive land** - land required to produce crops, grazing (pasture), timber (forest) etc. Use of these land types is usually calculated separately.
- **Bioproductive sea** - sea area required to provide fish and seafood.
- **Energy land** - 'new' forest required for the absorption of carbon emissions to stabilise CO_2 levels in the atmosphere. Calculations take into account the absorptive capacity of the oceans and discount it (Loh, 2002).
- **Built land** - such as buildings and roads. Once built on, land is no longer bioproductive in any year.

Figure 3: Area types used to calculate an ecological footprint



In addition, a fifth type - **biodiversity** - refers to the area of land and water that would need to be set-aside to preserve biodiversity. This area of land and water is allocated in proportion to the ecological footprint - for example, the larger the ecological footprint the larger the responsibility to maintain biodiversity. As biodiversity was not included in the headline *National Footprint Accounts,* it was not therefore presented in the main ecological footprint results. If biodiversity were included, a South West resident's ecological footprint would increase to 6.31 gha per person.

The following examples illustrate the relationship between the four main types of bioproductivity when an ecological footprint is calculated.

Example 1

A cooked meal of fish and rice would require bioproductive land for the rice, bioproductive sea for the fish, and forested 'energy' land to re-absorb the carbon emitted during processing and cooking.

Example 2

Driving a car requires built land for roads, parking and so on, as well as a large amount of forested 'energy' land to re-absorb the carbon emissions generated from petrol use. In addition, energy and materials are used for construction and maintenance of the vehicle.

Biocapacity and earthshares

One of the most powerful uses of the ecological footprint approach is in the assessment of sustainability. By comparing the ecological footprint (demand on natural resources) with biocapacity (the available supply of natural resources) it is possible to assess the ecological sustainability of current consumption - if demand is greater than supply, the level of consumption is not sustainable.

Biocapacity can be expressed as local biocapacity or as global average biocapacity - the latter is referred to as the average earthshare. If everyone lived within their earthshare, this would give an environmentally sustainable human existence on earth. Earthshare is calculated by dividing the total amount of bioproductive land and sea on Earth by the current population. This gives the average amount of bioproductive land and sea available globally per person. The latest calculations estimate the earthshare to be 1.9 gha per person (Loh, 2002).

The common reporting unit: National Footprint Accounts

The *National Footprint Accounts* (Redefining Progress, 2002), published as part of WWF's *Living Planet Report* (Loh, 2002), are a series of ecological footprint calculations for over 250 countries, prepared by Wackernagel in collaboration with WWF-International, UNEP World Conservation Monitoring Centre and his teams at Redefining Progress and the Centre for Sustainability Studies (Mexico).

The *National Footprint Accounts* use an ecological footprint methodology known as the 'compound' or 'top-down' approach. The compound approach captures all resource use, including trade, within a geographical boundary, and is measured at a national level.

To calculate the per person ecological footprint of a nation, using the compound methodology, the following national data is used:

- Production, import and export of materials, such as crops, animals, fish and wood.
- Energy consumption, including the net balance of embodied energy through traded products including minerals.
- National land use.

International bodies, such as the United Nations Food and Agriculture Organisation (see FAO, 2002) and the International Energy Agency (see IEA, 2003), regularly publish this type of data. Data for the South West was not represented in any of these publications, and not being a nation, it is not included in the *National Footprint Accounts.*

To enable comparisons between regions with different bioproductive capabilities, the ecological footprint is presented in global hectares (gha).

One global hectare is equivalent to one hectare of biologically productive space with world average productivity.

To convert different areas with different productivities into standardised global hectares, two conversion stages are required:

1. For each area type, the local area is converted to a 'global average' equivalent area using yield factors - so if one hectare of land is twice as productive as the global average, it becomes two 'global average hectares' of that area type. The *National Footprint Accounts* give 'yield factors' for each nation to enable this conversion. These results are presented in specific area types, for example 'global average arable area' or 'global average forest area'. However 'global average hectares' for different area types represent different amounts of bioproductivity.

2. 'Global average' areas for each area type (arable, pasture, forest, built land) are converted into standardised units of area by applying equivalence factors. The equivalence factors, from the *National Footprint Accounts*, are subject to change due to both data availability and variability in the bioproductivity of the planet over time. This international, standardised unit of area is the global hectare (gha).

The results of the *National Footprint Accounts* are reported in ecological footprint per person for each country, as totals and split between the different area types. Table 1 shows the results[1] for the UK, from the *Living Planet Report 2002* (Loh, 2002), based on 1999 data.

Table 1: The *National Footprint Account* for the UK, using 1999 data

Area type	Per person ecological footprint (gha)	Per person biocapacity (gha)
Total ecological footprint	**5.35**	**1.64**
Crop area	0.68	0.52
Forest AWS*	0.32	0.13
Wood fuel	3×10^{-4}	-
Forest NAWS**	-	0.001
Permanent pasture	0.33	0.41
Fishing grounds	0.47	0.36
Built land	0.21	0.21
Hydro area	0.001	0.001
Energy	3.33	0

* Available wood supply.
** No available wood supply.

Source: Redefining Progress, 2002.

Geographical and responsibility accounting principles

Before a regional ecological footprint, such as Stepping Forward, can be calculated, a fundamental boundary decision needs to be made - should it calculate the South West's footprint (geographical principle) or consumption associated with the South West's residents (responsibility principle)?

These two approaches can give very different results. Taking airports as an example, it is possible to include all the airport activities as part of the South West's footprint (geographical principle), or to estimate the impact attributable to South West residents using airports anywhere (responsibility principle).

This study calculated the South West residents' ecological footprint using the responsibility principle, as this is most compatible with other global, regional and city studies. Sustainability assessments using the average earthshare are only valid when using the responsibility principle. See Lewan & Simmons (2001) for further discussion on the responsibility versus geographical principle.

While the National Footprint Accounts represent the global ecological footprint 'gold standard', the results are not immediately relevant to national or regional policy-makers or individuals, as they do not relate to policy areas or activities such as waste or transport. It is possible, using a 'component' methodology, to provide a policy-relevant disaggregation of the *National Footprint Accounts*. Components relate to key activity and policy areas, such as the production and consumption of food, domestic energy, personal transport and the materials, products and services traded and consumed.

1 *The Living Planet Report 2004* (Loh & Wackernagel, 2004) was published in the final stages of the *Stepping Forward* study, too late for the updated figures to be incorporated into the calculations for this report.

Disaggregating the *National Footprint Accounts:* Stepwise™

Best Foot Forward Ltd use a component-based methodology called Stepwise™ to re-analyse the *National Footprint Accounts*. See Barrett & Simmons (2003) for a comprehensive account of the general approach. The results derived using the Stepwise™ methodology are wholly compatible with the *National Footprint Accounts*, and with the methodology used by the European Common Indicators Programme (ECIP), which allows for benchmarking of cities and regions across Europe. For further information on the ECIP methodology see Appendix 1 and Lewan & Simmons, 2001.

The Stepwise™ methodology combines resource consumption, life cycle, and trade data to calculate a range of smaller, more detailed ecological footprint components.

This is a two-step process:

Step 1

The national footprint account for the UK is disaggregated into Stepwise™ components: direct energy, materials and waste, food, personal transport, water and built land. For a detailed description of the disaggregation process, see Barrett & Simmons (2003). In essence it involves factoring consumption data with the ecological footprint conversion factors used in the *National Footprint Accounts*, supplemented by life cycle data when required, to derive ecological footprint results for each component. This is more complex for some components than others.

For example, deriving a component ecological footprint for a car passenger travelling one kilometre (1 pass-km), requires analysis of data on fuel use, materials and energy for manufacture and maintenance of the vehicle, and the share of UK roadspace appropriated by the car (Table 2). The associated conversion factors are then applied to the number of passenger-kilometres (pass-km) travelled, and used as a breakdown of the energy and built land categories of the *National Footprint Accounts.*

To derive a similar conversion factor for a material is considerably more complex, particularly where imports and exports, and differing national production efficiencies are taken into account.

