

# **The use of Ecological Footprint and Biocapacity Analyses as Sustainability Indicators for Sub- national Geographical Areas: A Recommended Way Forward**

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## Table of Contents

Definition of Terms .....	3
Description of Ecological Footprint and Biocapacity .....	3
Further reading.....	4
Description of criteria.....	4
Criterion 1: ‘Geographical’ or ‘Responsibility’ Principle .....	4
Criterion 2: Use of global versus local yields.....	5
Criterion 3: Use of equivalence factors.....	5
Criterion 4: Use of a component versus compound model.....	5
Criterion 5: Extent to which local, as opposed to national, consumption data has been used.....	5
Criterion 6: Extensions to basic footprint accounting.....	6
Criterion 7: Omissions from basic footprint accounting.....	6
Criterion 8: Data sources.....	6
Criterion 9: Means of dealing with Nuclear Power.....	6
Criterion 10: Embodied energy estimates used for calculating manufactured/processed products .....	6
Criteria 11: How Built Land is accounted .....	6
Criteria 12: How biodiversity is accounted .....	6
Criteria 13: How CO2 sequestration is accounted .....	6
Criteria 14: Whether biocapacity is considered.....	6
Comparison of Studies based on Criteria.....	7
Summary of main themes.....	11
The Compound and Component Methods .....	12
Our Initial Recommendations .....	13
Questions & Answers (Oslo Workshop; August 2001).....	16
Additional Comments/Decisions Arising from the Workshop.....	19
Variation in administrative powers and responsibilities between SGA’s.....	19
Problems with obtaining energy data .....	19
Response to Recommendation 1 in the draft report .....	19
Response to Recommendation 2 in the draft report .....	19
Response to Recommendation 3 in the draft report .....	19
Response to issues raised in Recommendation 4 of the draft report.....	19
Response to issues raised in Recommendation 5 of the draft report.....	20
Oslo Discussions on Methodology .....	20
Consumption Component groups.....	22
Method of Calculation.....	22
Use of Survey Tool.....	23
Calculation Spreadsheet .....	23
References .....	23

## Definition of Terms

In this report we use the following terminology and abbreviations:

**FoN** – The Footprint of Nations study and methodology used to calculate the footprints and biocapacities of 52 Nations as described in Wackernagel et al (1999) and Chambers, Simmons and Wackernagel (2000). These studies are based on 1993 consumption data. The calculation spreadsheet can be downloaded from [www.rprogress.org](http://www.rprogress.org).

**LPR** – The updated methodology used to calculate the footprints and biocapacities of 152 Nations for the 'Living Planet Report 2000' published by WWF International. These calculations were undertaken by Mathis Wackernagel et al. The full calculation spreadsheet can be downloaded from [www.rprogress.org](http://www.rprogress.org). These calculations are based on 1996 data. There is a current commitment from WWF to update this report every two years – the next report being produced in time for the World Summit on Sustainable Development (Rio +10) in 2002.

**SGA** – Sub-national geographical area. Any geographically defined area which is smaller than the Nation state. For example, a county, municipality, watershed or city. This term has been introduced to overcome the problem of defining the area of investigation (what constitutes a City?) and the differences between political and administrative structures across the Nation states of Europe.

## Description of Ecological Footprint and Biocapacity

The **ecological footprint** (EF) measures how much bioproductive area (whether land or water) a population would require to sustainably produce all the resources it consumes and to absorb the waste it generates, using prevailing technology. It therefore indicates the demand for resources.

Because of market mechanisms these areas can be anywhere in the world and the footprint is an aggregate of many plots of varying quality and size located in different climates.

The **biocapacity** (BC) measures the bioproductive supply, i.e. the biological production in an area. It is an aggregate of the production of various ecosystems within the area, e.g. arable, pasture, forest, productive sea. Some of it is built or degraded land. Biocapacity is dependent not only on natural conditions but also on prevailing farming/forestry practices.

Ecological footprints and biocapacities are usually presented together. In the FoN and LPR they are both expressed in the same area units – hectares of world average bioproductive space. Meaningful aggregation of areas of different quality is only possible where such normalisation occurs.

The EF (as measured using global average yields) is normalised by applying **equivalence factors** – these are multipliers which adjust different land and sea types according to their relative bioproductivity.

When calculating the biocapacity of an area, the land types and sea space 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 that of the world average for that land or sea type.

EF's and BC's have been used to indicate:

1. The extent of human demands on scarce global, national, regional etc. bioproductivity.
2. Whether the average per capita consumption is sustainable and equitable when compared with the global average available biocapacity.
3. The potential for Countries/SGA's to live within the biocapacity available within their own boundaries.

Various secondary analyses have also been undertaken comparing, for example, National ecological footprints with economic performance (Sturm et al 2000; Chambers et al 2000), indicators of welfare and social deprivation indices (Lewis 1997).

## Further reading

For those interested in understanding EF and BC concepts in more details the authors have prepared 2 background papers:

- More about Ecological Footprint Analysis
- Critiques of Ecological Footprints and Biocapacity Analysis

Both papers are attached as Annex 1.

## Description of criteria

We present here a set of criteria to try to understand the key differences between the applications of the EF concept within the EU. In this way we hope to move forward with a common, agreed method of analysis.

These criteria are then applied to the main National studies presented at the Rome Workshop. The results of this evaluation are shown in Table 1.

### ***Criterion 1: 'Geographical' or 'Responsibility' Principle***

A fundamental question is whether the aim of the study is to footprint the SGA or the consumption of the population (the community) within that SGA. The two can give very different answers. As an example let us imagine that a small region has an airport within it. Do we include the full impact of this airport as part of the footprint or estimate only that part of the impact that is attributable to the population within the region? The first approach has been termed the 'geographical principle', the latter the 'responsibility principle' (see 'European Common Indicators Methodology Sheet No. A2').

### ***Criterion 2: Use of global versus local yields***

Whether the yields used for agricultural and forest products are based on local (SGA), national or global average yields.

Studies are generally split into those that try to calculate the footprint based on 'actual' yields<sup>1</sup> (Italy), those that use global average yields (Sweden, FoN, LPR) and those that do both calculations (UK, Holland).

If the consumption is expressed in actual yields then the results cannot easily be compared with other countries/regions and no assessment of global sustainability can be made. This is because the results are not expressed in world average bioproductive area.

However, using actual yields does provide useful information for regional sustainability planning and gives a clearer picture of the actual productive area appropriated and the location of that area around the globe. But it is recognised that to obtain information on local yields for all imported products is extremely difficult.

### ***Criterion 3: Use of equivalence factors***

A description of whether different land types are adjusted for their differing bioproductivities when determining the footprint.

If equivalence factors are not used then the consumption of different land types cannot meaningfully be aggregated into a footprint and the result is not easily comparable across regions as the hectares have not been standardised to world average bioproductive space (or 'area units' as they are referred to in LPR).

### ***Criterion 4: Use of a component versus compound model***

A description of whether the footprint results are presented broken down into policy-relevant components (housing, travel and so on) or not.

Many studies fall in between 'pure' compound (e.g. FoN/Sweden) and component approaches (e.g. UK/Holland) as they do break down consumption into some activity components.

### ***Criterion 5: Extent to which local, as opposed to national, consumption data has been used***

Some studies have found regional data difficult, or impossible, to obtain and have been forced to resort to using National data adjusted for local population size.

This obviously has implications for the preparation of accurate regional footprints. Ideally, all data should be available collected uniquely for the study region but such an approach is difficult to standardise.

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<sup>1</sup> The yields where the products are grown – or a best estimate of these.

***Criterion 6: Extensions to basic footprint accounting***

This criterion indicates whether the study has gone beyond the FoN methodology and sought to account for a wider range of impacts.

***Criterion 7: Omissions from basic footprint accounting***

This criterion indicates whether the study has fallen short of FoN methodology and sought to account for fewer impacts or land types.

***Criterion 8: Data sources***

A description of whether data sources are International, National or SGA.

Europe-wide or International data sources are to be preferred as these could be used to apply the EF method in different countries using a consistent collection method.

***Criterion 9: Means of dealing with Nuclear Power***

How the controversial issue of nuclear power is dealt with.

Most studies treat nuclear power as fossil fuels to 'compensate' for the problems inherent in risk-based calculations.

***Criterion 10: Embodied energy estimates used for calculating manufactured/processed products***

Whether, or not, local, national or global estimates have been used to calculate the embodied energy in manufactured, process products.

***Criteria 11: How Built Land is accounted***

In the FoN study built land is accounted as having the same bioproductivity as arable land. Some studies, however, treat built land as having average bioproductivity.

***Criteria 12: How biodiversity is accounted***

Biodiversity has been variously accounted for as both a discount from supply (available biocapacity) and as a percentage responsibility of the footprint (LPR). Some studies do not refer to biodiversity at all.

***Criteria 13: How CO2 sequestration is accounted***

As CO2 is a global pollutant, most studies use the global average sequestration rate reported in FoN.

***Criteria 14: Whether biocapacity is considered***

Whether, or not, the study includes a calculation of biocapacity. Without such a calculation it is difficult to assess the sustainability of the SGA.

## Comparison of Studies based on Criteria

Table 1 describes Italian, Dutch, Swedish, Finnish, Spanish, Norwegian and UK methodological approaches based on the criteria described above. Where information is not known or unclear the relevant cell is marked with a question mark.

**Table 1: Comparison of studies on 14 criteria.**

Criteria	Studies (and SGAs)						
	Italy (Turin)	Netherlands (various)	Sweden (various)	Finland (various)	Spain (Navarre/Tudela)	Norway (Stavanger)	UK (various)
<b>1: Geographical or Responsibility principle</b>	Responsibility	Responsibility?	Responsibility	Responsibility	Responsibility	Responsibility	Responsibility
<b>2: Use of global versus local yields</b>	Uses estimated actual yields ( a mix of local, national and global according to origin).	Does calculations with both local and global yields.	Global	Does calculations with both estimated actual yields (a mix of regional, national and global according to origin) and global only. The former seems to be preferred.	Uses local yields except for 'imports'.	Local yields for agricultural products.	Does calculations with both local and global yields.
<b>3: Use of equivalence factors</b>	Equivalence factors used.	Only use equivalence factors when dealing with global yields. Global yields preferred.	Equivalence factors used.	Only use equivalence factors when dealing with global yields. Not preferred method.	Equivalence factors used.	?	Equivalence factors used.
<b>4: Use of a component versus compound model</b>	5 main components	22 components	Compound	5 components	4 components	5 components	25 main components
<b>5: Extent to</b>	A mix of local and	Mostly local –	All National	Food, commodities	Local consumption	National data for	All local data

<b>which local consumption data has been used</b>	adapted National data.	except energy data? Based on profiling by income group.	consumption data.	and transport (except road traffic) are National. The rest local.	data where available	food and commodities. Mix of Local/National data for housing, services and transport.	except air travel (estimated from a larger region)
<b>6: Extensions to basic footprint accounting</b>	Includes Methane from landfill plus several additional product consumption categories. Also includes embodied energy for unprocessed food and wood products.	Uses LCA data – not trade data – to determine consumption. Therefore includes additional life cycle effects?	Some attention to N & P pollution from farming	Treats processed wood products more extensively.	No	No?	Uses LCA data- not trade data - to determine consumption. Therefore includes additional life cycle effects.
<b>7: Omissions from basic footprint accounts</b>	None	Sea area excluded?	None	Sea area excluded		Sea area excluded?	None
<b>8: Sources of consumption data</b>	Municipal Land Coordination Plan, ISTAT, Italian Ministry of Industry & Trade, UN Industrial Statistics Yearbook, Ambiente Italia, Provincial Observatory on Waste	Dutch Central Bureau of Statistics, RIVM, Survey?	FAO	Various Finnish sources.	Institute of Statistics of Navarre, Directorate General for Ag, Livestock and Food, Dept. of Industry and Labour, Dept. of Public Works, Transport and Communications. Office for Territorial Wealth, Energy supply companies, Town Council of Tudela, National Statistics Institute.	?	Over 200 local orgs. including retailers, energy suppliers, passenger and freight transport companies, schools, local Council, waste disposal company, Environment Agency and so on.

