Potential of the Ecological Footprint for monitoring environmental impacts from natural resource use

Analysis of the potential of the Ecological Footprint and related assessment tools for use in the EU's Thematic Strategy on the Sustainable Use of Natural Resources

Report to the European Commission, DG Environment
EXECUTIVE SUMMARY

May 2008

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Suggested citation:
Best, Aaron, Stefan Giljum, Craig Simmons, Daniel Blobel, Kevin Lewis, Mark Hammer, Sandra Cavalieri, Stephan Lutter and Cathy Maguire. 2008. Potential of the Ecological Footprint for monitoring environmental impacts from natural resource use: Analysis of the potential of the Ecological Footprint and related assessment tools for use in the EU's Thematic Strategy on the Sustainable Use of Natural Resources. Report to the European Commission, DG Environment.

Executive Summary

Providing for the well-being of a growing human population within the limits of a finite planet is a key challenge for our future. Many people still need more natural resources just to meet basic needs. Yet many of nature's life support systems are already overburdened. To maintain and improve long-term human well-being, societies will have to reduce the environmental impacts of resource use and also use resources more efficiently. Due to their high levels of economic development and resource consumption, industrialised countries such as those of the EU share a special responsibility and opportunity for addressing these challenges.

In the Lisbon Strategy and the renewed Sustainable Development Strategy, the European Union recognised that using resources more efficiently is crucial for the economic development of the EU, for the European environment, and for a positive role of the EU in the world. Increasing energy and resource efficiency of the EU can accelerate innovation, create jobs, increase competitiveness and improve the state of the environment. But how far does Europe need to go? Certainly, there can be no sustainable development in the EU without reducing human demand on global natural resources. A main strategy is enhancing resource efficiency. Progress in industrialised countries therefore needs to be measured against the ability to increase resource productivity and decrease the demand for natural resources.

Objective of this study

The main aim of this study is to guide the development of indicators as called for in the EU's Thematic Strategy on the Sustainable Use of Natural Resources[1] (referred to shorthand as "Resource Strategy"). More precisely, the intended focus is on resource-specific indicators to evaluate the environmental impact of resource use.

The study should give input to further work on these indicators by the Data Centre on Resources hosted by Eurostat[2], in collaboration with the Joint Research Centre (JRC), in particular the European Platform on Life Cycle Assessment[3], and the European Environment Agency (EEA)[4], in particular the Topic Centre on Sustainable Consumption and Production[5].

This study is an evaluation of the Ecological Footprint indicator, including the specific advantages and shortcomings of the Ecological Footprint. The study also assesses how the Ecological Footprint could best be combined with other tools to meet the EU's desired monitoring objectives. The evaluation consists of three main tasks:

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1 COM (2005) 670 final.

2 http://ec.europa.eu/eurostat, In particular see Environmental Accounts: http://epp.eurostat.ec.europa.eu/portal/page?_pageid=2873,63643317,2873_63643793&_dad=portal&_schema=PORTAL

3 http://lca.jrc.ec.europa.eu

4 http://www.eea.europa.eu/themes/waste

5 http://waste.eionet.europa.eu/

1. An assessment of the potential of the Ecological Footprint as an aggregated indicator to measure resource-specific impacts as called for in the Resource Strategy.

2. An assessment of how other assessment tools and derived indicators can complement the Ecological Footprint in combination to fulfil EU policy requirements (e.g. through development of a basket of aggregated indicators capable of monitoring the environmental impact of natural resource use).

3. Identification of essential near-term improvements needed in the Ecological Footprint and the indicators in the basket of indicators (over the next 1 to 5 years).