Table 2: An example analysis for the footprint of average UK car travel, per pass-km

	Energy land	Built land
Carbon per pass-km (kg)	0.031	
Uplift factor*	145%	
Carbon responsibility**	69%	
World carbon absorption (tonnes C/ha/yr)**	0.95	
Direct land (total ha)		258,175
Land use (ha/car km)		6×10^{-7}
Equivalence factor	1.35	2.18
Yield factor		2.44
Average occupancy (persons/car)		1.6
Total ecological footprint (gha/pass-km)	**4.3×10^{-6}**	**2×10^{-6}**

* The uplift factor represents the fuel equivalent used for manufacturing and maintenance, and comes from Wackernagel & Rees (1996). Other sources suggest the uplift factor can range between 11% (derived from Hill *et al.*, 1995 and Teufel *et al.*, 1993) and 93% (derived from Teufel *et al.*, 1993).
** See glossary.
Sources: British Road Federation, 1998; DETR, 1997 and 1999; Loh, 2002 and Wackernagel & Rees, 1996.

For example, to calculate the ecological footprint of ' SIC 20101010: railway or tramway sleepers (cross-ties) of wood, not impregnated' the equations below are used. Separate equations are required for energy use and forest use, as well as for the production, imports and exports of the wood.

Example footprint calculation for railway sleepers

Energy footprint

PRODUCTION & EXPORTS:
((C*E*Nc)+(C*E*Wni*Wc))/WCA*CR*EQ
IMPORTS:
((C*E*Wc)+(C*E*Wni*Wc))/WCA*CR*EQ

Where:

C = Consumption (tonnes)
E = Embodied energy (GJ/tonne)
Nc = National carbon content of energy (tC/GJ)
Wni = World nuclear intensity (nuclear GJ/GJ)
Wc = World carbon content of energy (tC/GJ)
WCA = World average carbon absorption (tC/ha/yr)
CR = Carbon responsibility (69%)
EQ = Equivalence factor (1.35 for energy land)

Forest footprint

PRODUCTION:
(C/Cv*EQ)/(NY*(NHLF/NNLF)/YF)/Rr
IMPORTS:
(C/Cv*EQ)/(WY*(WHLF/WNLF))
EXPORTS:
C*((EFi+EFp)/(I+P))

Where:

C = Consumption (tonnes)
Cv = Conversion (tonnes to WRME tonnes underbark)
Efi = Ecological footprint of imports
EFp = Ecological footprint of production
EQ = Equivalence factor (1.35 for forest)
I = Import (tonnes)
NY = National yield (m^3 underbark/ha/yr)
NHLF = National harvest loss factor (%)
NNLF = National natural loss factor (%)
P = Production (tonnes)
Rr = Roundwood ratio (converts tonnes underbark to m^3 underbark)
WY = World yield (m^3 underbark/ha/yr)
WHLF = World harvest loss factor (%)
WNLF = World natural loss factor (%)
YF = Yield factor (2.63 for UK forest)

Additional equations are required whenever another area type is involved, for example cropland and pasture for animal-based food products, or the sea for fish and other sea-based products.

A similar approach is used to derive ecological footprint results for

- direct energy (domestic and services)
- materials and waste
- food and drink
- personal transport
- water
- built land.

Details of how ecological footprints were derived for these components is shown in 'Deriving the ecological footprint results: Component by component'.

The components represent the main categories of impact, and each key component can be sub-divided into smaller categories. For example direct energy splits into fuel types such as electricity, gas and domestic heating oil. Each of these sub-categories can be broken down further, for example into domestic and commercial sectors. The availability and reliability of data is the key limiting factor in determining the number and coverage of components.

Stepwise™ components are chosen to reflect data availability at the European level, to maintain consistency and compatibility. The key component ecological footprints are added together to obtain a total ecological footprint, which is then calibrated to the *National Footprint Accounts.*

Step 2

Once the *National Footprint Accounts* have been disaggregated into the Stepwise™ components, consumption data is assessed. Consumption data used in the ecological footprint analysis is taken from the resource flow analysis. The consumption data used for the ecological footprint is presented in component-specific units alongside the ecological footprint results. For a methodological description of data quality and availability for these components see the Resource Flow Analysis Methodology section.

Deriving the ecological footprint results: Component by component

Deriving ecological footprint conversions is different for each component. The following sections illustrate the key data and methodology issues involved.

The direct energy footprint

The *National Footprint Accounts* present energy consumption data for a nation, and per person. The Stepwise™ methodology enables this total to be broken down into direct and indirect energy.

Direct energy includes domestic energy, and energy for the provision of services, for example hotels and schools.

Indirect energy use is accounted for in other component ecological footprints. For example, energy used to produce materials and products (known as embodied energy) is accounted for in the materials and waste ecological footprint, and energy for transport is accounted for in the personal transport component.

CO_2 emissions associated with direct energy usage are calculated according to energy source (see Table 3), and the ecological footprint derived by calculating the global hectares of new forest required to assimilate these emissions (see formulae in the Stepwise™ Step 1 section). The conversion factor used for brown grid electricity is given in Table 4.

The materials and waste footprint

The *National Footprint Accounts* assess the bioproductive land and energy land requirements of materials and products separately. The bioproductive land requirements are all accounted for in the raw materials production, import and export data. Additional embodied energy impacts, which occur during the manufacture and production of materials and products are not identified separately, but aggregated as part of a national energy consumption figure adjusted for imports and exports.

The Stepwise™ methodology uses the same approach, but disaggregates energy and materials into more detailed components. Consumption data is taken from the resource flow analysis, where double counting between materials and products has been removed (see Resource Flow Analysis Methodology section).

Unlike the other components, official data on consumption of materials and products was not available for the South West and was therefore based on UK data. In the resource flow analysis UK ProdCom data was proxied to reflect the economic activity of the South West (geographical principle). For the ecological footprint analysis the UK data was proxied using domestic waste as a proxy to reflect South West residents' consumption (responsibility principle).

Table 3: CO_2 emissions from the use of different energy sources

Energy source	Kg CO_2 per kWh
Coal	0.30
Oil	0.25
Gas	0.19
Renewables	0.00

Source: DETR, 1999.

Table 4: Calculating the brown grid electricity conversion factor

Brown grid electricity (per GWh)		Energy land
A	Carbon per GWh (tonnes)	131.47
B	Carbon responsibility*	69%
C	World carbon absorption (tonnes C/ha/yr)**	0.95
D	Equivalence factor	1.35
(A*B*D)/C	**Ecological footprint (gha/GWh)**	**128.89**

* CO_2 emissions assimilated by the sea are excluded from the ecological footprint, which leaves approximately 69% of emissions to be accounted.
** See glossary.

Consumption by area type (energy land, crop land, pasture, forest and sea) is first calculated from the *National Footprint Accounts* for the UK and then disaggregated into Stepwise™ components (see Barrett & Simmons (2003) for further details). Built land is not included in the 'materials and waste' component but is presented as a separate component.

To adjust the UK material and products data to estimate South West consumption, household waste was used as a proxy. This proxy is a comparison between household waste arisings in the UK for 1999 (Barrett & Simmons, 2003)) and the South West for 2001:

UK household
waste arisings = 480 kg per person.
South West household
waste arisings = 504 kg per person.

Therefore:
Proxy = South West waste / UK waste
= 504 / 480
= 105%

The South West per person footprint for materials and waste in 2001 will be 5% more than the UK footprint for materials and waste in 1999.

Materials and products

Energy ecological footprints are captured separately from other area types for materials and products, driven by data availability and the necessity to discount double counting between material and product consumption data.