<b>9: Means of dealing with Nuclear Power</b>	Treated as fossil fuel	Treated as fossil fuel	Treated as fossil fuel	Given a low footprint of 0.00002 ha-yrs per GJ	Treats as Fossil Fuel?	?	Treats as fossil fuel
<b>10: Embodied energy estimates used for calculating manufactured/processed products</b>	Mix of local, national and global embodied energy figures	?	Global (Hofstetter 1992)	Use global figures (from Hofstetter 1992?) adjusted to reflect lower % of fossil fuels in imported goods except forest products where national energy intensity figures are used	Global (Hofstetter 1992)	?	Based on energy data from a variety of life cycle studies (incl. Hofstetter 1992).
<b>11: Built land accounting</b>	Treated as arable land - adjusted with equivalence factor?	Treated as arable land	Treated as arable land?	Not adjusted with equivalence factor	No equivalence factor applied.	?	Uses arable land yield factor.
<b>12: Biodiversity accounting</b>	12% deducted from biocapacity	Not included?	12% deducted from biocapacity	12% is referred to but not used.	Not included	Not included?	12% deducted from biocapacity
<b>13: CO2 sequestration</b>	As FoN	As FoN?	As FoN	Uses local sequestration value	Uses local sequestration value	?	Uses FoN figure for CO2 sequestration
<b>14: Whether biocapacity is considered</b>	Yes	No?	Yes	Yes	No?	Yes?	Yes
<b>Other Comments</b>	Calculations complex.	Main methodology reports in Dutch only.  Key calculations are confidential. Seems similar to UK approach.	Study which most closely follows FoN methodology.		Developed 2 consumption scenarios.	Only summary paper available.	Component approach has been developed as complementary approach to FoN nat. accounting.  Describes several scenarios.



## Summary of main themes

Examination of the EU footprint studies has highlighted some key points:

- The methods used for calculation of SGA footprints vary greatly to the extent that it is not easy to compare one SGA with another. This is due in part to the use of different data sources (cf. Sweden) and in part from the use of different methodologies (for example Finland and Italy).
- A fundamental difference between studies is the use of estimated 'actual' versus global average yields for primary production. Some partners that have chosen to use 'actual' yields have also tried to modify embodied energy estimates for manufactured products to better reflect production at the place of origin. Few partner have tried, or succeeded, in obtaining 'actual' yields for imported products due to the effort and complexity of calculating these. Thus most partners using local yields have, in fact, ended up using global yields for imported products.
- Differences in the treatment of nuclear power, built land and CO<sub>2</sub> sequestration have also affected footprint results.
- A few studies have gone beyond basic footprint accounting and included additional consumption/waste categories. The only obvious omission was the exclusion of sea footprints.
- Most studies are based on local investigations. These have been time-consuming and resulted in a variety of data collection approaches. Many partners have had difficulties in finding local data. It is rare that accurate and reliable local consumption data is available. Furthermore, where such data does exist it is not always collected with sufficient frequency to permit the monitoring of future progress. Of course, such data problems are not unique to footprint analysis but are common to all data-intensive methods of environmental research.
- The lack of SGA data has forced most partners to fall-back on proxy National data. This tends to mask differences between regions and make it difficult to draw conclusions about SGA-specific consumption patterns. Another view is that the differences between SGA's within a single Country are small (as is suggested in the Dutch and Swedish studies). It is likely that other factors, such as income, are a more accurate indicator of consumption in some cases than place of residence.
- Components have been used to better categorise the consumption associated with certain activities/services but few studies have then used this information to develop scenarios or suggest ways forward. More information about the Component method for calculating footprints is provided below.
- Surprisingly few studies have even undertaken biocapacity calculations to determine whether consumption is greater than the available local or global supply.
- Similarly, few studies have mentioned biodiversity.

## The Compound and Component Methods

Confusion exists about the similarities and differences between the compound and component approaches to calculating ecological footprints (see Simmons et al 2000; Ecological Economics, 32, 375-380; and Chambers et al 2000 for further information on these two approaches).

The main distinction between them is they draw upon different data sources to estimate appropriated biocapacity. The compound method estimates consumption based on national trade statistics and energy budgets (a 'top down' approach). This methodology is used in the FoN/LPR studies. The component method estimates consumption through analyses of material flows and activity components (a 'bottom-up' approach). This methodology was originated in the UK by Best Foot Forward, a similar approach has been taken in the Dutch studies. The main sources of data for the component method are local investigations and life cycle studies. Analysis relies on having access to a significant database of environmental information.

The two methods are similar in other respects. For example, they both express results in world average 'area units'.

The top down, compound approach, using trade statistics, was taken in the Swedish study. National statistics on regional activities was used in order to find major local/regional differences. As the standard of living and ways of life are rather similar over the country no essential differences were found, and the SGA footprint was found through multiplication of the national average footprint with the SGA population. The conclusion for Sweden is that differences between people's footprints are more likely to be related to the level of income than to their place of residence. This may not be true elsewhere.

The component approach is illustrated in the UK Isle of Wight and Guernsey studies (the former is available from [www.bestfootforward.com](http://www.bestfootforward.com); the latter is reported in Ecological Economics 32, 375-380). The former involved contacting more than 200 organisations and drew heavily on BFF's EcoIndex™ database of product and material life cycle data. BFF also assisted in the detailed study of Guernsey which was undertaken as a PhD project by John Barrett (now at the Stockholm Environment Institute). In the UK differences between geographical regions has been shown by such studies. This is to be expected as the UK has both a larger and less homogenous population than Countries such as Sweden. The advantage of the component approach is that it is more educative and can be easily applied at the organisation and product levels. The disadvantage is that the data sources are more specific to the region/organisation/activity under investigation and that data collection is therefore also more time-consuming. Also, care has to be taken to avoid double-counting of impacts.

The method used by Wackernagel et al (1998) for the investigation of Santiago de Chile and subsequently by Redefining Progress and BFF in the development of their online footprint calculators (see [www.rprogress.org](http://www.rprogress.org) and [www.ecologicalfootprint.com](http://www.ecologicalfootprint.com)) combines elements from each approach. Consumption is disaggregated into a few components representing key parts of the footprint which are, in turn, calibrated to reflect 100% of the average per capita consumption. Thus when average per capita national data is used the result is the same as that reported in the appropriate FoN/LPR study. The components used in Santiago and calculators are different - but the principle for calculating the footprint is the same (see Table 2).

Table 2: Components used in Santiago and the online calculators

Santiago de Chile	RP Calculator (12 questions)	BFF Calculator (11 questions)
Food <ul style="list-style-type: none"> <li>vegetarian</li> <li>animal products</li> <li>water</li> </ul>	Food <ul style="list-style-type: none"> <li>type of diet</li> <li>amount</li> <li>food waste</li> <li>food 'miles'</li> </ul>	Food <ul style="list-style-type: none"> <li>type of diet</li> <li>food 'miles' and freshness</li> </ul>
Housing & furniture	Housing <ul style="list-style-type: none"> <li>number of people</li> <li>house size</li> <li>electricity source</li> <li>energy efficiency</li> </ul>	Housing <ul style="list-style-type: none"> <li>number of people</li> <li>house size</li> <li>heating/cooling bills</li> <li>electricity source</li> <li>energy efficiency</li> </ul>
Transport <ul style="list-style-type: none"> <li>road</li> <li>rail</li> <li>air</li> <li>coastal/water-ways</li> </ul>	Transport <ul style="list-style-type: none"> <li>car mileage</li> <li>ride sharing</li> <li>fuel efficiency</li> <li>air travel</li> </ul>	Transport <ul style="list-style-type: none"> <li>main travel mode</li> <li>vacation distance and travel mode</li> </ul>
Goods <ul style="list-style-type: none"> <li>paper</li> <li>nonsynthetic clothes</li> <li>tobacco</li> <li>others</li> </ul>		Waste <ul style="list-style-type: none"> <li>volume of waste</li> <li>recycling habits</li> </ul> <p>(Note: waste is used as a proxy for commodities)</p>

## Our Initial Recommendations

These initial recommendations represent the views of the authors based on the findings of this study and our own experience of applying and developing ecological footprint and biocapacity analyses. They reflect our initial views of the best way to progress the use of the methodology for indicating the sustainability of EU SGAs.

**Recommendation 1.** A template method should be developed for measuring ecological footprints and biocapacity. This should be applicable across the EU regardless of the size of a SGA or its population. This method should have the following features:

- It should be based on the responsibility principle. This is consistent with the approach taken by the EU CO<sub>2</sub> indicator project (see CO<sub>2</sub> Indicator number 2).
- Sustainability assessments should focus on comparisons with global biocapacity although some assessments may also choose to look at comparisons with their own SGA biocapacity, national biocapacity or even EU biocapacity.
- The method should use as a basis the FoN/LPR National footprint and biocapacity calculations. That is, the average per capita footprint should be used to determine the mean SGA footprint. It is felt desirable to make some changes to this method (see 2. below). These should be coordinated with the FoN/LPR authors to avoid a proliferation of different techniques. In addition, the method needs to be applied in a more sector/activity based manner to make it suitable for application at the SGA level (see 3. below). The problem

of inconsistent, unreliable and incomplete local data sources needs to be tackled.

**Recommendation 2.** There are two reasons to make some small changes to the basic FoN/LPR calculation method. Firstly, to incorporate ideas from other footprint studies and, secondly, to facilitate the calculation of SGA footprints. The changes are itemised here:

- The energy consumption portion of the FoN/ LPR calculations should be subdivided (perhaps based on Eurostat or EEA National data) into key activities areas (e.g. transport, industrial energy, and so on as per Indicator No. 2).
- Embodied energy calculations for raw materials should be included for net trade at national level. Embodied energy for food and wood are currently incomplete and could have a significant effect on certain national footprints.
- Embodied energy calculations for exported produces should reflect the National energy supply mix. It is currently assumed that all energy is fossil fuel.
- The way in which wood products are accounted should be revisited in the light of the Finnish study data.
- By default, the equivalence factor used for built land should be 1 (world average bioproductivity). This would give a more modest footprint result but it would be more widely acceptable.
- Some means of recognising the importance of low intensity agricultural methods for biodiversity and water quality is recommended to enhance this aspect of the footprint calculation This would need further research.