Policy context

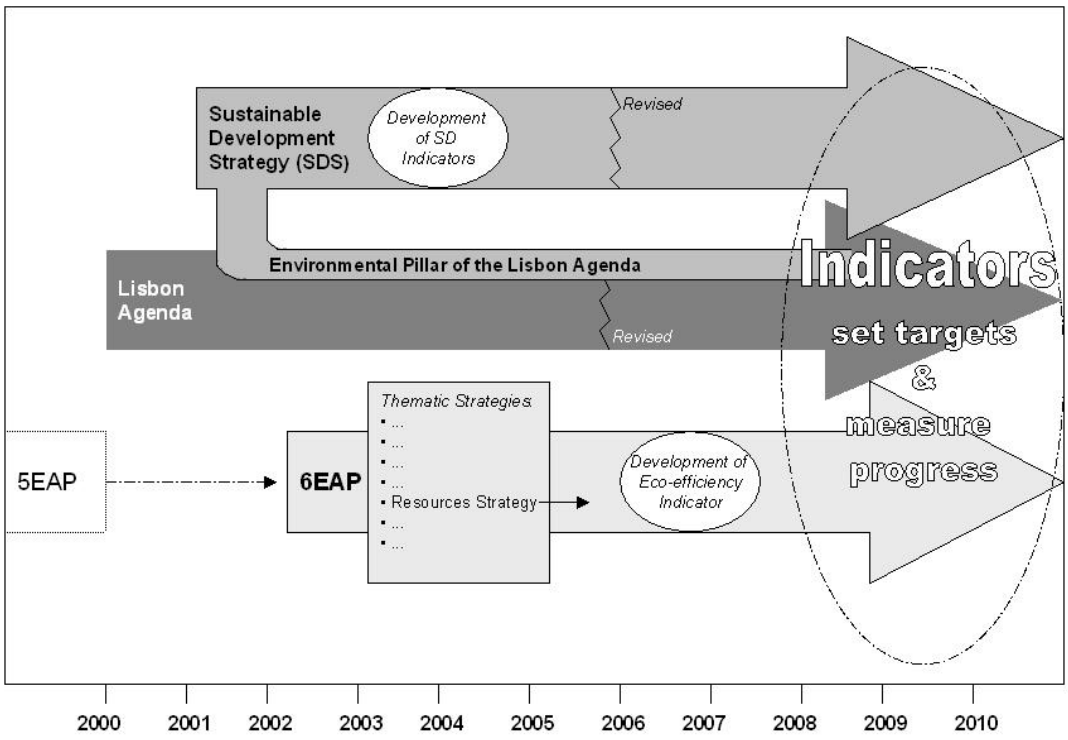
The EU's resource policies aim to reduce environmental impacts through the sustainable use of natural resources. Both the EU's 2001 Sustainable Development Strategy (SDS) (renewed in 2006) and the 2005 Resource Strategy build on the goal of sustainable development through the decoupling of economic activity from environmental impacts by considering the entire life cycle of resource use.

Underscoring the need for this decoupling is the fact that EU policy is also committed to the continued economic growth in the EU. In March 2000, the Lisbon European Council agreed the Lisbon Agenda, which aims at increasing competitiveness and employment within the EU. The Lisbon Agenda as initially formulated came under criticism due to a lack of consideration for the environment in its socio-economic goals. At the June 2001 Gothenburg European Council, the European Commission adopted the Sustainable Development Strategy (SDS), which provides an environmental pillar to the Lisbon Agenda. The revised goal for the Lisbon Agenda is to focus primarily on job growth until 2008, after which the policy will be reviewed. The revised SDS sets enhanced objectives and action items for seven key priority areas and proposes ways to improve government co-ordination. The revised SDS will be reviewed every two years, beginning in 2007, to monitor progress towards its goals.

Both the SDS and Resource Strategy cite a lack of suitable indicators as a key challenge to setting targets and measuring progress on global resource impacts. Thus, both strategies propose that indicators be developed that consider the entire life cycle of resource use to achieve the overall objective of decoupling economic activity from environmental impacts.

The figure below illustrates the relationships among the different EU natural resource policies over a ten-year period beginning in 2000. Each of the policies is shown in a different arrow with a policy timeframe that extends beyond 2010.

Figure I: Relationships among the EU's natural resource policies: 2000-2010



The basket of indicators

After extensive evaluation in this study, the following four aggregate indicators were found suitable as complementary tools capable of monitoring the environmental impact of natural resource use: Ecological Footprint (EF), Environmentally Weighted Material Consumption (EMC), Human Appropriation of Net Primary Production (HANPP) and Land and Ecosystem Accounts (LEAC). It should be clarified that three of the four elements of the basket (EF, EMC, HANPP) are indicators or indices, while LEAC is an accounting framework from which aggregated indicators can be derived. As LEAC-based indicators are currently only under development, we decided to include the overall framework in the basket.