Energy land ecological footprints for materials and products are captured from the embodied energy associated with final products, which includes energy inputs throughout the lifecycle of the product, including extraction and harvesting of the raw materials. Embodied energy figures used in the *National Footprint Accounts* were applied to the 4,800 products outlined in ProdCom (ONS, 2001) to ensure consistency. See Appendix 5 for a detailed discussion of ProdCom data.

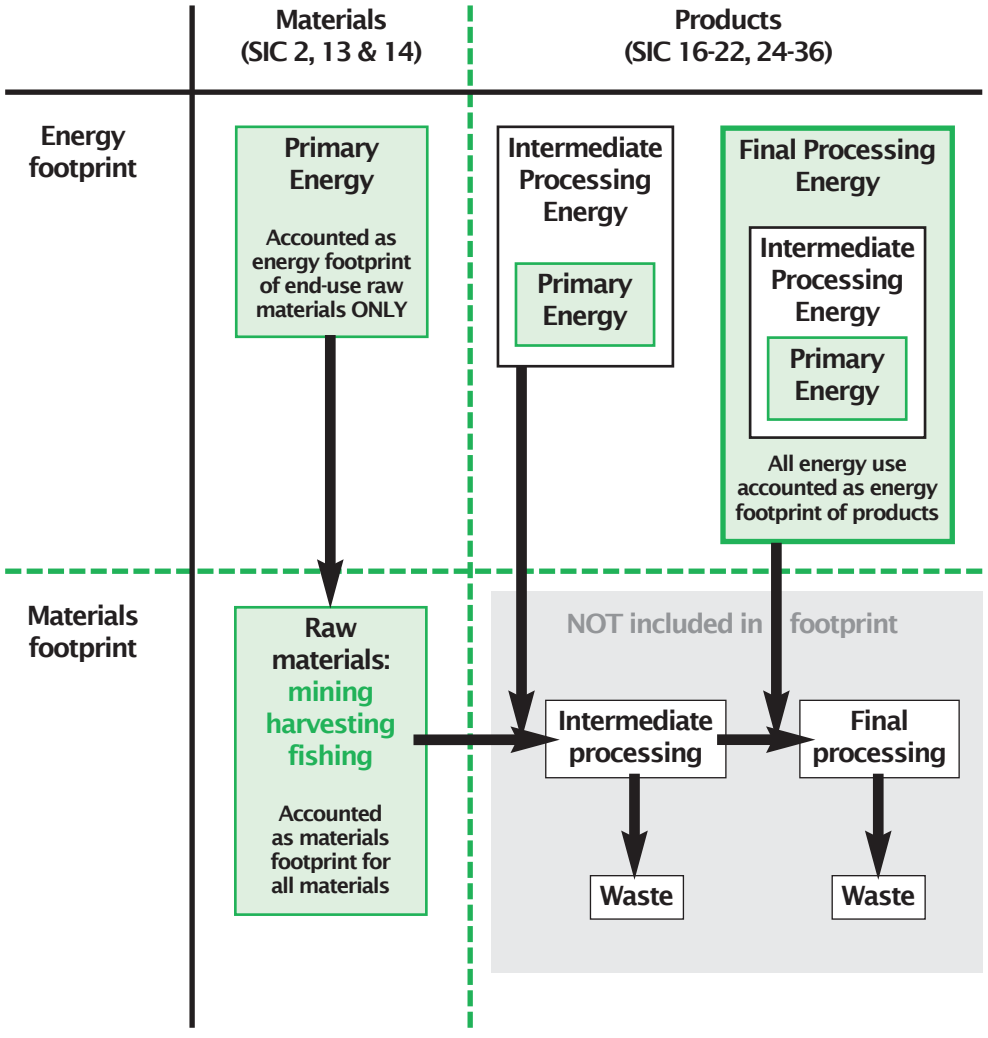
The energy ecological footprint calculations do not capture data for materials consumed as raw materials. This was the case for SIC 13: 'metal ores' and SIC 14: 'other quarrying and mining' and part of SIC 2: 'timber'. These categories were analysed further to incorporate associated energy land requirements not elsewhere captured.

Ecological footprints for the other bioproductive area types (arable, pasture, forest and sea) are captured from raw materials consumption data, which includes all the materials used in the production of final products. Examples of the algorithms used to derive the bioproductive ecological footprints are shown earlier (see formulae in the Stepwise™ Step 1 section) and are compatible with those used for the *National Footprint Accounts.*

Once the separate ecological footprints were calculated for materials and products, they were combined to give a total ecological footprint for materials and products in the South West.

This approach is summarised in Figure 4.

Figure 4: The boundaries considered for calculating the ecological footprint of materials and products



Waste management

Where waste was sent to landfill for disposal, no embodied energy savings were assumed. Where waste was sent for incineration, the energy reclaimed from the incineration of waste was accounted for in the energy data. Where waste was recycled or composted, it was assumed to reduce the need for virgin resource consumption: embodied energy savings of 51% were assumed (Barrett & Simmons, 2003) for recycled and composted materials. Waste sent for recycling or composting resulted in a net deduction from the materials ecological footprint.

The food footprint

The *National Footprint Accounts* (Redefining Progress, 2002) identify food materials and products only at the raw material stage, for example wheat, potatoes, bovine meat. Food products such as ice cream or soup are not identified. For this study, food was disaggregated into categories listed in the *National Food Survey* (DEFRA, 2000). The embodied energy associated with food production was also identified and accounted. The methodology for calculating the ecological footprint of fish and seafood in the *National Footprint Accounts* is based on the bioproductivity of the continental shelves, the trophic level of the fish catch, normalisation of ocean and land bioproductivity, and also includes freshwater fish and aquaculture (Wackernagel *et al.,* 2002).

The consumption of food products in the South West (net consumption) (taken from DEFRA, 2000) was converted into the raw materials required to produce them. Thus the energy used, and biodegradable waste produced, during the production and manufacturing of food products (not post-consumer food waste, which was included in the 'materials and waste component'), were included in the ecological footprint of food consumed by South West residents.

Table 5: Estimates for embodied energy in food

Food type	MJ per kg
Confectionery	43
Fish & seafood	40
Other aquatic products	40
Meat	37
Edible offal	37
Animal fats	37
Stimulants	30
Spices	30
Vegetable oils	21
Treenuts	20
Soft drinks	18
Miscellaneous	17
Sugar & sweeteners	15
Alcoholic beverages	15
Oil crops	7
Pulses	5
Milk	5
Cereals	4
Starchy root	2
Vegetables	1
Fruits	1
Eggs	1

Sources: Based on Redefining Progress, 2002 and Coley *et al.*, 1998.

Table 6: Calculation of beef and veal import conversion factors

Beef & veal* (1 tonne)		Energy land
A	Carbon per tonne	0.681
B	Carbon responsibility**	69%
C	World carbon absorption (tC/ha/yr)**	0.95
D	Equivalence factor	1.35
(AxBxD)/C	Ecological footprint (gha/tonne)	0.668

Beef & veal* (1 tonne)		Pasture
A	World yield (tonnes/ha/yr)	0.032
B	World waste factor	1
C	Equivalence factor	0.47
(1/(AxB))xC	Ecological footprint (gha/tonne)	14.92

Beef & veal* (1 tonne)		Crop area
	UK imports as % of world production	0.10%
A	Feed (gha/tonne)	1.08
B	Fodder (gha/tonne)	1.95
A+B	Ecological footprint (gha/tonne)	3.03

* Tables relate to imports only. Separate calculations are undertaken for home production and exports.
** See glossary.
Note: *National Footprint Accounts* (Redefining Progress, 2002) conversion factors are used.

The area required for growing crops and rearing animals to supply the South West population with food, was calculated using global yield factors from the *National Footprint Accounts,* and converted to global hectares following methodology set out there. Embodied energy of food products was derived from South West consumption data, and embodied energy estimates are shown in Table 5. An example of calculating a food ecological footprint is shown in Table 6.