The authors would recommend that the way in which nuclear energy is accounted should stay the same (accounted as fossil fuel). But we recognise that further research is needed to understand the ongoing loss of bioproductivity arising from past nuclear incidents, the actual embodied fossil fuel energy associated with the life cycle of a nuclear installation, and the issue of risk as applied to EF calculations.

**Recommendation 3.** For use of the FoN/LPR method at the SGA level it needs to be applied in a sector/activity based manner. Thus the mean national footprint must be disaggregated into components which are understood and can be adjusted at the SGA level. A good example is that of the Santiago de Chile study, which can be further elaborated (see Table 2 above). A similar approach was taken in the Swedish study of subnational areas, although disaggregation was found unnecessary because of the small difference between SGAs.

No standard method for doing SGA footprints, based on National calculations, has, however, emerged – but several such projects are in progress (Scotland, Wales and London in the UK alone) which are working towards a standardised approach based on adjustment of the national FoN/LPR figures. The recommended approach is to vary consumption data from the national average by applying the relative differences between statistics on National and SGA consumption (SGA consumption correction factors).

For example, although Scotland has 8.6% of the UK population, statistics show that Scots consume 12% of UK energy. Thus when calculating the footprint of Scotland (a SGA) 12% of the UK's energy 'footprint' should be accounted. In this way data

from National statistical services can (still) be utilised, where it exists, to vary the consumption profile of the FoN/LPR data set to match that of the SGA.

Of course, such an approach requires statistics to be collected and then aggregated in a similar way at both national and SGA levels so that the relative difference can be applied to the FoN/LPR national footprint results. It also requires that any extra statistics collected relate to the consumption categories listed in the FoN/LPR spreadsheets.

The former problem can be addressed by developing a survey (preferably both paper-based and online), drawing on both the UK, Dutch and USA experiences, which can be used for directly or indirectly estimating consumption in key lifestyle areas.

Such changes as are necessary to turn the FoN/LPR calculations into more usable components can be applied 'post hoc' on a Country by Country basis without affecting the raw data. For example, using EuroStat data it would be possible to determine how much of the liquid fuel component of the FoN/LPR energy calculation is attributable to different travel modes.

Clearly, further research work is necessary to establish the relationships between FoN/LPR national consumption results and available Europe-wide data sources, and the survey data that would be needed to link these.

Such calculations shall not be allowed to become too tedious and could be automated by the design of a spreadsheet model. The development of such a model is also recommended as a means of making such analyses more accessible to less technical audiences and to ensure the consistency and integrity of the method.

**Recommendation 4.** As shown by the experience in many countries the footprint is a powerful tool for engaging the general public. Any use of the footprint should be promoted in such a way as to gain most benefit from this.

**Recommendation 5.** Carefully used, footprinting can also prove an aid to policy-making. A document should be developed which gives clear guidance on the potential uses of EF/BC in this context.

## Questions & Answers (Oslo Workshop; August 2001)

The first version of this report (dated 3<sup>rd</sup> August) was presented to delegates at the Oslo Workshop on Ecological Footprints held between 23<sup>rd</sup> and 25<sup>th</sup> August 2001<sup>2</sup>. The original report contained four questions specifically for discussion in Oslo. These are reproduced below along with the consensus view of the workshop delegates.

**Q1: What do we want to footprint – the economic activity within a geographical area (geographical principle) or the consumption attributable to the residents of the area, whether the impacts occur inside or outside the boundaries of the SGA (responsibility principle)?**

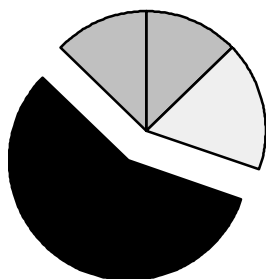
### Workshop view:

*Although this terminology is used elsewhere in the European Common Indicators Programme, it did cause some confusion and resulted in considerable discussion. The consensus view was that the SGA would probably want to measure the environmental impact of all activities within its borders (the geographical principle) but that only that part of the consumption attributable to the residents of the area (the responsibility principle) should be reported as part of the European Common Indicators to ensure comparability across regions. However, the ECIP should support the SGA in fulfilling the geographical principle and, ideally, any spreadsheet tool or guidance produced should cover this aspect of the footprint measurement.*

*In the course of the discussion several participants presented helpful diagrams to assist in the clarification of what portion of a SGA footprint should be reported to the ECIP. The diagram below shows (Diagram 1) all the impacts that might occur within an example SGA with an aluminium works, airport and significant tourist activity.*

*Diagram 1: Illustration of what portion of a SGA footprint would be reported as part of the ECIP. Only the black slice of the pie chart would be reported.*

SGA Footprint (for example, Oslo)



- Impact of aluminium works (excl. aluminium consumption attributable to local residents)
- Impact of airport (excl. flights by local residents)
- Consumption attributable to residents (will include impacts occurring outside of SGA)
- Consumption attributable to tourism

**Q2: Should the footprint be compared with biocapacity at all, or some, of the SGA, global or EU levels.**

### Workshop view:

*It was recommended that SGA footprints are compared primarily with global biocapacity but that national biocapacity should also be made available.*

<sup>2</sup> Co-sponsors: **ProSus** (Program for Research and Documentation for a Sustainable Society, Centre for Development and Documentation for a Sustainable Society, Oslo University), **WNRI** (Western Norway Research Institute, Sogndal), **ENSURE** (European Network for Sustainable Urban and Regional Development, Graz, Austria), **ECIP** European Common Indicators Project, European Commission/Ambiente Italia, Rome

*Comparisons with local biocapacity was not recommended, since local supply for big cities are unrealistic. Ethical issues should also be considered. Where can people in over populated areas go? Also people in SGA with surplus biocapacity may feel comfortable and believe they can continue business as before.*

*This must, however, be considered in relation to the informative and educational value of looking upon the own local biocapacity. This is basic for community sustainable planning. It must also be considered in relation to allocation of biocapacity for biodiversity, which must occur from the local SGA over the nation, EU and the Earth. Most important is the possibility of reducing biocapacity used in farming and forestry for maintenance of biodiversity and ecological services.*

*In conclusion, the consensus view was that any (tool or) guideline should tell SGA's how to calculate their own biocapacity but that this should not be reported as part of the ECIP.*

**Q3: Should we use the FoN/LPR methodology as a basis for calculating the EF/BC of SGAs? (i.e. use of the main national footprint with SGA adjustments combined with SGA local BC measurements).**

**Workshop View:**

*The FoN/LPR method was generally accepted assuming that some changes and improvements could be incorporated (as set out in this report and Q4 below).*

*It was the view of the partners that these changes should be undertaken in cooperation with the authors of the FoN/LPR.*

**Q4: What changes should/could be made to the FoN/LPR methodology – both to improve the accounting and to make it applicable to SGAs. Issues include those highlighted by the present comparisons between EU SGA studies such as how to deal with:**

- embodied energy in traded produce/goods
- nuclear energy
- biodiversity
- built land

**It has become clear to the authors during our discussions that sub-national administrative powers and responsibilities vary enormously from Country to Country. This greatly affects the quality and quantity of SGA data available and the opportunity to influence decision-making. To assist partners in better understanding the situation in other parts of Europe it would be useful for each delegate to the Oslo Meeting to give a basic overview of the situation in their locality.**

**Workshop view:**

*Although the participants seemed generally supportive of the initial recommendations of the authors on these points, it was the consensus view that these issues (and other unresolved methodological issues) were best discussed in a smaller experts' group involving those taking part in the planned pilot studies. It was suggested that this meeting takes place as soon as possible (September/October 2001).*

*Concerns were expressed that this expert group would not be independently resourced but would have to rely on contributions from the pilot project.*

*Similarly, time to liaise with the authors of the FoN/LPR is not resourced. Agreement with the FoN/LPR authors (probably Mathis Wackernagel and Jonathon Loh) needs to be reached before the end of the year to permit changes to be incorporated into the next FoN/LPR study.*

## **Additional Comments/Decisions Arising from the Workshop.**

### ***Variation in administrative powers and responsibilities between SGA's***

In the original draft of this report the authors drew attention to the need to discuss the variation in administrative powers and responsibilities from Country to Country. This greatly affects the quality and quantity of SGA data available and the opportunity to influence decision-making. It was recommended that to assist partners in better understanding the situation in other parts of Europe it would be useful for each delegate to the Oslo Conference to give a basic overview of the situation in their locality. This issue was generally acknowledged but little discussion took place.

### ***Problems with obtaining energy data***

During the Rome meeting, partners commonly reported problems obtaining energy data due, in part, to the liberalisation of the energy market. Partners wished to see action at the European level to address this. This point was re-iterated at the Oslo Workshop.

### ***Response to Recommendation 1 in the draft report***

Recommendation 1 dealt with the need to develop a template method for measuring ecological footprints and biocapacity applicable across the EU regardless of the size of a SGA or its population. It was recommended that this method should have certain features which were the subject of debate at the Oslo Workshop as part of Questions 1, 2, and 3.

As reported earlier in this document, the authors' recommendations were agreed.

### ***Response to Recommendation 2 in the draft report***

Recommendation 2 dealt with changes to the FoN/LPR methodology.

As reported earlier, these recommendations were generally agreed but final decisions were deferred to an experts' meeting.

### ***Response to Recommendation 3 in the draft report***

Recommendation 3 set out the preferred methodology in more detail. Again, the general consensus was to defer final decisions on this to the experts' meeting although there was some general agreement at the Oslo Workshop which would form a good basis for these further discussions. These are reported in the section below headed 'Oslo discussions on methodology'.

### ***Response to issues raised in Recommendation 4 of the draft report***

Recommendation 4 read:

*As shown by the experience in many countries the footprint is a powerful tool for engaging the general public. Any use of the footprint should be promoted in such a way as to gain most benefit from this.*

This was generally accepted.

Participants were impressed by the coherent public education campaign in Holland and would like to see this replicated at a Europe-wide level. It was suggested that

this should include an online 'quick scan' type questionnaire which not only estimated an individual's footprint but also acted as a data collection survey tool of the type recommended by the authors.

Craig Simmons agreed to pursue funding for this in collaboration with Anthony van de Ven.

### ***Response to issues raised in Recommendation 5 of the draft report***

Recommendation 5 read:

*Carefully used, footprinting can also prove an aid to policy-making. A document should be developed which gives clear guidance on the potential uses of EF/BC in this context.*

This was generally accepted.

There is currently no resources identified to support the production of such a document but funding could be pursued as part of the more general public education bid identified above.

## **Oslo Discussions on Methodology**

Although it was generally agreed that final decisions on methodology should be deferred to a smaller experts' group, some progress was made on methodology at the Oslo Workshop. Those points, which were generally agreed, are documented below (see also Diagram 2).