The selection of those four tools and related indicators is based on the current state of the art. The Resource Strategy defines the ultimate objective to develop one aggregated indicator, illustrating the environmental impacts related to resource use with a single score. Therefore, future efforts will be devoted to the analysis of overlaps among the different indicators and their further development and extension. This might allow integration of some of the components in the basket (in particular, the Ecological Footprint with indicators based on life cycle analysis such as EMC) and thus reduce the number of indicators in the basket.

Ecological Footprint (EF). The Ecological Footprint measures how much biologically productive land and water area is required to provide the resources consumed and absorb the wastes generated by a human population, taking into account prevailing technology. The annual production of biologically provided resources, called biocapacity, is also measured as part of the methodology. The Ecological Footprint and biocapacity are each measured in *global hectares*, a standardised unit of measurement equal to 1 hectare with global average

bioproductivity. This study only evaluated the EF methodology used at the national level (and did not evaluate subnational applications).

Environmentally Weighted Material Consumption (EMC). EMC is a weighted indicator of material consumption based on environmental impacts. It currently is the most advanced indicator capable of illustrating how data on material flows (for example, data included in the indicator Direct Material Consumption, DMC) can be linked with information on the life-cycle wide environmental impacts of these materials, derived from Life Cycle Assessment (LCA) (Oers et al., 2005). EMC estimates the environmental impacts of materials throughout a product's life cycle. The underlying data for the EMC overlaps with that of the Ecological Footprint to some extent but unlike the Footprint's expression in a single spatial unit (global hectares), the EMC combines a set of specific impact indicators (e.g. CO_2 emissions, land use) that are then aggregated using weighting factors. Environmental issues not captured by the Ecological Footprint are included in the EMC, including the human-health and eco-toxicity impacts of certain materials, and the issues of ozone depletion, eutrophication, and acidification.

Human Appropriation of Net Primary Production (HANPP). HANPP is a measure of human use of ecosystems and can be defined as the amount of terrestrial net primary production required to derive food and fibre products consumed by humans, including the organic matter that is lost during the harvesting and processing of whole plants into end products. HANPP is complementary to the Ecological Footprint as it measures how much bioproductivity is appropriated in a given territory, whereas the Ecological Footprint measures how much biocapacity a country utilizes wherever that biocapacity is located in the world (Haberl et al., 2004). HANPP can thus illustrate the "depth" of the Footprint by tracking how intensively given ecosystems are being harvested.

Land and Ecosystem Accounts (LEAC). LEAC is a method developed and used by the EEA to account for the interactions between nature and society on the basis of a detailed grid (1km x 1km) for land use and land cover changes within the European Union. It is based on CORINE land cover data and its goal is to provide information on land cover and related land use changes. Within LEAC, ecosystem accounts incorporate material and energy stocks and flows, health of ecosystems counts and ecosystem services measurements. The ultimate goal is to measure the resilience of natural capital, its services and maintenance costs. As an example indicator derived from LEAC, we selected "land cover change" for the illustration of the basket in this report.

EF and EMC can be applied on the national, regional, sectoral as well as on the product level.[6] Although there are current efforts to calculate HANPP of products, both HANPP and LEAC are mostly used for analysing land use-related impacts of regions or countries. It shall be emphasised that HANPP and LEAC thus differ from EF and EMC, as the former do not include aspects of burden shifting related to international trade of goods and services. Therefore, HANPP and LEAC in general do not include life-cycle aspects related to the production and use of products.

HANPP and LEAC focus on issues related to land cover and land use and their changes over time. Also EF and EMC cover land use-related impacts; however, the latter two

[6] The report at hand, however, focuses on their national application and methodology of the Ecological Footprint.

approaches do not provide geographical specifications of these impacts, i.e. do not inform, where exactly those impacts take place. For some key policy areas, geographically explicit indicators are required, which explain the land-related impacts of natural resource use in specific regions or countries. These policy areas include urban planning, regional planning (in particular, of infrastructure) and ecosystem management and protection, with the particular issue of how resource use impacts on biodiversity. These questions cannot be addressed (only) with product-related approaches; therefore HANPP and LEAC are suggested to be included in the basket.

Table I provides a summary of the key aspects related to each tool in the basket.