The personal transport footprint

The *National Footprint Accounts* do not identify transport impacts separately; instead the energy and built land impacts are aggregated within the total ecological footprint calculations. Freight transport was accounted for in the 'food' and 'materials and waste' ecological footprints, with only passenger transport data accounted for in the personal transport component.

In this study, personal transport impacts were disaggregated by mode. A range of personal transport modes was considered. Carbon emissions associated with each mode are given in Table 7. An example calculation for the ecological footprint of air transport is shown in Table 8.

Table 7: Carbon dioxide emissions per passenger-kilometre, by mode

Transport mode	CO_2/ pass-km (kg)
Car	0.11
Motorbike & scooters	0.10
Rail	0.06
Bus & coach	0.05
Waterborne	0.28
Tram & metro	0.03
Air intra-EU (short haul)	0.25
Air extra-EU (long haul)	0.16

Sources: CAA, 2002; DfT, 2002 & 2002a and Scottish Executive, 2002a.

Table 8: Calculation of the air transport conversion factor

Air intra-EU (1 pass-km)		Energy land
A	Carbon per pass-km (kg)	0.067
B	Uplift[1] factor	145%
C	Air uplift[2] factor	168%
D	Carbon responsibility*	69%
E	World carbon absorption (tonnes C/ha/yr)*	0.95
F	Equivalence factor	1.35
((A/1000) *B*C*D*F)/E	**Ecological footprint (gha/pass-km)**	**1.6×10^{-6}**

Note 1: The uplift factor represents the fuel equivalent used for manufacturing and maintenance, and comes from Wackernagel & Rees (1996). Other sources suggest the uplift factor can range between 11% (derived from Hill *et al.*, 1995 and Teufel *et al.*, 1993) and 93% (derived from Teufel *et al.,* 1993).
Note 2: The air uplift factor is an additional adjustment used to account for international air travel.
* See glossary.

The water footprint

The supply and consumption of water is not identified in the *National Footprint Accounts* (Redefining Progress, 2002). For this study, the ecological footprint of water was calculated by measuring the energy used to supply, collect and treat water, as well as treatment of wastewater and release back into the environment. Table 9 shows the ecological footprint calculations for the supply of water.

Table 9: Calculation of the water supply conversion factor

Water supply (1 Megalitre)		Energy land
A	Carbon per megalitre (tonnes)	0.1
B	Carbon responsibility*	69%
C	World carbon absorption (tonnes C/ha/yr)*	0.95
D	Equivalence factor	1.35
(A*B*D)/C	Ecological footprint (gha/megalitre)	0.099

* See glossary.

It has been argued (see Chambers *et al.,* 2000) that water catchment area should also be included in water ecological footprints. However, including the catchment area would incur a double counting of existing areas of demand (arable, energy, pasture, forest and sea areas), because most land types also serve a water catchment function.

The built land footprint

The *National Footprint Accounts* include built land as a separate component, but do not distinguish different uses. Built land includes all areas that are built on, contaminated or degraded to the degree that they are rendered biologically unproductive. This study used South West-specific data to identify land uses within the region. To calculate each built land ecological footprint, a yield factor was applied to the raw data to convert it into hectares of global average crop area (*National Footprint Accounts* assume that most built land was once productive). A crop area equivalence factor was then applied to convert the data into global hectares. Table 10 shows the ecological footprint calculation for built land.

Table 10: Calculation of the built land conversion factor

Built land (per hectare)		Built land
A	Built land (ha)	1
B	Crop yield factor	2.44
C	Equivalence factor	2.18
A*B*C	Ecological footprint (gha/hectare)	5.32

Ecological sustainability assessment methodology

Calculating the biocapacity of the South West

To estimate the South West's biocapacity, three steps were followed:

1. The various area types within the South West were defined and aligned with a yield class used in the *National Footprint Accounts* to find the relevant yield factors.
2. The yield factors were then applied to each area type to give South West bioproductivity in terms of global averages. The yield factors take into account the differences between local bioproductivity (only UK factors were available) and average global bioproductivity for each resource type (see Table 11).
3. The different land types were then converted into global hectares (gha) using *National Footprint Accounts* equivalence factors. The exception to this process was the calculation of sea biocapacity, where the UK average is retained.

Table 11: South West area types, by hectares, with associated UK yield factors

Yield Class	Of which...*	Ha in the South West	Yield factor	Equivalence factor
Arable	Arable & horticulture	536,572	2.44	2.18
Pasture	Grassland	1,173,462	4.57	0.47
	Dwarf shrub heath	33,275	4.57	0.47
	Fen, marsh, swamp & bog	18,941	4.57	0.47
Built land	Inland rock	2,093	2.44	2.18
	Built land	240,834	2.44	2.18
Forest	Woodland	293,009	2.26	1.35
Total		**2,298,186**		

* Tables relate to imports only. Separate calculations are undertaken for home production and exports.
** See glossary.
Note: *National Footprint Accounts* (Redefining Progress, 2002) conversion factors are used.

Tourism

The South West is a key tourist destination within the UK. Tourists have an impact on the environment through their travel, the food and other resources they consume, and the waste they generate. These tourists are mainly residents of other regions so their ecological footprints should not be included in the ecological footprints of South West residents. On the contrary, the ecological footprint of South West residents when away from home does need to be included.

In the *National Footprint Accounts* (Redefining Progress, 2002), resources consumed by domestic and foreign tourists are included in the ecological footprint of the residents of the destination, but are not explicitly identified. The methodologies presented below use different assumptions to identify the amount of the ecological footprint of South West residents which is actually attributable to tourists.

Three methodologies were identified for this calculation, with bednights as an indicator being judged the most appropriate.

Method 1: Tourist bednights

In previous studies, such as *Scotland's Footprint* (BFF, 2004), the impact of tourists on a resident's ecological footprint was estimated by using bednight data - the number of overnight stays. Due to insufficient data, it was assumed that tourists consumed at the same rate as South West residents. However this is likely to be an underestimate, because people probably consume more on holiday than when they are at home.

The South West is a net importer of tourists - people visiting the region from outside spent 88 million bed-nights in the South West (South West Tourism, 2001), whereas South West residents spent 42 million bed-nights (ONS, 2002 and South West Tourism, 2001) visiting other places. The ecological footprint of tourism using this method is a measure of 'net' tourism (tourists visiting the South West minus South West residents visiting elsewhere).

Under these assumptions it is estimated that 0.14 gha of the 5.56 gha per person ecological footprint is due to 'net' tourism within the South West.

Method 2: Resident assumption

This method assumes that no tourist data is included in the data sources used to calculate the ecological footprint of residents in the South West. This is possible, as the data sources used in *Stepping Forward* are far more detailed than those used in previous studies of a similar kind, such as *Scotland's Footprint* (BFF, 2004) and *City Limits* (BFF, 2002).

Under this assumption, 'net' tourism accounts for none of the 5.56 gha per person ecological footprint within the South West.

Method 3: Bed & Breakfasts (B&B)

This method assumes that B&B data was the only possible tourist data included in the sources used to calculate the ecological footprint of residents in the South West. Using new estimated tourist consumption data the 2001 ecological footprint for B&B visitors was calculated. This data was then divided between South West residents to obtain 'per person' consumption estimates and ecological footprints (Table 12).

Examination of the data sources used to generate the estimates presented in Table 12, revealed boundary issues within the food and transport components. Tourist consumption of food and transport is not included in the data used for the *Stepping Forward* ecological footprint analysis, so accounting for it here would over-estimate the impact of tourist consumption on the ecological footprint of South West residents. Consequently only energy, waste and water were included in this analysis.