### **Data Sources**

As indicated above, **the calculations should be based on international trade analyses and biocapacity calculations** as illustrated in the FoN study and used in the LPR. The spreadsheets for these calculations are available on the net through Redefining Progress ([www.rprogress.org](http://www.rprogress.org)) and are supposed to be regularly updated through the WWF International. Next update is in progress to be ready Autumn 2002

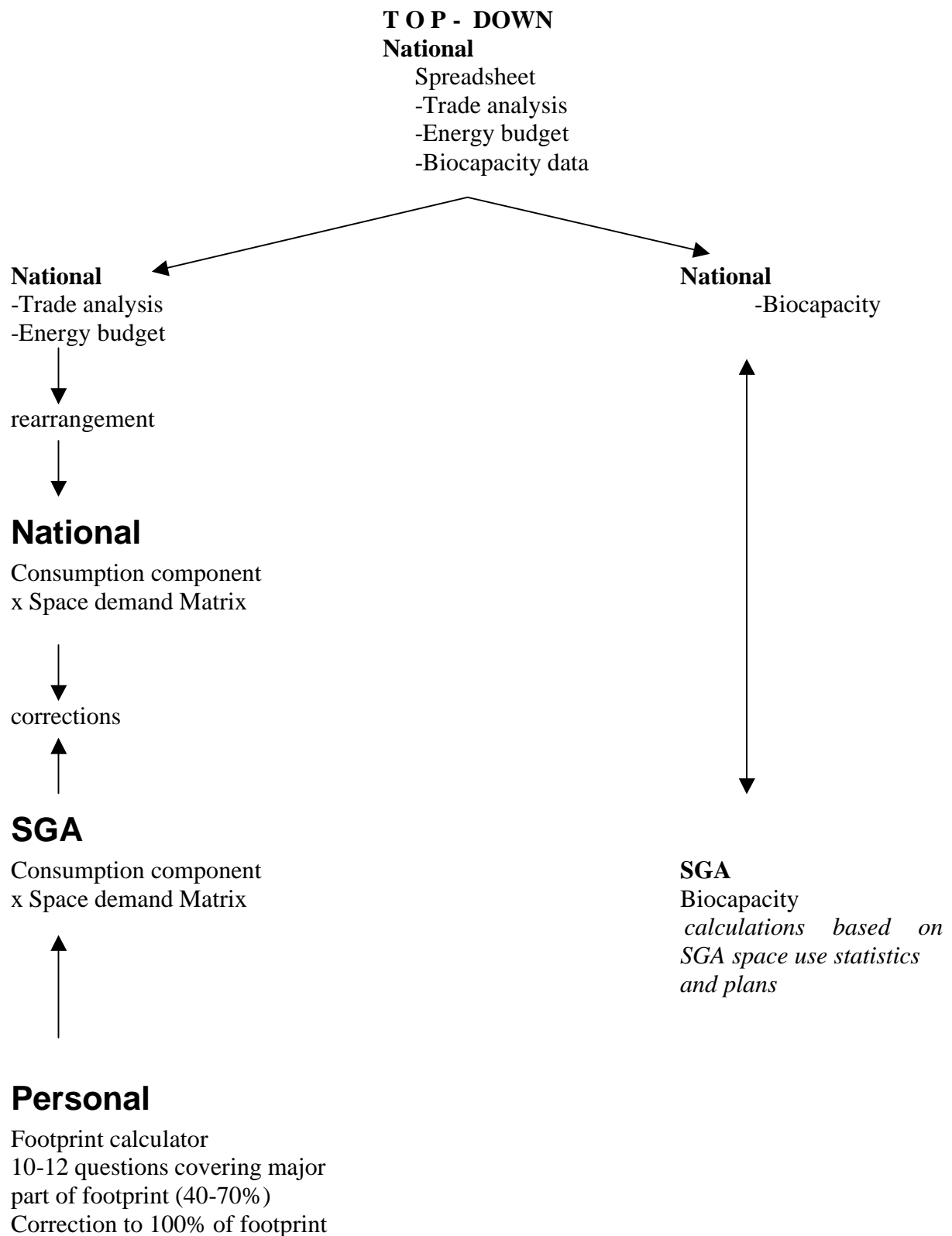
Thus each of the participating countries can get their spreadsheet showing the total consumption of around 120 items grouped into around 7 categories (animal based food products, animal based non-food products, plant based food products, chemical products etc.) The spreadsheet will also include the country's energy budget and the biocapacity. The footprint of each item consumed including the energy land demanded according to the energy budget is expressed in area units (ha world average productive space). The results are aggregated into a mean national ecological footprint.

**Europe-wide data sources will need to be identified to permit the re-arrangement of the national spreadsheet components into more sector/activity-based groupings** which relate more directly to consumer activities and purchases. Europe-wide data sources should ensure that there is a common methodology. (There should be a Eurostat data shop in each country).

In a second step National statistics, national and local surveys, and other local investigations will play a role in determining the deviation of SGA consumption from the National average (as described in initial recommendation 3).

Though global yields should be used for reporting to the ECIP, to ensure commonality of approach, each country/SGA can recalculate their results in local yields should they so wish.

Diagram 2: First thoughts on how National and Local Statistics might be integrated.



**BOT TOM - UP**

### **Consumption Component groups**

It was agreed that, to keep the methodology and reporting simple, only a limited set of five component footprint values would need to be calculated to derive the European ecological footprint indicator to be reported to ECIP.

Many, if not most, SGA's would also wish to calculate many more footprint components – either as part of the overall calculation process or to assist in policy-making and scenario development. These additional components should form part of a hierarchy linked to the five 'top level' components.

It could be that an SGA would not wish to use ecological footprint analysis for smaller components and the suggested reporting format allows for this flexibility. For example, having identified a large 'housing' footprint, the SGA would be free to use a technique such as the Sustainable Process Indicator (SPI) to further explore the reasons for this and for choice of less demanding technology. Importantly, such a hierarchy of components also allows for the use of more local data sources to investigate smaller impacts where Europe-wide sources/National statistics would provide insufficient resolution.

**The five recommended top level components are reported in Table 3 below.**

Note: A request to the Swedish Statistics EuroStat Data Shop after the Workshop found that they could, for a fee, reorganise the Trade consumption data into Consumption Component groups. A pilot study is recommended.

**Table 3: Component x Area demand Matrix for five 'top level' components. Calculated per capita (entries with a '?' are likely to be very small)**

	Food	Transport (passenger)	Housing	Commodities	Services
Energy	x	x	x	x	X
Built Land	X?	x	x	x	X
Arable	X			X	
Pasture	X			X	
Forest	X		x	X	
Sea	x			X?	

**Total mean national footprint: as before**

**Total SGA mean footprint after corrections:**

### **Method of Calculation**

The matrix given in Table 3 is first constructed for the average national citizen and then corrected for SGA peculiarities by comparing the difference between national and local consumption. In this way a figure for the average SGA resident can be calculated.

The **method for achieving this needs further research and documentation** to ensure compatibility of approach throughout Europe.

The most certain **estimation of the biocapacity** can be made at the level of an SGA where there should be information about land use in agriculture, about built areas, areas for roads, deposits and other installations, for water protection, nature

reserves, etc. Only at the local level can information about the management intensity and the yield on such areas be found. It can also be found to what extent biocapacity is set aside for ecosystem services and biodiversity. Thus there may be considerable deviations from the mean national biocapacity per capita and changes can be considered in the planning process.

### **Use of Survey Tool**

A survey tool, such as the Dutch Quick Scan or UK EcoCal (both available as electronic and paper-based questionnaires) can be used both to engage with the public and to collect SGA-specific data. The results can be used to adjust the National average footprint directly or to validate other data sources.

**The development of a survey tool, which integrates into a Europe-wide compatible approach needs further research.**

### **Calculation Spreadsheet**

The other main topic of discussion was the means by which the footprint calculations would be performed. It is important that the municipalities can do the calculations themselves.

**There was strong support for the development of a simple, easy-to-use computer programme/spreadsheet which goes beyond the basic component calculations to provide more general support and guidance for the calculations.**

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## **Annex 1: Ecological Footprint Analysis**

This Annex contains two short background papers:

- More about Ecological Footprint Analysis
- Critiques of Ecological Footprint Analysis

### **Paper 1: More about Ecological Footprint Analysis**

#### ***What is an Ecological Footprint?***

Footprinting essentially accounts the use of the planet's renewable resources (its 'interest' rather than its 'capital'). Non-renewable resources are accounted for only by their impact on, or use of, renewable, bioproductive capacity.

The footprint deals only with demands placed on the environment. It does not attempt to include the social or economic dimensions of sustainability.

The footprint is a 'snapshot' estimate of biocapacity demand and supply usually based on data from a single year. Both available biocapacity and the eco-efficiency of the economy can change over time which is why it is not possible to forecast or 'backcast' footprints from current data although it is possible to make assumptions about future consumption and thus create informative, but speculative, scenarios.

The use of bioproductive area as an aggregate unit makes it a powerful and resonant means of measuring and communicating environmental impact and sustainability. In this sense it is comparable to many economic indicators such as the Retail Prices Index (RPI) and GDP.

#### **The Bathroom Scales and Footprints**

The footprint has been compared to measuring ones own weight. You can find out how heavy you are, and the difference from your ideal weight, but the process of measuring does not tell you how to lose weight. However, you can speculate that if you do certain exercises and eliminate certain calorific foods from your diet you will shed a certain number of kilos.

#### ***An Additive Model***

The basic ecological footprint is an additive model. It sums several mutually exclusive uses of bioproductive area; arable, forest (for both wood products and carbon sequestration), pasture, degraded or built land, and sea space. Exceptions to the additive model have been made for footprinting certain types of pollution and water catchment where spatial uses overlap.

A key issue in the calculation of ecological footprints and biocapacities is the method used to aggregate areas of different quality facilitating international comparisons. Areas of generally different productivity (arable, pasture, forest, sea) are 'normalised' by multiplying them by equivalence factors relating to their bioproductivity. The equivalent areas are then expressed as standardised hectares of world average productivity (more recently referred to merely as 'area units').

## The use of Ecological Footprint and Biocapacity Analyses as Sustainability Indicators for Sub-national Geographical Areas: A Recommended Way Forward: Annexes

Use of fossil fuel-derived energy is typically accounted for in terms of its carbon dioxide emissions although it is also possible to assess ecological footprints of energy use in terms of the land area required to sustainably derive biofuel alternatives. The former results in a more conservative estimate of the impact of fossil fuel use and have thus been the more common method.

### ***Biocapacity***

For calculation of national/regional biocapacity, local yield factors are introduced. These factors show how much higher or lower the yield per local ha is compared to the yield per area unit. There is always the possibility of converting ha of unit area into ha of national/regional average productive space for both supply and demand. Thus it is possible to answer two questions; *How many planets would it take to if everyone consumed as much as the average resident of Region X* and *How many Region X's would it take to satisfy the current demands of that Region*. This calculation was performed for the Isle of Wight (Chambers et al 2000). Using local yield values it was shown that two additional Islands would be needed to sustainably support consumption. Using global yield factors it was shown that, if everyone lived like the average Islander, 1½ extra planets would be required. The approach of using local yields is also favoured by a number of the studies reviewed in this report.