Table I: Basket of tools / indicators – summary of key aspects

Tool	Main issues addressed	Covered impact categories *	Complementary property in basket	Data requirements	Strengths	Limitations and weaknesses
EF	How much of the regenerative capacity of the planet is occupied by a given human activity or population? In which countries is biocapacity located?	Resource consumption (Climate change) (Land use) (Impact on ecosystems and biodiversity)	Provides clear benchmark for assessments of carrying capacity and overshoot. Allows assessing the impacts of natural resource use on the regenerative capacity of ecosystems.	Data on material flows, land use and CO_2 emissions. Conversion factors for transformation of resource and waste flows into necessary biocapacity to sustain flows (measured in global hectares)	Integrates all resource use in terms of demand on regenerative capacity. Allows relating human demand to supply by nature and determining clear target. Considers trade flows (incl. embodied energy). Based on a clear research question.	EF cannot cover impacts for which no regenerative capacity exists (e.g. pollution in terms of waste generation, toxicity, eutrophication, etc.). EF shows pressures that could lead to degradation of natural capital (e.g. reduced quality of land or reduced biodiversity), but does not predict this degradation.
EMC	What is the global environmental impact potential of materials consumed in a national economy and where does it occur in the production and recycling of materials?	Climate change Human health (Land use) Stratospheric ozone depletion Eco-toxicity Photo-oxidant formation Acidification Eutrophication Ionizing radiation	Covers impacts independent from absorption capacities, such as human health and eco-toxic impacts of certain materials or issues of ozone depletion, eutrophication, acidification, etc.	Material flow data / production and trade statistics. Data on life-cycle wide emission inventories and environmental impacts of different materials.	Comprehensive measure based on biotic and abiotic resource accounts. Covers a large number of LCA impact categories. Includes direct trade flows and life-cycle wide impacts associated with these flows.	Not an accounting approach, but an aggregate of separate assessments. Subjective weighting involved to calculate aggregated indicator. No endogenous definition of benchmarks / sustainable levels.
HANPP	How intensely are ecosystems being used by human beings?	(Impact on ecosystems and biodiversity) Land use	Relates material flows (biomass extraction) to pressures on ecosystems. Monitors the intensity of ecosystem and land use and establishes links to natural capital deterioration (e.g. soil erosion) and pressures on biodiversity.	Agricultural and forestry statistics and inventories, land use statistics, remotely-sensed (satellite) data.	Provides an illustrative and spatially explicit indicator on human pressures on ecosystems. Can serve as early warning indicator for land degradation and pressure on biodiversity.	No endogenous definition of benchmarks / sustainable levels. No consideration of trade and trade-related demand on biosphere.
LEAC	For which economic activities are different land areas being used? Which are the socio-economic drivers for land cover changes?	(Impact on ecosystems and biodiversity) Land use	Links land cover change to socio-economic (sectoral) aspects of land use. Assesses spatially explicit consequences of resource use for land cover change.	Remotely-sensed (satellite) data. Data on net primary production. Demographic data and spatially distributed economic data.	Provides a SEEA-compatible account for impacts of resource use on land cover and land use and changes over time. Bridges with monetary valuation of ecosystem services and maintenance costs of ecosystems.	Sectoral information (in particular, industry and service sectors) very aggregated. No endogenous definition of benchmarks / sustainable levels. No consideration of trade.

* Note: Brackets indicate that impact category is only partly covered.

Key findings of the study

Key findings: Ecological Footprint (*National Footprint Accounts only*)

The Ecological Footprint could be an effective indicator for assessing and communicating progress toward the policy objectives of the EU's Resource Strategy. National data can be aggregated at EU scales, disaggregated to understand key drivers, and used to track long-term changes in how resource use relates to carrying capacity. The EU could also capitalise now on a 'window of opportunity' by participating in efforts to make the indicator more robust through independent third party review, methodological improvements, and the development of a collective database for resource use, furthering and relating to the ongoing efforts for a European Reference Life Cycle Data System. These efforts to improve the Ecological Footprint could also benefit the development of complementary indicators.