Table 12: Estimated B&B consumption and resulting ecological footprint

Component	2001 SW B&B consumption (per capita)	Unit	Ecological footprint (gha/capita)
Total			**0.0097**
Energy	**89**	kWh	0.0072
Food*	**N/A**	N/A	N/A
Waste*	**2**	Kg	0.0024
Transport*	**N/A**	N/A	N/A
Water	**580**	Litres	0.0001

* Food and transport are excluded from this analysis as tourist data is not included in the data sources used for *Stepping Forward's* ecological footprint analysis.

Assuming this level of tourist consumption, the B&B ecological footprint per capita was then adjusted according to the 'net tourism' assumptions (see Method 1). This gives an estimated 0.005 gha of the 5.56 gha per capita ecological footprint due to 'net' tourism within the South West.

The ecological footprint of the tourism sector has been investigated separately and the results are presented in the *Tourism Report* at www.steppingforward.org.uk.

Appendix 1: European Common Indicators Programme (ECIP)

The European Common Indicators Programme (ECIP) is a monitoring initiative focused on sustainability at the local level. A partnership of different organisations and levels are working together, in a joint effort to find comparable data and a better understanding of sustainability in local communities across Europe. Ten common local sustainability indicators were identified through a bottom-up process. Used in combination with other indicators and other evaluation methods, the European Common Indicators can contribute to a comprehensive local or regional monitoring strategy.

Over 100 local and regional authorities have so far signed the adoption agreement and are now testing the indicators, and refining the monitoring initiative based on practical experiences.

Support services are provided to participating authorities during the testing phase: technical support (scientific expertise, helpdesk, workshops, etc.), methodological development, pilot activities on the ecological footprint, good practice collection and exchange, dissemination activities, evaluation, reporting, recommendations and guidelines.

For further information on the ECIP programme visit www.sustainable-cities.org or see Lewan & Simmons (2001).

Appendix 2: SIC Industrial sectors used in the resource flow analysis

SIC code	Industrial sector
1	Agriculture, hunting and related service activities
2	Forestry, logging and related service activities
5	Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing
10	Mining of coal and lignite; extraction of peat
11	Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction exc. surveying
13	Mining of metal ores
14	Other mining and quarrying
15	Manufacture of food products and beverages
16	Manufacture of tobacco products
17	Manufacture of textiles
18	Manufacture of wearing apparel; dressing and dyeing of fur
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
20	Manufacture of wood and products of wood and cord (except furniture), articles of straw and plaiting materials
21	Manufacture of pulp, paper and paper products
22	Publishing, printing and reproduction of recorded media
23	Manufacture of coke, refined petroleum products and nuclear fuel
24	Manufacture of chemicals and chemical products
25	Manufacture of rubber and plastic products
26	Manufacture of other non-metallic mineral products
27	Manufacture of basic metals
28	Manufacture of fabricated metal products except machinery and equipment
29	Manufacture of machinery and equipment not elsewhere classified
30	Manufacture of office machinery and computers
31	Manufacture of electrical machinery and apparatus not elsewhere classified
32	Manufacture of radio, television and communication equipment and apparatus
33	Manufacture of medical, precision and optical instruments, watches and clocks
34	Manufacture of motor vehicles, trailers and semi-trailers
35	Manufacture of other transport equipment
36	Manufacture of furniture; manufacturing not elsewhere classified

Source: ONS, 2002.

Appendix 3: Agricultural materials covered by the FAO's UK Food Balance Sheets

Cereals (excluding beer) - Wheat, rice (milled equivalent), barley, maize, rye, oats, millet, sorghum and other cereals.

Starchy roots - Potatoes, cassava, sweet potatoes and other roots.

Sugarcrops - Sugar cane and sugar beet.

Sugar and sweeteners - Sugar (raw equivalent), other sweeteners and honey.

Pulses - Beans, peas and other pulses.

Treenuts

Oilcrops - Soya beans, groundnuts (shelled equivalent), sunflower seed, rape and mustard seed, cottonseed, coconuts (including copra), sesame seed, palm kernels, olives and other oilcrops.

Vegetable oils - Soya bean oil, groundnut oil, sunflower seed oil, rape and mustard oil, cottonseed oil, palm kernel oil, palm oil, coconut oil, sesame seed oil, olive oil, maize germ oil and other oilcrop oils.

Vegetables - Tomatoes, onions and other vegetables.

Fruits (excluding wine) - Oranges, mandarines, lemons, limes, grapefruit, other citrus, bananas, plantains, apples, pineapples, dates, grapes and other fruits.

Stimulants - Coffee, cocoa beans, tea, spices: pepper, pimento, cloves and other spices.

Alcoholic beverages - Wine, beer, beverages (fermented), beverages (alcoholic) and alcohol (non-food).

Meat - Bovine meat, mutton & goat meat, pigmeat, poultry meat and other meat.

Offals

Animal fats - Butter and ghee, cream, raw animal fats, fish body oil and fish liver oil.

Milk (excluding butter)

Eggs

Fish (seafood) - Freshwater fish, demersal fish, pelagic fish, other marine fish, crustaceans, cephalopods, other molluscs.

Aquatic products (other)

Aquatic animals (other)

Miscellaneous

Source: FAO, 2002.

Appendix 4: Summary of proxies applied to the FAO's UK Food Balance Sheet figures to derive agricultural figures for the South West

AGRICULTURAL MATERIAL (incl FISH)	DESCRIPTION OF PROXIES APPLIED PRODUCTION	IMPORTS, STOCK & EXPORTS
Cereals - Excluding Beer	13.36% - SW to UK ratio of cereal growing agricultural holdings	3.6% - SW to GB ratio of FTE in the Grain Milling & Starch manufacturing industry (SIC 15.6)
Starchy Roots	6.23% - SW to UK ratio of potato growing agricultural holdings	14.1% - SW to GB ratio of FTE in the Agriculture (primary industry) (SIC 1)
Sugarcrops	0.46% - SW to UK ratio of sugar beet growing agricultural holdings	0.0% - SW to GB ratio of FTE in the Sugar manufacturing industry (SIC 15.830)
Sugar & Sweeteners	0.46% - SW to UK ratio of sugar beet growing agricultural holdings	14.1% - SW to GB ratio of FTE in the Agriculture (primary industry) (SIC 1)
Pulses	7.06% - SW to UK ratio of horticultural holdings	14.1% - SW to GB ratio of FTE in the Agriculture (primary industry) (SIC 1)
Treenuts	No data	14.1% - SW to GB ratio of FTE in the Agriculture (primary industry) (SIC 1)
Oilcrops	9.67% - SW to UK ratio of rape seed growing agricultural holdings	14.1% - SW to GB ratio of FTE in the Agriculture (primary industry) (SIC 1)
Vegetable Oils	7.06% - SW to UK ratio of horticultural holdings	14.1% - SW to GB ratio of FTE in the Agriculture (primary industry) (SIC 1)
Vegetables	7.06% - SW to UK ratio of horticultural holdings	8% - SW to GB ratio of FTE in the manufacturing of other food products (SIC 15.890)
Fruits - Excluding Wine		5.9% - SW to GB ratio of GVA in the Fish & Fruit processing and manufacturing industry (SIC 15.3)
Apples	3.77% - SW to UK ratio of apple growing farms	"
Grapes	5.87% - SW to UK ratio of grape growing farms	"
Fruits, Other	5.87% - SW to UK ratio of grape growing farms	"
Stimulants	No data	14.1% - SW to GB ratio of FTE in the Agriculture (primary industry) (SIC 1)
Spices	No data	14.1% - SW to GB ratio of FTE in the Agriculture (primary industry) (SIC 1)
Alcoholic Beverages	8.1% - SW to GB ratio of FTE in the Alcoholic Beverages manufacturing industry (SIC 15.9)	8.1% - SW to GB ratio of FTE in the Alcoholic Beverages manufacturing industry (SIC 15.9)
Meat		10.5% - SW to GB ratio of FTW in the Meat Processing manufacturing industry (SIC 15.1)
Bovine Meat	11% - SW to UK ratio of Beef Cows (livestock) on agricultural holdings	"
Mutton & Goat Meat	9% - SW to UK ratio of Sheep & Lamb (livestock) on agricultural holdings	"
Pigmeat	10% - SW to UK ratio of Pigs (livestock) on agricultural holdings	"
Poultry Meat	12% - SW to UK ratio of poultry (livestock) on agricultural holdings	"
Meat, Other	18% - SW to UK ratio of all livestock on agricultural holdings	"
Offals	11% - SW to UK ratio of Beef Cows (livestock) on agricultural holdings	10.5% - SW to GB ratio of FTW in the Meat Processing manufacturing industry (SIC 15.1)
Animal Fats		10.5% - SW to GB ratio of FTW in the Meat Processing manufacturing industry (SIC 15.1)
Butter, Ghee	14.1% - SW to GB ratio of FTE in the Agriculture (primary industry) (SIC 1)	"
Cream	14.1% - SW to GB ratio of FTE in the Agriculture (primary industry) (SIC 1)	"
Fats, Animals, Raw	11% - SW to UK ratio of Beef Cows (livestock) on agricultural holdings	"
Fish, Body Oil	30% - SW to UK ratio of fish landings on all major ports	"
Fish, Liver Oil	30% - SW to UK ratio of fish landings on all major ports	"
Milk - Excluding Butter	14.1% - SW to GB ratio of FTE in the Agriculture (primary industry) (SIC 1)	25.4% - SW to UK ratio of FTE in the Dairy Products manufacturing industry (SIC 15.5)
Eggs	21.38% - SW to GB ratio of hens producing eggs	14.1% - SW to GB ratio of FTE in the Agriculture (primary industry) (SIC 1)
Fish, Seafood	30% - SW to UK ratio of fish landings on all major ports	4.7% - SW to GB ratio of FTE in the Fish & Fruit processing and manufacturing industry (SIC 15.3)
Aquatic Products, Other	No data	4.7% - SW to GB ratio of FTE in the Fish & Fruit processing and manufacturing industry (SIC 15.3)
Miscellaneous	No data	No data