Some biocapacity must be set aside for non-human use. The necessary amount of pristine habitat is not known but, as a general rule in footprint calculations, not more than 88% of the existing biocapacity is considered 'available' for human use. The LPR 2000 accounts for biodiversity as a percentage of the footprint (demand). Previously biodiversity area has been subtracted from the available regional supply.

## **Paper 2: Critiques of the Ecological Footprint**

### ***Critical Studies***

Several critiques of the ecological footprint exist (notably VROM-Council 1999, Van Kooten and Bulte 2000, van den Bergh and Verbruggen 1999, Pearce 2000). These reviews contain a mix of positive and negative comments relating to the application of the methodology as well as suggestions for improving its structure and use.

It is important to address these briefly both to understand the limitations of the methodology, its strength and weaknesses, and to assist in assessing the various applications of the methodology within the EU.

### ***Answering the Critics***

Here we paraphrase 10 key points listed by Van Kooten and Bulte (2000) and use these as a framework for comment. Their comprehensive critique is arguably the most harsh of those listed above and was used by Pearce as the basis for his submission to the EU Commission DGXI. One of the co-founders of the ecological footprint concept, Dr. Mathis Wackernagel, has also had the opportunity to address the points raised in a corresponding submission to the EU Commission (Wackernagel 2000) and here we draw on his comments augmenting these with our own thoughts and experiences. The reader is also referred to Chapter 6 of 'Sharing Nature's Interest' (Chambers, Simmons and Wackernagel 2000) which addressed these and additional points.

#### **1. Footprint accounts are incomplete**

Ecological Footprint Analysis does not claim to account for all human impacts on the environment. Instead it prefers to offer a conservative underestimate whilst acknowledging that other impacts exist. Most obviously, the accounts focus on resource consumption, with the exception of water, and underestimate the impacts of waste products.

However, several footprint studies have addressed both of these shortfalls. Chambers et al (2000) demonstrate two methods of incorporating water consumption into footprint accounts. The same publication presents a study which includes footprint estimates for several pollutants.

Other studies have tackled the complex task of accounting for pollutants other than carbon dioxide, for example, Folke et al 1997, Wackernagel et al 1997 though they remain excluded from National footprint calculations. The main hurdle to further integration of pollution accounting would seem to be a lack of reliable research data on the way in which pollutants interact and affect bioproductivity. Further discussion on this issue is contained within a paper by Holmberg, Lundqvist, Rob ert and Wackernagel (1999).

There is also some confusion amongst critics of the method as to what the footprint is intended to account. The footprint typically accounts only those resources which are part of the biosphere's cycles. It is implicitly assumed that the use of heavy metals and hazardous chemical (those which are persistent,

bio-accumulative or toxic) should either be eliminated or must be handled in totally closed loops which do not involve release into the natural environment. Studies have shown that the impact on bioproductive capacity of, for example, heavy metals are massive and usually swamp other effects of consumption. The natural assimilation rate of Copper, for example, is 42mg per square metre per year . The footprint of a kilogram of copper would therefore be 2.38 ha-years. The footprint of a kilogram of PCB's is an impressive 2,000 ha-years (Krotscheck & Narodoslowsky 1996).

**2. Applying Carrying Capacity concepts to human populations is flawed. Evidence has shown that (a) humans, unlike other animals, can and do increase the carrying capacity of their environment to meet their needs and (b) certain regions and communities seem to be living beyond their local carrying capacity now with few ill effects.**

Criticism (a) is based on a misunderstanding of how footprinting accounts for changes in biocapacity. As the footprint is a 'snap shot' measure, reflecting the supply and demand at the time of the analysis, future effects (such as increases or decrease in biocapacity) would only become apparent in subsequent analyses.

Criticism (b) ignores the fact that populations can exceed local carrying capacity either temporarily, by running down natural capital, or more permanently, by importing or appropriating capacity from elsewhere. Take the example of a fishing community dependent on a local lake for their food. They can over-fish the lake, temporarily increasing supply, by catching smaller and smaller fish. This will impact on the ability of the fish population to sustain itself leading to decline in stocks. This is of course what has happened on a wider scale in European waters where arguments have raged over the gauge of fishing nets which will allow the immature females to escape. Another option for the fishing community is to simply import produce from elsewhere, either fish or another protein substitute, thus appropriating carrying capacity form elsewhere.

**3. The very process of aggregating land types to calculate a footprint assumes substitution - yet this is not possible.**

This is a complex point raised in different forms by various commentators. Basically, this comment is based on a misunderstanding about the nature of the footprint as a measure of impact based on current biocapacity calculations. Aggregating information into a single indicator need NOT imply that the elements being measured are interchangeable in any real sense. For example, MTOEs (Million Tonnes of Oil Equivalent) is a common unit used for aggregating the energy content of different fuel types to derive a overall indication of energy consumption. Aggregating in this way does not imply that the fuels are in any way interchangeable - natural gas cannot substitute for diesel, for example.

**4. Carrying capacity is irrelevant since resource yields can be increased in the case of renewable resources, and depletion profiles can be extended by technology in the case of non-renewable resources.**

Indeed, carrying capacity can be altered: both eroded as in the case of desertification, and enhanced as in the case of careful management schemes. That's why ecological footprints are always compared to the biocapacity of a given year (as mentioned earlier). In fact, as footprint accounts point out, technological efficiency is one possible strategy to reduce humanity's draw on nature (as long as the efficiency gains are not outpaced by an increase in consumption).

**5. Carrying capacity calculations have limited relevance when trade is possible since the scarce resource can be imported in exchange for another asset in which the exporting nation has a comparative advantage.**

Footprint accounts do not argue against trade. They point out that not all countries can be net-importers of ecological capacity if global overshoot is to be avoided. Footprint accounts make ecological trade imbalance visible and show to what extent nations depend on net imports of ecological services. Further, Pearce's interpretation that shifting to imports from high-yield areas will reduce a country's overall footprint is incorrect. From a global perspective, this is a zero-sum game at best. And in fact, in our accounts, a shift to imports from higher-yield areas does not reduce the importer's footprint.

**6. Certain economies that are highly urbanized (Netherlands, Singapore, Hong Kong) can never be sustainable since they can never meet their ecological demands from their own land.**

Of course, urbanised economies are more likely, by definition, to need to import resources to meet their needs. This does not mean they can never achieve sustainability, it just means that they will have a more dispersed footprint which will have a certain transportation 'overhead'.

**7. Footprinting is a survivability concept not a sustainability concept. Survivability is about maximizing the time available on Earth for human species, independently of the quality of that existence.**

Certainly footprint estimates are a *minimum* requirement for sustainability. In other words, living within global carrying capacity is necessary but not sufficient for sustainability. It may be desirable to increase the footprint to allow for a higher quality of existence.

**8. Calculating the fossil fuel footprints in terms of area needed to absorb the corresponding CO<sub>2</sub> is inadequate according to some critics.**

The area included for CO<sub>2</sub> sequestration represents the degree by which the planet would need to be larger in order to cope with anthropogenic CO<sub>2</sub> output. Finding other ways to combat atmospheric CO<sub>2</sub> accumulation would open dramatic possibilities for reducing humanity's footprint. Calculations for various forms of renewable energy are included in Chambers et al (2000). Another method of calculating the fossil fuel footprint is to assess the biological area necessary to produce a substitute. This would lead to even larger footprints.

**9. There are substantial uncertainties about how to calculate the land areas required to offset waste flows.**

## The use of Ecological Footprint and Biocapacity Analyses as Sustainability Indicators for Sub-national Geographical Areas: A Recommended Way Forward: Annexes

The science of accounting for various pollutants is in its early stages and by omitting these footprint studies underestimate environmental impact. Examples of studies where the footprints of wastes have been included are referred to earlier.

### **10. Footprint accounts make no distinction between land uses that are sustainable and those that are not.**

This is correct. But as mentioned previously changes in productivity due to unsustainable land use do appear in future estimates of biocapacity. If activities in one year lead to an increase in desertification, for example, then the bioproductive supply will decrease in subsequent years.

## Annex 2: Summary of current EF applications in Europe

### 1) *Global Footprints: A pilot project with 8 municipalities in the Netherlands 1999-2001*

**Project management:** 'De Kleine Aarde' ('The Small Earth'), a foundation/NGO and a national centre for sustainable lifestyles, since 1972

Address: Klaverblad 1, Boxtel, Holland. [www.dekleineaarde.nl](http://www.dekleineaarde.nl) for footprints  
[www.voetenbank.nl](http://www.voetenbank.nl)

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The cities of Amsterdam and The Hague calculated their footprints in 1997 and 1998 using different methods. Thus their results were not comparable, and a new project The Global Ecological Footprint developed using the method of William Rees and Mathis Wackernagel, Canada. The aim was to calculate the impact of lifestyles on the globe, expressed in hectares. Thus illustrating the limited carrying capacity of the earth and the necessity fair allocation of global resources of food, wood, energy etc.. The project separates between the consumption footprint per capita per year. and the production footprint of a municipality and looks forward to measuring footprints of products and services.

#### **Participating municipalities:**

<i>Bergen op Zoom (65.000 inhabitants))</i>	<i>Footprint 4,53 ha</i>
<i>'s-Hertogenbosch (130.000)</i>	<i>Footprint 4,62</i>
<i>Den Haag/The Hague (441.000)</i>	<i>Footprint 4,46</i>
<i>Leidschendam (37.500)</i>	<i>Footprint 4,73</i>
<i>Nieuwegein (63.000)</i>	<i>Footprint 4,73</i>
<i>Pijnacker (22.500)</i>	<i>Footprint 4,87</i>
<i>Wymbritseradiel (16.000)</i>	<i>Footprint 4,61</i>
<i>Zoetermeer (110.000)</i>	<i>Footprint 4,80</i>

#### **Cooperating partners:**

- *Foundation Boog, The Hague (mainly discussion partner)*
- *De Kleine Aarde (The Small Earth), Boxtel (project management)*
- *Thijs de la Court, Haarlem (model development)*
- *Van Hall Institute in Leeuwarden (calculations and model development)*

Financial support:

Dutch Ministry of Environment

Commission for International Cooperation and Sustainable Development

the Provinces Noord-Brabant and Zuid-Holland

the eight Municipalities

#### **Collection of data and calculation of the local footprints:**

It was hard to find local figures on local consumption. Even the data on energy use were hard to get. Therefore a national system of 5 income groups was used and combined with the consumption data of these groups. These were based on national

## The use of Ecological Footprint and Biocapacity Analyses as Sustainability Indicators for Sub-national Geographical Areas: A Recommended Way Forward: Annexes

investigations and available from the Dutch Central Bureau of Statistics (CBS) and the National Institute of Public Health and the Environment (RIVM). The estimated consumption was divided by global yields for the production, and thus a system was found that is comparable with the first footprint method developed by Wackernagel and Rees in Canada (1996). The method was applied during 1999 in 8 municipalities and the results are given above.

Another model for footprint calculations was applied in two of the municipalities (Bergen op Zoom and Nieuwegein) during 2000. This model is based on a representative poll, using a set of 13 specific consumption questions. The method results in slightly bigger footprints in both municipalities. That might depend on the use of recent, real figures on consumption, but also on the fact that the two methods are quite different.