Key additional findings regarding the Ecological Footprint are:

- The Ecological Footprint is a useful indicator for assessing progress on the EU's resource policies and is unique among the reviewed indicators in its ability to relate resource use to carrying capacity.
- The Ecological Footprint is an intuitively appealing indicator (easy to communicate and understand with a strong conservation message). The indicator is most effective, meaningful and robust at aggregate levels (national and above).
- Further improvements in data quality, methodologies and assumptions are required. There remains a lack of transparency regarding certain aspects.
- A strong stakeholder network has emerged around the indicator, and opportunities exist for public sector involvement to develop and refine the methodology.
- This study identified a short/medium term research agenda for the Ecological Footprint (National Footprint Accounts methodology). The final research agenda is compiled of 9 research proposals, which focus on the top issues identified by experts as needing further development.

Key findings: basket of indicators

The main objective of analysing the various resource-related indicators was to identify those methods and indicators which could best complement the Ecological Footprint in assessing and monitoring the environmental impacts of natural resource use.

RACER evaluation performed for 13 potential tools and indicators. Out of a list of 25 methodological approaches that were initially identified as potentially relevant for the purpose of this study, the project team selected 13 approaches, for which a detailed RACER[7] evaluation was performed. Results of the RACER evaluation, which were summarised

[7] RACER is an acronym for the criteria on which the indicators were evaluated (**Relevant**– i.e. closely linked to the objectives to be reached; **Accepted** – e.g. by staff, stakeholders; **Credible** for non experts, unambiguous and easy to interpret; **Easy** to monitor (e.g. data collection should be possible at low cost); **Robust** against manipulation and error.

through indicative numerical scores, revealed significant differences in the overall quality and suitability of the different approaches for the respective purpose.

The suggested basket contains four complementary tools. The tools included in the basket were selected through a set of three main criteria: policy relevance, high ranking in the RACER evaluation and completeness/complementarity. Four tools and related indicators passed all criteria and were therefore suggested to form the basket of indicators: Ecological Footprint (EF), Environmentally-weighted Material Consumption (EMC), Human Appropriation of Net Primary Production (HANPP) and Land and Ecosystem Accounts (LEAC). These four tools and related indicators all scored high in the RACER evaluation, in particular with regard to the criterion of policy relevance. Applied as a basket, these four tools are comprehensive regarding the coverage of a large number of different environmental impacts. At the same time, they are complementary and each impact category is well covered by (at least) one of the tools. (Impacts on biodiversity and ecosystems are the only category, which is only indirectly covered. For this impact category, development of robust indicators is still ongoing.) The RACER evaluation of the whole basket of tools delivered higher scores for the basket than for any single approaches.

The basket allows monitoring the impacts of a wide range of policies. The identified basket of tools can be applied to monitor de-coupling of economic growth from environmental impacts as well as illustrating the effectiveness of a number of specific policies aiming at a more sustainable use of natural resources. Main policy fields covered by the basket are energy and climate policies, agriculture and forestry policies, material policies and spatial planning/urban planning. The main deficits regard missing information about the geographical distribution of pollution impacts as well as the impacts on ecosystems and biodiversity. To capture the regional and local impacts, indicators from the basket (in particular, EMC) must be combined with other data, for example on the exposure to pollutants in cities and industrial regions or with data from health statistics.

Table II: Summary of policies that can be addressed by the basket of indicators

Tool	Policy area / issue	Examples
EF	**De-coupling:**	
	De-coupling of economic growth from demands on biosphere	Measuring “overshoot” and countries’ ecological deficit; comparing human demand against local and global ecological supply (‘carrying capacity’)
	Sectors:	
	Energy and climate	Impacts of changes in energy supply structure on land appropriation and CO_2 emissions
	Agriculture and forestry	Conventional vs. organic farming; trade-offs between renewable energy sources and land availability
	Other policies:	
	Sustainable household consumption	Informing consumers regarding resource impacts of household consumption

Tool	Policy area / issue	Examples
EMC	**De-coupling:** De-coupling of economic growth from impacts on the natural environment and human health	Aggregated de-coupling indicators as called for by the Resource Strategy.
	Sectors: Agriculture	Impacts of production of agricultural production, in particular animal products
	Products and services (including materials)	Identifying materials' production and energy carriers' use with highest impacts along life-cycle
	Energy and climate	Impacts on GHG emissions of changes in energy supply structure
	Other policies: Sustainable production / cleaner production	Changes in environmental impacts due to substitution of materials, e.g. composite materials vs. metals
HANPP	**De-coupling:** De-coupling of economic growth from intensity of ecosystem use	
	Sectors: Agriculture and forestry	CAP policies to de-intensify agricultural production
	Other policies: Biodiversity (indirectly)	Increasing ecosystem exploitation through intensified agriculture and related loss of (forest) ecosystems
LEAC	**De-coupling:** De-coupling of economic growth from undesired land cover change	Increase of built-up land, extension of intensive agriculture for biofuels production
	Sectors: Agriculture and forestry	Land cover changes between agricultural, pasture and forest areas
	Other policies: Land use management and urban planning	Policies to moderate urban sprawl and related fragmentation of landscapes.
	Biodiversity (indirectly)	Conservation of protected and non protected ecosystems