Appendix 5: A detailed breakdown of the materials and waste ecological footprint

This discussion is presented separately as there is confidence in the calculation of the total 'materials and products' ecological footprint, but the detailed SIC breakdown is less robust, due to uncertainties in ProdCom statistics.

What is SIC?

SIC stands for Standard Industrial Classification, which was first introduced into the UK in 1948 classifying business establishments and other statistical units by the type of economic activity in which they are engaged. This classification provides a framework for the collection, tabulation, presentation and analysis of data and its use promotes uniformity.

Calculating the ecological footprint of personal material consumption

It is possible to estimate personal material consumption for an average South West resident by SIC category (see Table 6). Several steps are involved:

1. UK resource consumption data (in tonnes) - for materials and products - is adjusted to remove double counting (both intermediate products and materials accounted elsewhere in the ecological footprint - food, energy, forestry and transport).

a. The following SIC categories were included in their entirety: Mining of metal ores (SIC 13), Other mining and quarrying (SIC 14), Manufacture of tobacco products (SIC 16), Manufacture of textiles (SIC 17), Manufacture of wearing apparel; dressing and dyeing of fur (SIC 18), Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear (SIC 19), Manufacture of wood and products of wood and cord (except furniture), articles of straw and plaiting materials (SIC 20), Manufacture of pulp, paper and paper products (SIC 21), Publishing, printing and reproduction of recorded media (SIC 22), Manufacture of chemicals and chemical products (SIC 24), Manufacture of rubber and plastic products (SIC 25), Manufacture of other non-metallic mineral products (SIC 26), Manufacture of basic metals (SIC 27), Manufacture of fabricated metal products except machinery and equipment (SIC 28), Manufacture of machinery and equipment not elsewhere classified (SIC 29), Manufacture of office machinery and computers (SIC 30), Manufacture of electrical machinery and apparatus not elsewhere classified (SIC 31), Manufacture of radio, television and communication equipment and apparatus (SIC 32), Manufacture of medical, precision and optical instruments, watches and clocks (SIC 33) and Manufacture of furniture; manufacturing not elsewhere classified (SIC 36).

b. SIC categories Manufacturing of motor vehicles, trailers and semi-trailers (SIC 34) and Manufacture of other transport equipment (SIC 35) are partially included, which illustrates that personal transport is also accounted elsewhere in the ecological footprint.

c. SIC categories Agriculture, hunting and related service activities (SIC 1), Forestry, logging and related service activities (SIC 2); Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing (SIC 5), Mining of coal and lignite; extraction of peat (SIC 10), Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction excl. surveying (SIC 11), Manufacture of food products and beverages (SIC 15) and Manufacture of coke, refined petroleum products and nuclear fuel (SIC 23) are excluded, as they are accounted elsewhere in the ecological footprint.

2. The production, import and export tonnage results are converted - at the aggregated two-digit SIC level - to their corresponding ecological footprints, using energy and bioproductive land factors extracted from the National Footprint Accounts. This is done for consistency[1] (Redefining Progress, 2002).

3. The breakdown of consumption into SIC categories 16-20, 21, 24 and 25 is additionally based on the ecological footprint data for 'tobacco', 'textiles', 'paper & pulp', 'fishing - non food' and 'rubber' contained within the UK National Footprint Accounts[2] (Redefining Progress, 2002).

4. The UK ecological footprint data, by SIC code, was proxied to reflect the variation between UK and South West domestic waste arisings, on a per person basis. Household domestic waste in the South West was 2% higher than the UK average[3].

5. This figure was further calibrated, for compatibility with the UK National Footprint Accounts (Redefining Progress, 2002), by applying a constant across all SIC categories. This made adjustments for any variations in the data sources used, and any outstanding double counting not previously captured[3].

Notes:

1 All SIC categories include embodied energy factors. SIC categories 16-21, 24 and 25 additionally include bioproductive land factors.

2 Although the vast majority of timber (by mass) is used in construction (SIC 20), some would be used to manufacture furniture (SIC 36). However, no data was available to determine the split between SIC 20 and SIC 36. Therefore, all bioproductive area associated with timber under SIC 20 is taken into account. Data on harvested materials, not accounted for in the tobacco or rubber bioproductive area, was assumed to fall within SIC 17 (textiles).

3 Household waste data is the most reliable, widely collected indicator of material consumption. Use of this as a proxy is based on the assumption that overall personal material consumption is proportional to the waste produced.

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Conversion tables

Length	Data	Unit
1 kilometre (km) is equal to:	0.621	Miles
	1,094	Yards
	1,000	Metres
1 metre (m) is equal to:	100	Centimetres
	39.4	Inches
1 mile is equal to:	1.609	Kilometres
	1,760	Yards
	1,609	Metres
1 passenger-km	one person travelling 1 km	
1 tonne-km	one tonne travelling 1 km	

Weight	Data	Unit
1 tonne (t) is equal to:	1000	Kilogrammes
	1 million	Grammes
	0.984	Long ton
	1.102	Short ton

Volume	Data	Unit
1 litre (l) is equal to:	0.22	Imperial gallon (UK gal)
	0.26	US gallons

Area	Data	Unit
1 hectare (ha) is equal to:	10,000	Square metres
	2.47	Acres
	107,639	Square feet

Energy	Data	Unit
1 GigaWatt hour (GWh) is equal to:	85.98	Tonnes of oil equivalents
	3,600	Gigajoules
	1 million	KiloWatt hours (KWh)
	34,120	Therms (European)
	3,412 million	British thermal units (Btu)
	8,598,452,278,590	Calories
1 tonne of oil equivalent is equal to:	10,000,000	Kilocalories
	396.8	Therms (European)
	41.87	Gigajoules
	11,630	KWh
	39,680,000	British thermal units (Btu)

The following prefixes are commonly used:

Kilo (k) = 1000 or 10^3
Mega (M) = 1,000,000 or 10^6
Giga (G) = 1,000,000,000 or 10^9

Source: DTI, 2002.