Public campaigns using joint materials with quick footprint scans (10 min), discussions between representatives for the involved municipalities, lessons at secondary schools and discs for calculation of personal footprints (30 min) have also been introduced <[www.voetenbank.nl](http://www.voetenbank.nl)>.

Every aldermen and also every section of the local government, is responsible for a part of the total global footprint of the municipality. This information will be extended with ideas and examples for every section in order to show how the local government can provide a better infrastructure for the development of sustainable lifestyles.

### **Some conclusions**

- It is much easier to calculate the national and personal footprints than those of a city or town.
- Differences between footprints of cities and towns in the Netherlands are small, and the results may not pay the extra work to collect local data. Along with changes in the municipalities differences may, however, grow and thus motivate the extra work. It is quite possible to initiate local campaigns based on the national per capita footprint.
- The best combination for estimation of municipal footprints may be direct information on energy use from the energy companies and a limited poll using 10 crucial questions.
- We might need a European approach towards the energy companies to get the right of access to the energy consumption figures per year, for every quarter of cities and towns.
- A Walk of Fame project may be useful, including an exhibition and the calculation of footprints of 5 major groups of people, among them the members of the Dutch second chamber

## ***2) Local Ecological Footprint in Navarre & other experiences in Spain***

Departamento de Medio Ambiente, Territorio y Vivienda del Gobierno de Navarra (Spain).

May – November 2000

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<http://www.cfnavarra.es/MEDIOAMBIENTE/Indexnoflash.html>

# The use of Ecological Footprint and Biocapacity Analyses as Sustainability Indicators for Sub-national Geographical Areas: A Recommended Way Forward: Annexes

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## Geography and administration

The investigation was carried out in the Foral Community of Navarre, north of Spain, west of the Pyrenees. Area 1 million ha with mountains and humid climate. 530 000 inhabitants (1998). A dynamic, open economy based on industry with export of manufactured goods and an import of raw materials, intermediate goods and equipment. One of the most important among the 17 Spanish autonomous communities, with a *per capita* income some 16.3 percent above the Spanish average.

A local ecological footprint was estimated for the municipality of Tudela, the capital of Ribera Tudelana county, south Navarre, with 27 000 inhabitants.

Regional institution: Department of Environment, Land and Housing including the Local Agenda 21

Finance: Department Environment, Land and Housing, Section for Urban Environment (Mr. R. Tortajada), Department of Environment (Mr. J.I. Elorrieta, Mr. J. Marcotegui).

## **METHODS**

### **a) Data Collection for calculation of the EF of Navarre**

Information was obtained from interviews and forms sent to different administrations and institutions at local, regional and state level. Information was also compiled from and generated within the framework of the Environmental Audit of the municipality of Tudela (2000). The undertaking of this latter study also meant that interviews were carried out and that forms requesting information were sent to different administrations, supply companies and diverse organisations.

**Table 1. Main sources of information**

Institution	Information requested
Institute of Statistics of Navarre Government of Navarre	<ul style="list-style-type: none"> <li>- Import and export of products classified under the TARIC<sup>1</sup> and CNAE<sup>2</sup> codes</li> <li>- Demographic data</li> <li>- Economic structure of Navarre and Tudela</li> </ul>
Directorate General for Agriculture, Livestock and Food. Government of Navarre	<ul style="list-style-type: none"> <li>- Data on the production and productivity of the agricultural, livestock and forestry sectors</li> <li>- The total surface area covered by arable land and pastures</li> <li>- Forestry production and productivity</li> <li>- The distribution of land-use in Navarre and in the municipality of Tudela</li> </ul>
The Department of Industry and Labour. Government of Navarre	<ul style="list-style-type: none"> <li>- Consumption and energy production according to energy sources and sectors</li> </ul>
The Department of Public Works, Transport and Communications. Government of Navarre	<ul style="list-style-type: none"> <li>- Data on the structure of transport and traffic.</li> <li>- The surface area covered by transportation and communications infrastructures</li> </ul>
The Office for Territorial Wealth. Register Section for Territorial Wealth	<ul style="list-style-type: none"> <li>- Plots of industrial use and associated areas in the Catastro of Navarre and Tudela</li> </ul>
Energy supply companies	<ul style="list-style-type: none"> <li>- Energy consumption according to sources and sectors in the municipality of Tudela</li> </ul>
The Town Council of Tudela	<ul style="list-style-type: none"> <li>- The vehicle fleet of Tudela</li> </ul>
The National Statistics Institute. Government of Spain	<ul style="list-style-type: none"> <li>- Fish consumption</li> </ul>

### **b) Calculation methodologies**

The *per capita* consumption of the main categories of products were listed, and a combination of world and local productivity was used for calculation of the footprint components as previously made for Catalonia and Barcelona. An additional calculation was included using only world productivity.

The total ecological footprint was calculated according Wackernagel, M. and Rees, W. (1996), by summing up the *per capita* surface area required, classified under the

<sup>1</sup> TARIC: *Tarif Intégré Comunitaire*

<sup>2</sup> CNAE: *Código Nacional de Actividades Económicas* ('National Code of Economic Activities')

categories of ecologically productive land: arable land, pasture, forest, built-up land, energy and productive sea.

### c) Calculation of the local footprint in Tudela

Once the value of the ecological footprint was calculated for the region, the ecological footprint was estimated for the city of Tudela. An extrapolation of the regional profile on consumption was combined with specific calculations for certain consumptions: energy and build-up land – (see table 2).

Table 2: Productive Land and activities linked to the EF of Tudela

Productive Land	Activities				Total activities
	Food	Housing and Services	Traffic	Commodities	
CO2 absorption	0.1127	0.1690 <sup>3</sup>	0.5198 <sup>4</sup>	0.4584	<b>1.2600</b>
Built-up land		0.0331 <sup>5</sup>	0.0204 <sup>5</sup>	0.0038 <sup>5</sup>	<b>0.0572<sup>5</sup></b>
Arable land	0.5646			0.0000	<b>0.5646</b>
Pasture	0.1092			0.1331	<b>0.2423</b>
Forest				0.3933	<b>0.3933</b>
Productive sea	0.9873				<b>0.9873</b>
<b>Total Surface areas</b>	<b>1.7738</b>	<b>0.2021</b>	<b>0.5402</b>	<b>0.9886</b>	<b>3.5047</b>

### d) Strategies for reduction of the regional/local EF

The study proposed a series of strategies for the reduction of the ecological footprint in Navarre establishing two different scenarios.

### e) Some conclusions

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## The use of Ecological Footprint and Biocapacity Analyses as Sustainability Indicators for Sub-national Geographical Areas: A Recommended Way Forward: Annexes

There is limited availability of information on internal commerce and scarcity of information on consumption at a local level. There are problems to find local data on energy consumption, especially for traffic, and some extrapolations from regional data are necessary. The incorporation of more intense agricultural/forestry production systems at regional level – frequently with a greater environmental impact – can represent an apparent reduction of the ecological deficit.

The investigations in Navarre and Tuleda benefited, however, from big interest at the level of the local government and its Agenda 21, and several new and special investigations were available.

Similar conclusions have been drawn from footprint calculations in Catalonia/Barcelona, Andalusia/Seville, Balearic Islands, Basque Countries/San Sebastian

### **3) Experiences from local ecological footprint calculations in Finland**

Association of Finnish Local and Regional Authorities

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*The Association of Finnish Local and Regional Authorities* has made a free of charge calculation programme for Finnish municipalities for estimation of their Ecological Footprints (designed by consultant Mr. Niko Nyman).

Calculating Ecological Footprints at local level in Finland started in 1996 when seven municipalities were recruited to a pilot project and the basic method developed. First results came in early 1999. The present calculation programme was developed in 2000 (the EFs for the year 1995). The calculations are now updated for 1999.

There are results from ten municipalities with the cities/towns of

- Helsinki (551123) (inhabitants in parentheses)
- Espoo (209667)
- Tampere (193174)
- Vantaa (176386)
- Kuopio (86575)
- Mikkeli (46669)
- Kouvola (31614)

## The use of Ecological Footprint and Biocapacity Analyses as Sustainability Indicators for Sub-national Geographical Areas: A Recommended Way Forward: Annexes

- Riihimäki (26106)
- Hirvensalmi (2683), a municipality
- Ristiina (5185), a municipality

The cities of Joensuu (51514) and Kotka (55238). are in progress with their calculations.

### Method

The method used is based on two main phases: firstly the EF of an average Finn for a certain year is calculated using an Excel spread sheet. The sheet was originally received from Mathis Wackernagel and compared to the one used by him and Lillemor Lewan for Sweden. It is made even more detailed to suit Finnish circumstances. Besides being more detailed, some changes have been made

- national averages are used for footprints of consumption based on arable land, pasture and forest (those products which are not produced in Finland, such as coffee and rice, are of course calculated by global yields);
- the forest part of the ecological footprint is calculated in slightly different way (a detailed description in the annex);
- embodied fossil energy in net trade has been corrected to match the Finnish situation (50 % of the total embodied energy in net trade is fossil);
- the calculation is transparent concerning energy (all fossil, hydro, bio and nuclear energy are put together in the energy component of the EF);
- the footprint factor for nuclear power is not the same as for fossil fuel. One of the most powerful features of the EF is its connection to real biogeophysical processes. This is lost if the fossil fuel factor is used for nuclear energy;
- no sea area is included in the municipal footprints, because conceptually it is far from ecologically productive land. If a sea area is included, it also actualises some general problems of indexes.

In a second phase *local* data are being collected for built-up land and energy. For food consumption and commodities national averages are used (except build up land for commodities). Local differences in these categories are assumed to be so insignificant that gathering of local data is irrelevant. In other words, data related to built-up land for housing, traffic, commodities and services, energy consumption (except embodied energy in commodities) and existing ecological capacity are based on the local situation.

It has been possible to link the average Finnish energy consumption to different activities (food, housing, traffic, commodities and services) on the basis of some Finnish studies on total energy consumption in households and on primary energy consumption in Finland. Table 1 shows which of the EF components that are based on national averages (light grey) and which on local data. (dark grey). The national built-up land is not split into different activities because such information is not available at national level. Similarly, forest is not divided into housing and commodities.

**TABLE 1.** National averages (light gray) and local data (dark gray) used in local calculations of ecological footprints, year 1995.

Land use categories	Activities/consumption					Total
	food	housing	traffic	commodities	services	
energy	0,32	0,69	0,37	0,43	0,34	2,15
arable land	0,31			0,01		0,32
pasture	0,11			0,04		0,15
forest				0,47		0,47
built-up						0,25
Total	0,74	0,69	0,37	0,95	0,34	3,34

#### f.. Data collection and calculations

The Association of Finnish Local and Regional Authorities collects data for calculation of the EF of an average Finn. Local data are collected by the municipalities.

##### *Land use*

Detailed analyses are made in planned areas (industry and warehouses, traffic areas, technical services, sport areas, parks and recreation grounds, graveyards, etc) and approximations are used for e.g. , housing in rural areas. The calculation programme asks for data on the yields of arable land, pasture and forest. These data (besides local registers) can also be found in national master files.

##### *Energy*

Municipal energy consumption in road traffic can be obtained from the national LIISA-database. In principle this information base is not correct for the EF accounting, because the consumption is not the consumption of the inhabitants' but any consumption that takes place in the municipality. This is unfavourable for geographically large municipalities with a lot of through traffic. But it is the only information available. National averages are used for rail, waterborne and airborne traffic.

Local heating energy and electricity consumption data are given for power plants (export excluded), electricity from the national grid, regional heating and heating of individual buildings (residential buildings 150 kWh/flatm<sup>2</sup>/yr, others 30 % less, that is 110 kWh/flat m<sup>2</sup>/yr).

## The use of Ecological Footprint and Biocapacity Analyses as Sustainability Indicators for Sub-national Geographical Areas: A Recommended Way Forward: Annexes

For power plants the calculation programme asks for primary energy used (Gwh), share of different energy sources (% of coal, natural gas, oil, peat, wood chips, water power, wind and solar), share of heating and electricity power produced (%), and finally the share of consumption in housing, services and production (%). The figure for energy used in production is registered but not used, because it is embodied in commodities.

A different calculating method is suggested in an annex for the forest component of the EF (as compared to Wackernagel & Lewan)

### **Some conclusions**

Data for the municipal land use has been surprisingly difficult to get, especially for traffic areas. The situation is similar for yields of arable land, pasture and forest. Residents' energy use in traffic is not known. Liberalisation of the energy market causes problems with data concerning local energy consumption. Municipal EF calculations can stimulate municipalities to register and provide new kind of information and statistics. The EF calculation method can help to harmonize data gathering.

The calculation programme is relatively complex with a lot of factors and coefficients. This information and part of the data must be provided nationally, or internationally. Some coefficients need further elaboration, as land area needed for hydro and nuclear electricity (at the moment international averages have been used), land required for building lots in rural and also productivity in some animal based agricultural production.

## **4) Ecological footprint analysis of the Turin province, Italy.**

Project management: **Ambiente Italia**

Contact person:

### **Method**

The evaluation of the ecological footprint of Turin Province was carried out according to the original methodology of Wackernagel with adaptation to Italian circumstances. For each consumption good, all the resources incorporated in its production, use and disposal were considered. Energy and resources incorporated into the good therefore refer to the total amount of energy and/or matter used and released within the product's life cycle.

*The main consumption categories considered are:*

1. food;
  2. housing;
  3. transport;
  4. consumption goods,
  5. services,
- each of which can be further disaggregated.*

*Land use is classified as:*

- direct for specific biological production
- indirect for absorption of waste (green house gases).

Natural space appropriated is calculated on the basis of the real productivity levels of the area considered (productivity varies in fact remarkably with respect to both the level of economic efficiency and geo – climatic conditions).

### Land Use

For agricultural production the amount of land associated with the final product used in the area considered is calculated, irrespective of the place of production. In general , the land thus obtained can be seen as the combination of various components (see the following diagram):

- land associated to local production of raw materials (LL)
- land associated to the production of imported raw materials (IL)
- land associated to the production of exported raw materials (EL)
- land associated to the production of imported final products (IL)
- land associated to the production of exported final products (EL)

It should be noted that ***the only local information refers to raw materials production***, while all other items are connected to foreign trade<sup>6</sup>.

### AGRICULTURAL PRODUCTION RESOURCES' FLOWS

Agricultural production land (APL) is given by:

$$APL = [LL_r + (IL_r - EL_r)] + [(IL_f - EL_f)]$$

the above formula allows to calculate the hectares of land effectively used to meet consumption needs within the Province of Turin, considering consumption of both local and imported products.

Exports, on the contrary, are not included since the footprint only considers products consumed locally. On a national level, consumption of raw materials and final goods from agricultural production can be deduced from data on production and foreign trade [report 1, table 2a of the annex].

On a provincial level, data on total amount and yield per ha are only available for a few products [report 1, table 2a of the annex].

Where available, provincial data have been used; for the rest, national Italian data have been adjusted by means of a conversion factor equal to the ratio between consumption within the Province of Turin and national consumption. Thus one can obtain a proportionality factor (K) linking the average Turin Province inhabitant's consumption to that of the average Italian using data from survey carried out by Istat (Italian Institute of Statistics) on households behaviour in the various areas of Italy [Report 6, table 12 of the annex]:

The difference between consumption (estimated) and production (Istat data) makes it possible to evaluate whether production itself exceeds consumption or not. In the first case, the imported

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<sup>6</sup>It should further be noticed that a combination of the first three elements accounts for the portion of land needed to make the final good locally.

surplus footprint was added to that of local production<sup>7</sup>; in the latter, no addition was made to the footprint

Translating consumption amounts in kg into footprint hectares implies dividing the first by the relevant yields:

- local yields for the consumption of locally produced goods [Report 1, table 2b of the annex]
- Italian yields for Italian production data [report 1, table 1 of the annex]
- average global yields for imports [Report 1, table 2a of the annex]

In the case of average global yields – the degree of approximation due to use of global yield is evident. To reduce the error, the agricultural products that mostly affect footprint calculations have been identified and their origins traced. The most important geographical areas of origin have thus been traced (mainly Western Europe) for some of them (beef meat, sheep and pig meat, wool, milk, wheat and rye, animal based oils and fats, corn) and global average yield has been substituted with their specific average yield; this implied a significant change in the footprint final value.

Finally, we should allocate the direct land use footprint into the consumption categories that make up the final items of the total footprint (food, housing, transport, consumption goods, services).

Ambiente Italia has estimated the percentage codes weights for the contribution of each product, classified according to SITC (*Standard international Trade Classification*) for the various consumption categories. Once put into this allocation matrix, data on the footprint has been aggregated into four soil use categories: arable land, pasture, forest and sea.

The quota of built up land within the Province is also included in direct land use: this data has been deduced from the 1999 Land Coordination Plan, containing all General Regulatory Plans of the various Municipalities.

### **3.3 Indirect land use.**

As already mentioned, indirect land use is associated to carbon dioxide emissions (or equivalent carbon dioxide) characterising the whole life cycle of a product: its industry production (of an automobile or of a refrigerator, for example), its management (the functioning of the automobile or refrigerator) and its disposal.

#### **Industry production**

Industry production is associated to land use in terms of the carbon dioxide emissions caused by associated energy consumption.

The first step in determining associated land is therefore that of evaluating the overall energy required to obtain the final product, irrespectively of where the latter has been produced.

Conceptually, the procedure is similar to the one adopted for agricultural production. Here, though, flows of possible intermediate products are also taken into account.

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<sup>7</sup>An accurate estimate of the footprint associated to the imported surplus should distinguish between the quota of consumption goods with a national origin and the quota of those coming from outside national boundaries and subsequently use the different relative yields. Since this disaggregation was not available locally, an "average yield" has been estimated by means of weighed coefficients based on the percentage weight of imports on national consumption.

## **INDUSTRY PRODUCTION RESOURCES FLOWS**

In general, energy used can be seen as a combination of various elements (see the following diagram):

- Energy associated to local production of raw materials ( $LE_r$ );
- Energy associated to the production of imported raw materials ( $IE_r$ );
- Energy associated to the production of exported raw materials ( $EE_r$ );
- Energy associated to local production of intermediate products ( $LE_i$ );
- Energy associated to the production of imported intermediate products ( $IE_i$ );
- Energy associated to the production of exported intermediate products ( $EE_i$ );
- Energy associated to the local production of final products ( $LE_f$ );
- Energy associated to the production of imported final products ( $IE_f$ );
- Energy associated to the production of exported final products ( $EE_f$ ).

For production an exhaustive list of products could not be obtained; but information on the amount of labour units employed for each production item both on a national and on a provincial level is available [report 3 table 4 of the annex].

On the basis of the amount of local labour units and of Italian energy data, energy use of the local industry was estimated; such estimation was then normalised according to the effective data on provincial energy use, recorded by the Italian Ministry of Industry and Trade [report 3 table 7 of the annex].

Products disposal, both in landfills and incinerators, is accompanied by greenhouse gases emissions. Especially in the case of landfills, waste disposal implies a remarkable amount of methane, a gas characterised by a high global warming potential. Converting these substances into a carbon dioxide equivalent thus allows to calculate the wooded land needed for absorption, as already done for emissions from energy sources [report 5 table 11 of the annex].

### **5) Ecological footprint studies in UK**

Completed projects include:

Isle of Wight

Oxfordshire

Guernsey

Project management; Best Foot Forward. Guernsey study with Liverpool John Moores University. Isle of Wight Study with Imperial College, London.

All BFF footprints are calculated using a component footprint approach. They are derived using proprietary EcoIndex<sup>TM</sup> software. The method builds components 'bottom-up' using life cycle data, rather than relying on national trade data. Information is collated from local investigations and resource flow calculations. Thus the method is more integrated into other resource accounting techniques. Resource flow analyses are typically specified for the following key consumption areas:

- Materials and waste
- Direct energy use
- Passenger transport

The use of Ecological Footprint and Biocapacity Analyses as Sustainability Indicators for Sub-national Geographical Areas: A Recommended Way Forward: Annexes

- Freight transport
- Food
- Water (production of tap water, not purification of outlets)
- Built (degraded) land

These are broken down into numerous further components. Care is taken not to double count impacts.

The method has recently been adapted for consistency with the Living Planet Report National accounts. The components use global yields and equivalence factors. Local biocapacity is calculated in the same manner as the LPR. A detailed component model of the UK has been constructed which is consistent with the LPR 2000 results.

BFF have also developed a USA, European and Australian online footprint calculator which uses components calibrated to the LPR 2000 compound results (see [www.ecologicalfootprint.com](http://www.ecologicalfootprint.com)). This is a natural extension of earlier work on personal footprint survey tools; EcoCal (1996), EcoCal for Schools (1998), Personal Stepwise (2000). Versions of these can be downloaded from the Best Foot Forward web site.

The Isle of Wight and Oxfordshire studies can be downloaded from the internet at [www.bestfootforward.com](http://www.bestfootforward.com).

Ongoing regional studies include footprints for Wales, London ([www.citylimitslondon.com](http://www.citylimitslondon.com)) and Herefordshire .

The method is documented, with examples, in 'Sharing Nature's Interest' (Chambers, Simmons and Wackernagel 2000). See website [www.ecologicalfootprint.com](http://www.ecologicalfootprint.com) for details.

## **6) Ecological Footprint studies in Sweden**

Responsible institution A: Dept of Housing and Planning, Swedish EPA, mainly introductory experiments

Responsible institution B:

Project management: Researchers Folke et al.; Wackernagel-Lewan

The Carl Folke group focused the appropriation of land by cities in the Baltic drainage region and to some extent megacities in other areas. They showed that absorption of waste (carbon dioxide from fossil fuels, nitrogen and phosphorous from sewage treatment plants) demanded much more productive space than production of food and fibre for direct consumption. They also showed the huge areas demanded for production of feed for fish farming. There was a certain interest in these results and in the results of Wackernagel and Rees (1996) in the city of Stockholm, and an exhibition was arranged along with other environmental topics in the Natural history museum. But there was no real interest in the global situation. On the contrary focus was very much on the possibility of local supply of food, alternative energy (much biofuel) and recycling. Local studies employing the Wackernagel & Rees (1996) method were performed by consultants in connection with an EU Life supported project (SAMS –Planning with Environmental Goals, 2000) headed by the Swedish EPA and the National Dept of Housing and Planning.