Abbreviations

£	Pound Stirling
˚C	Degrees Celsius
AEAT	AEA Technology
BGS	British Geological Survey
BFF	Best Foot Forward Ltd.
C&D	Construction & Development
C&I	Commercial & Industrial
CAA	Civil Aviation Authority
CHP	Combined heat & power
CO_2	Carbon dioxide
CPU	Central processing unit
CIRIA	Construction Industry Research & Information Association
CREM	Consultancy & Research for Environmental Management
DEFRA	Department of Environment, Food & Rural Affairs
DfT	Department for Transport
DTI	Department of Trade & Industry
EC	European Community
ECIP	European Common Indicators Programme
ECONI	An integrated economic information system for the South West, University of Plymouth
EEBPP	Energy Efficiency Best Practice Program (now known as Envirowise)
EfW	Energy from Waste
ESD	Energy for Sustainable Development
EST	Energy Saving Trust
EU	European Union
FTE	Full-time equivalent
g	Grammes
GDP	Gross Domestic Product
gha	Global hectares
GVA	Gross Value Added
GJ	Gigajoules
GOSW	Government Office for the South West
GWh	Gigawatt hour
ha	Hectare
HM	Her Majesty's
IEA	International Energy Agency
km	Kilometre
KWh	KiloWatt hour
l	Litre
m^2	Square metre
m^3	Cubic metre
M l	Megalitre
MSW	Municipal Solid Waste
MWh	MegaWatt hour
NAEI	National Air Emissions Inventory
NFU	National Farmers Union
ODPM	Office of the Deputy Prime Mnister
OFWAT	Office of Water Services
ONS	Office for National Statistics
pass-km	Passenger kilometre
ProdCom	Products of the European Community
PV	Photovoltaics
RPG	Regional Planning Guidance
SIC	Standard Industrial Classification
SITC	Standard International Trade Classification
Sq. m.	Square metre
Sq. km.	Square kilometre
SWRA	South West Regional Assembly
SWRDA	South West Regional Development Agency
SWRRG	South West Regional Research Group
t	Tonne
TCA	Total Carbon Audit
™	Trademark
UK	United Kingdom
WBCSD	World Business Council for Sustainable Development
WEAF	West of England Aerospace Forum
WEEE	Waste electrical & electronic equipment

Glossary

Ancillary flow - A term applied to certain hidden flows. This is the material that is removed from the natural environment along with the economically useful material, for instance the biomass that is removed from forests to obtain useful wood.

Apparent consumption - Production plus imports minus exports of a product or material over a defined time period. This equates to the consumption of that material or product within the region being examined, and consists of additions to stock and direct consumption.

Biofuel - A gaseous liquid or solid fuel that is rendered from raw biological material (plants, sewage, dry waste, cane sugar or wood pulp) through combustion or fermentation.

Carbon intensity - Carbon intensity is the ratio of CO2 emissions to GDP.

Carbon Responsibility - Carbon dioxide (CO2) emissions that are included in the ecological footprint. The National Footprint Accounts include 69% of the CO2 emitted from fossil fuel combustion, and excludes the 31% absorbed by the oceans (Redefining Progress, 2002).

Composting - The aerobic process by which biologically degradable wastes are broken down to form a stable material containing organic matter and plant nutrients.

Combined heat & power (CHP) - An energy service provided by an on site generator plant (normally with heat recovery).

Conversion factor - A co-efficient used, in this case, to convert between systems of units.

Degraded land - A composite term. Degraded land has no single readily identifiable feature, but instead describes how one or more of the land resources (soil, water, vegetation, rocks, air or climate) has changed for the worse.

Direct energy - Energy consumed, as opposed to embodied or indirect energy.

Double counting - In a resource flow analysis, double counting can best be illustrated by using paper as an example. Paper will go through many stages of production until it becomes the final product we might read (a book) or use (office paper). Economic data can track these sequential processes and report the financial value of each stage. However, it is still the same paper, and for resource accounting purposes this presents a risk of double counting. For the purposes of this study, only the final product has been counted, all intermediate products have been removed.

Earthshare - The average amount of global resources available per person. To calculate an earthshare, the total available land and sea area of the planet is divided equally among the current global population. It is estimated that the current earthshare is 1.9 gha (Loh, 2002). If everyone lived within his or her earthshare, we would achieve 'one planet lifestyles'.

Ecological footprint - The ecological footprint is a sustainability indicator which expresses the relationship between humans and the natural environment. The ecological footprint accounts the use of natural resources. It is a 'snapshot' measure and typically refers to average annual consumption.

Embodied (incorporated) - When the mass of a material becomes incorporated with another material or materials during a manufacturing process, and becomes a different material or product. Embodied energy in a commodity is the energy used (from all sources: electricity, liquid and solid fuels to provide heat, light and/or power) during its entire life cycle for manufacturing, transporting, use and disposal.

Gross Domestic Product (GDP) - A measure of the total flow of goods and services produced over a specified time period. It is obtained by valuing outputs of goods and services at market prices.

Gross Value Added (GVA) - Measures the contribution to the economy of each individual producer, industry or sector in the United Kingdom. GVA is used in the estimation of GDP, which is a key indicator of the state of the whole economy.

Global hectares (gha) - One global hectare is equivalent to one hectare of biologically productive space with world average productivity.

Hidden flow - A flow of a material that will not enter the economy. Hidden flows occur at the harvesting or extraction stage of the material cycle, such as dead fish caught and discarded during shellfish harvesting. The hidden material flow has two components: ancillary material flow and excavated/disturbed flow.

Incineration - A treatment technology used to destroy waste by controlled burning at high temperatures.

Inert - Inert waste is chemically non-reactive, non-combustible, non-biodegradable and non-polluting waste, for example bricks, masonry, rubble, sand, stone and hardcore.

Mass balance - A study that quantifies the flow of a material or materials in a defined situation over a period of time. The underlying principle is the fundamental physical law that within a closed system the total mass is constant. There may be movement of mass and transformation of mass into different forms, but it is not created or destroyed, therefore the mass moving into the system should equal the mass moving out of the system.

Material - A substance or an object that can be classed as primary production, such as agricultural crops, fishing and mineral extraction.

Overburden (excavated and/or disturbed material flow) - The material that is moved or disturbed in order to obtain the useful resource, or the material that is moved to create or maintain infrastructure.

Passenger kilometre - One person travelling one kilometre.

Per capita - refers to per person or resident of the South West.

Personal transport - Transport carrying passengers, as opposed to freight.

ProdCom - The European Union (EU) common basis by which industrial production statistics for mining and quarrying and manufacturing (section D of the NACE Rev. 1 (Statistical Classification of Economic Activities in the European Community)) are collected throughout the European Union. The ProdCom reports provide import, export and manufacturing sales data for 4,800 products for the whole of the UK by an eight-digit code.

Products - Materials in final processed form or created by the combination of two or more different materials. There are two main types of products: Intermediate: A product that is further processed or incorporated into another product before being sold to the consumer. Final: A product that does not require further processing and can be sold in its current form to the consumer.

Proxy - A method normally used to compensate for a lack of raw data. It is an estimation derived from an existing data set using a statistical modifier. For example, deriving local water consumption data by using average per capita consumption of a region in which the locality is part.

Recycling - The process of collecting, sorting, cleansing, treating and reconstituting materials that would otherwise become waste, and returning them to the economic stream as raw materials for new, reused or reconstituted products.