## The use of Ecological Footprint and Biocapacity Analyses as Sustainability Indicators for Sub-national Geographical Areas: A Recommended Way Forward: Annexes

In the meantime research was initiated for investigation of the local ecological footprint of the population in a river drainage area in South Sweden using the possibility to include calculations of areas for production of tap water and for some purification of drainage water from farmland (Wackernagel, Lewan, Borgström-Hansson, Ambio 1999). The results were compared to the biocapacity in the river drainage area. Use of the compound method, which is based on the national ecological footprint, in local studies in the river drainage area made the calculation of a national footprint for Sweden necessary. That was by then not made. The result of this separate calculation of the mean Swedish ecological footprint was not quite in agreement with the later result on Sweden in the Footprint of nations study (Wackernagel et al. (1999) although the same method and the same factors were used. The difference was one ha unit area in the ecological footprint of Sweden and one ha in the biocapacity. Reasons for the different results were probably use of direct Swedish national statistics and use of statistics from a different year. Thus it was clear that the use of statistical sources is most important for the results of footprint studies.

One more aim of the studies in Sweden was to coordinate the footprinting analytical methods of the Carl Folke et al group in Stockholm/Sweden and the Wackernagel-Lewan group in Lund/Sweden. This was, however not fulfilled.

Footprinting analyses in Sweden show the development of widely different approaches and results, which are not possible to compare and are badly understood between groups. A summary report of methods used and results gained was issued by the Swedish EPA and the National Dept of Housing and Planning within the SAMS (see above) project (Lewan 2000, An English version for the internet is planned). The report includes results from studies of ecological footprints and available biocapacities in the southernmost administrative county, Skane and its around 30 municipalities/cities which were analysed in one series using the compound method (national footprint x population) for analysis of the ecological footprint. The results were compared to local biocapacities. The report also includes results on ecological footprints and biocapacities calculated in another series using the same method in eight municipalities/cities from different parts of the country including the very south and the very north..

The compound method is easy to apply once the mean national footprint is calculated. This should be calculated in one and the same series as for other countries using international statistics for one and the same year. With access to the Excel spreadsheet for a country including consumption analyses based on Trade Statistics (STCS codes) and the national energy budget. (Wackernagel et al. 1999; the Living Planet Report 2000), specialities for different cities/municipalities can be traced using official statistics and local investigations/surveys and corrections introduced. In our studies in Sweden we found only small differences between standard of living in different parts of the country. This was based on observations on car ownership, mileage of travelling, housing etc. More detailed studies of such differences in cooperation with national statistics experts are, however recommended. Comparison between the ecological footprint of the population in an area and the existing biocapacity is useful. It illustrates the local land use, and to what extent there is space for the activities demanded by the population. A

## The use of Ecological Footprint and Biocapacity Analyses as Sustainability Indicators for Sub-national Geographical Areas: A Recommended Way Forward: Annexes

discussion about possibilities to find extra space or to offer surplus productive space can be initiated among the public and in planning.

Ecological footprint and biocapacity calculations in municipalities/cities (ca 300 in Sweden) are recommended as one of several methods for judgement of sustainable development, but there is no ongoing national project. The local authorities are informed about the concepts/tools and one of the municipalities/cities involved in the above mentioned SAMS project would be a possible candidates in a future EU project using ecological footprints and biocapacities as sustainability indicators.

### **7) Experiences on Local Ecological Footprints in Norway [Western Norway Research Institute] and future plans**

Western Norway Research Institute is the leading research unit in Norway in the field of Ecological Footprint Analysis using the city of Stavanger as a study area (part of a local climate strategy process). Three different levels were used: the city, the household (a doctoral project) and the individual. The efforts are part of a larger project under the Norwegian Ministry of Environment individual. The studies are part of a project headed by the Norwegian Ministry of Environment for integration of global and local problems. Similar footprint calculations will also be carried out for the cities of Kristiansand and Oslo.

Additionally a new forthcoming project in Oslo will be conducted as a joint effort by the Western Norway Research Institute and ProSus (Program for Research and Documentation for a Sustainable Society/University of Oslo). The project is financed by both the Municipality of Oslo and the two research institutions, and is also meant to be included in a future European research project in the area of sustainable regional development and the use of indicators. Here only the methodological approach of the studies in Stavanger are presented.

Stavanger is the fourth largest city in Norway (approximately 110 000), County of Rogaland with an active Local Agenda 21 programme. The city has a small area - 70 km<sup>2</sup> - which makes it the most densely populated city in Norway. One objective is to find out how the Ecological Footprint methodology can be used in practice without too much effort on data collection.

The Western Norway Research Institute has focused on  
Wackernagel and Rees

- Best Foot Forward
- The Association of Finnish Local and Regional Authorities

with a preference for the Finnish approach, including both national averages and local data (especially for built-up land and direct energy consumption for heating and transport). National yields and productivity have been used, and the calculations include data based on national per capita assessments. The Western Norway Research Institute emphasises area consumption related to energy production and carbon binding.

#### **Footprint calculation for the city of Stavanger**

The consumption is grouped into five categories based on

## The use of Ecological Footprint and Biocapacity Analyses as Sustainability Indicators for Sub-national Geographical Areas: A Recommended Way Forward: Annexes

### Food:

- national averages for the indirect energy consumption and climate gas emissions related to the consumption of food
- national averages for the consumption of areas related to the production of food

### Housing:

- national averages for the indirect energy consumption and climate gas emissions related to the consumption of construction material for housing and furnishing
- local data for energy consumption (electricity, oil and fire wood)
- local data for housing area (floor space)
- local data for the household's share of the methane emissions from waste deposits

### Transport:

- local transport data for private cars (based on numbers of registered cars and county calculations for average driving distance) and local bus (data from the local transport companies)
- partly local data for air travel (national averages adjusted for county specific travel habits)
- national averages for transport by boat and railway

### Goods:

- national averages for the indirect energy consumption and climate gas emissions related to the consumption of fibres (with the exception of construction materials), paper, clothing, shoes, printed matter, leisure articles and services, and industrial areas

### Services:

- local data for energy consumption for heating in both private and public sector
- national averages for the indirect energy consumption and climate gas emissions related to the consumption of health services, postal and telecommunication services, hotels and restaurants, public administration and other services

### *Footprint calculations for households*

In the doctoral project for the household footprint the method is quite different. The main question is: *'How do differences in the physical living situation influence the 'housing related consumption'?*

A survey of a large number of households in Førde, Stavanger and Greater Oslo and case studies with in depth interviews were made. The ecological footprint of households in a whole range of situations in the three cities were calculated.. The following data were included:

- Energy use for housing (heating and household appliances)
- 'Material housing consumption' (rebuilding, redecorating and indoor/outdoor housing commodities)
- Transport
- Everyday travels
- private car
- public transport
- Irregular leisure and vacation travels
- private car

## The use of Ecological Footprint and Biocapacity Analyses as Sustainability Indicators for Sub-national Geographical Areas: A Recommended Way Forward: Annexes

- air travel

### *Individual footprint calculations*

For the individual footprint calculations, more or less the same categories as for the Stavanger footprint calculation were used.

For the Stavanger 'climate/footprint calculator' see the 'Environmental Home Guard' (Miljøheimet) <http://www.webskjema.no/miljokalk/>).

### **Annex 3: The Ecological Footprint of Santiago de Chile**

(Full reference: Wackernagel, M. (1998) The Ecological Footprint of Santiago de Chile, Local Env Vol. 3 No 1, p 7-25. Revised Version June 11 2001 Redefining Progress, Oakland, CA USA [www.rprogress.org](http://www.rprogress.org))

The methodology used in the above paper is summarised here as it is one of the few published studies which shows how National FoN data can be adapted for use at the SGA level using the capital of Chile, Santiago de Chile as an example.

Calculations for the National EF and BC of Chile are listed in the FoN and LPR reports and, as for other nations, an Excel data spreadsheet is available from the Redefining Progress web site ([www.rprogress.org](http://www.rprogress.org)).

For comparison of the national and local consumption patterns and estimation of SGA footprints a consumption x space use matrix was constructed. Then the consumption data, energy budget and consequent demands of space categories in the national EF are reallocated into human activities like housing, transports, etc. which are more easily connected to lifestyles and thus more easily compared and adjusted to local circumstances. For the whole country the reallocation of consumption data into human activities must not change the total result, i.e. the average EF for Chile, 2.4 ha. Specific adjustments for Santiago de Chile resulted, however, in an EF of 2,6 ha, see Table 1 below.

Good local information was not readily available in the case of Santiago de Chile. The data in the Table below are rough estimates mainly based on official information from ICLEI South America, and thus the study results do not claim to give a complete picture. Generally wood consumption was lower in the Santiago SGA as compared to Chile. All other consumption such as food and energy was higher in the capital.

In the Santiago study it was also suggested that the footprint might change by income group ranging from 0.4 ha per capita for the 10% of the population with lowest income to 12 ha for the 10% with highest income.

Table 1 shows the 'space use' or component matrix used for Santiago de Chile. The population of the Santiago Metropolitan Area was 4 756 663 in 1992. The total area is 791 581 ha of which 701 619 ha was protected natural area, 41 215 built upon land and 48 747 ha planned or agricultural land.

**TABLE 1: Consumption – space use matrix for the average citizen of Santiago de Chile in hectares.**

	<b>fossil energy</b>	<b>built-up area</b>	<b>arable land</b>	<b>pasture</b>	<b>forest</b>	<b>sea</b>	<b>Total</b>
<b>Food</b>	<b>0,11</b>		<b>0,35</b>	<b>0,75</b>		<b>0,24</b>	<b>1.45</b>
.vegetarian	?		0,32				0,32
.animal products	?			0,75		0,24	0,99
.water			0,03				
<b>Housing and furniture</b>	<b>0,04</b>	<b>0,01</b>			<b>0,11</b>		<b>0,16</b>
<b>Transport</b>	<b>0,25</b>	<b>0,00</b>			<b>0,04</b>		<b>0,29</b>
.road	0,18						0,18
.rail	0,00						0,00
.air	0,02						0,0
.coastal and waterways	0,04						0,04
<b>Goods</b>	<b>0,43</b>	<b>0,00</b>	<b>0,15</b>	<b>0,07</b>	<b>0,09</b>		<b>0,74</b>
.paper production	0,18				0,09		0,27
.clothes (non-synthetic)	0,00		0,02	0,07			0,08
.tobacco			0,13				0,13
.others	0,25						0,25!
<b>Total</b>	<b>0,83</b>	<b>0,02</b>	<b>0,49</b>	<b>0,82</b>	<b>0,24</b>	<b>0,24</b>	<b>2.64</b>