Resource flow analysis - A systematic methodology used for tracking the flow of materials through a country, region, city or organisation. The outcomes of a resource flow analysis provide an opportunity for a better understanding of how and where to target activities to manage material consumption and minimisation (see Griffiths & Lewis, 2004 and Linstead et al., 2003).

Resources - Energy, materials and products, water and land that have a useful purpose to humanity either in their original form or when embodied into a final product.

Reuse - The recovery or reapplication of a product for uses similar or identical to its original application, without manufacturing or preparation processes that significantly alter the original product.

SIC (Standard Industrial Classification) - SIC was first introduced into the United Kingdom in 1948 for use in classifying business establishments and other statistical units by the type of economic activity in which they are engaged. The classification provides a framework for the collection, tabulation, presentation and analysis of data and its use promotes uniformity.

Stock -A term used to describe products that are not discarded by a region during the study year. Examples of products that remain as stock could include: addition of resources to the built environment, for example, new buildings, and durable goods that remain in use beyond the timescale of the study year, for example, mechanical equipment.

Wastewater - Spent or used water from a home, community, farm, or industry that contains dissolved or suspended matter.

World Carbon Absorption: The capacity of world-average forests to sequester carbon. This capacity is estimated by taking a weighted average across 26 main forest biomes (Redefining Progress, 2002).

About the authors

Nicky Chambers is Co-Director of Best Foot Forward. An environmental management and communication specialist, she has previously worked with industry and policy makers. Anticipating the need for resonant communication and robust metrics, she has been heavily involved with the development and promotion of resource efficiency indicators such as ecological footprinting since 1994. She has led several regional resource flow and ecological footprint projects including *Island State, City Limits, Scotland's Footprint, Material Health* and analyses for organisations, including *Ecological Footprint Analysis: Towards a Sustainability Indicator for Business.* She is co-author of *Sharing Nature's Interest.*

Rachel Child is a consultant with Energy for Sustainable Development (ESD), working on a range of activities designed to provide practical solutions to climate change by reducing CO_2 emissions. These include working with businesses, local authorities, housing associations and communities to develop strategies that will provide economically viable solutions, particularly through energy efficiency measures and renewable energy technologies. Rachel is particularly interested in methods of alleviating fuel poverty in conjunction with reducing carbon dioxide emissions in domestic dwellings.

Nicola Jenkin is a projects manager at Best Foot Forward. She is involved in the management of resource flow, mass balance and ecological footprint projects, research and publications. Her main area of interest is in education and communication for sustainable development in industry, business and local authorities, having developed a background in this field in South Africa. She has managed, amongst others, the *Material Health* and *Scotland's Footprint* projects. She was also involved in *City Limits,* and produced Best Foot Forward's award-winning *Environmental Report 2002.*

Kevin Lewis is the senior researcher for Best Foot Forward. He is a principal specialist in ecological footprint methodology and has applied the concept in a wide variety of applications. He comes from an ecological background and for his degree specialised in and focussed on human interactions with the environment, using life cycle and ecological footprint analyses. He has worked on a number of important footprint projects, and has been involved in or produced a variety of publications, notably *Scotland's Footprint, Material Health, City Limits, Island State, The Footprint of Wales, Sharing Nature's Interest* and *Ecological Footprint Analysis: Towards a Sustainability Indicator for Business for ACCA.*

George Vergoulas is a researcher at Best Foot Forward, primarily focusing on resource flow analyses at a regional and sectoral level. He is also involved in ecological footprint at a local level in the UK. Some of the projects he has worked on include *Material Health, Scotland's Footprint, City Limits* and ecological footprints of Jersey, Angus, Essex, Buckinghamshire and East Renfrewshire. He has a background in environmental management and technology, and is particularly interested in sustainable resource consumption issues and their links to supply chain management.

Further information

For this project, different research responsibilities were allocated between Best Foot Forward and Energy for Sustainable Development (ESD). If you require further information on certain components covered in the report, please contact the relevant researchers, as listed below:

For direct energy contact Rachel Child at ESD: rachel@esd.co.uk

For materials and products, food, waste, personal transport, water and built land contact George Vergoulas at Best Foot Forward: george@bestfootforward.com

For general information contact the Project Manager, Nicola Jenkin at Best Foot Forward: nicola@bestfootforward.com

Other ecological footprint studies

Best Foot Forward's Environmental Report 2004. Use of ecological footprinting in a corporate context. www.bestfootforward.com

City Limits: *A resource flow and ecological footprint analysis of Greater London.* www.citylimitslondon.com

Island State: *An ecological footprint analysis of the Isle of Wight.* www.bestfootforward.com

Material Health: *A mass balance and ecological footprint analysis of the NHS in England and Wales.* www.materialhealth.com

Northern Limits: *A resource flow analysis and ecological footprint for Northern Ireland.* www.northern-limits.com

Scotland's Footprint: *A resource flow and ecological footprint analysis of Scotland.* www.scotlands-footprint.com

Sharing Nature's Interest: *Ecological footprints as an indicator of sustainability.* www.ecologicalfootprint.com

Project partners

Biffaward

www.biffaward.org

In December 1997, Biffa Waste Services agreed to donate landfill tax credits to the Royal Society for Nature Conservation (RSNC) to administer under the fund name Biffaward. Grants made from the fund currently amount to more than £63 million, supporting many worthwhile environmental projects.

Best Foot Forward Ltd

www.bestfootforward.com

Best Foot Forward Ltd (BFF) is a sustainability consultancy based in Oxford, specialising in sustainability metrics, resource flow and ecological footprint analyses. BFF have developed the EcoIndex™ and Stepwise™ methodologies, based on ecological footprint, which can be used to calculate the environmental impact and sustainability of a product, organisation, process, lifestyle or region. BFF's ecological footprint of the Isle of Wight was voted Overall Winner at the Biffaward Awards 2001, and their Environmental Report 2002 won an ACCA UK Award for Best SME reporter in the Environmental Reporting Category. Some other publications include: *Scotland's Footprint, Material Health* (a mass balance and ecological footprint of the NHS) and *City Limits* (a resource flow and ecological footprint of Greater London, and a Biffaward 2003 finalist in the R&D category).

South West Regional Development Agency

www.southwestrda.org.uk

The South West of England Regional Development Agency (SW RDA) was established in 1999. Its most important responsibility is to ensure the long-term economic success of the region through providing conditions in which businesses can thrive, and to encourage individuals, businesses and communities in areas with greater social and economic needs to take advantage of new opportunities. The SWRDA is also responsible for providing regional economic leadership by gathering and sharing best intelligence, and promoting the South West both in the UK and abroad.

The Rudloe Centre for Climate Change Solutions

www.rudloecentre.co.uk

A joint venture between Energy for Sustainable Development Ltd. (ESD), the University of Bath and Alkemi Park plc., the Rudloe Centre seeks to produce low carbon technological innovations to mitigate climate change.

South West England Environment Trust

www.sweet-uk.com

The South West England Environmental Trust (SWEET) is a dynamic organisation whose primary aim is to ensure that monies made available through the Landfill Tax Credit Scheme (LTCS) are used to the maximum benefit of all those involved. Their role is to assist projects and sponsors to achieve sustainable waste management and improve the social, economic and natural environment of local communities at local, regional and national level.

Energy for Sustainable Development (ESD)

www.esd.co.uk

Energy for Sustainable Development Ltd (ESD) is Europe's leading climate change and sustainable energy company with a specialist UK staff of 45 across four regional locations, and offices in Nairobi and Sofia. Affiliates in every European country and in most commerce regions beyond. ESD works across the carbon climate change market. Shaping the carbon market through policy, market mechanism development and trading. Building low carbon strategies for commercial and public clients and managing its effective delivery through low carbon and sustainable energy implementation. Helping clients to realise the new carbon market opportunities in the UK, Europe and internationally.