Key recommendations

Key recommendations: Ecological Footprint (*National Footprint Accounts only*)

The following are key recommendations for EU institutions and policy makers to use in considering how to implement the Ecological Footprint within the current indicator framework.

1. **Combine with complementary sustainability indictors.** The Ecological Footprint is designed to measure a specific aspect of sustainability (i.e. human demand for renewable resources for production and consumption as compared to available biocapacity). It is not designed to comprehensively measure overall sustainability. Therefore, many aspects of sustainability are missing from the calculation that should be covered by complementary indicators. This is further explored in Task 2 within the project (Final Report Part III).
2. **Use within the Sustainable Development Indicator (SDI) framework.** The Ecological Footprint should be used by EU institutions within the Sustainable Development Indicators (SDI) framework. The SDI framework consists of 155 indicators organised hierarchically to measure 10 broad sustainability themes. It was created by the SDI Task Force in order to monitor the implementation of the Sustainable Development Strategy and was adopted by the European Commission in 2005. The SDI framework currently lacks a measure of global carrying capacity, and the Ecological Footprint can provide a measure of biocapacity with respect to human demand. Thereby it could add an important missing element to the SDIs, specifically with respect to Theme 6 “Production and consumption patterns”.
3. **Join the effort to improve the EF methodology.** Global Footprint Network and its partner organisations are dedicated to improving the Ecological Footprint. This includes developing standards, identifying higher quality data and refining the calculation to increase transparency and reproducibility. In order to ensure objectivity in the methodology, EU institutions should partner with Global Footprint Network to ensure that its criteria are met and that the Ecological Footprint can be a useful indicator at the European level.
4. **Develop and use highest quality data.** Resources are required to improve data quality at all levels of government. While this recommendation is not specific to the Ecological Footprint, it is important that resources for data collection and management be dedicated in order to measure all aspects of resource use (i.e. fisheries) to accurately identify sustainability targets. In addition, it is important that different data sources link together. For example, if the system of National Footprint Accounts was compatible with the UN System of National Accounts, it would be possible to link the aggregate Ecological Footprint with GDP. Presenting these two indicators together could help further communicate the problems related to overuse of natural resources (Giljum et al. 2007).
5. **Dedicate resources for implementation and require third party review.** In addition to dedicating resources to improve the data quality and methodology of the Ecological Footprint, resources are also required to implement the Ecological Footprint at the EU level. The quality of the National Footprint Accounts would need to be consistent with national data and experts will be needed to draw data related to policies and progress toward sustainability targets. Findings from the Ecological Footprint could be bolstered by

independent third party review, which would enhance data accuracy and credibility. Third party reviews have already been done in Ireland, Finland and Switzerland.

6. **Explore further possibilities to derive meaningful and easily understood indicators from National Footprint Accounts.** It has become clear from the analysis of the Ecological Footprint that while a nation's total Footprint can serve as a valuable headline indicator, the underlying account system provides a great deal of information that could be used to provide more specific guidance to policies. However, at present, much of such information is "hidden" in the calculation tables. An effort should be made to explore the possibilities to convert the available data into easily understood indicators that could guide sectoral policies, e.g. by assessing the sustainability of trade flows for certain groups of products.

Key recommendations: basket of indicators

1. **Apply basket instead of single indicators**. The use of natural resources entails a large number of different environmental impacts. These range from pressures on the planet's overall biocapacity, impacts on land, ecosystem functions and biodiversity, impacts on climate, to the release of different forms of emissions and pollutants, which effect health of humans and ecosystems. One single tool or indicator is unable to illustrate the complexity of these impacts and their interrelations, in particular, regarding burden shifting between different types of impacts. Applying a basket of tools allows monitoring the spectrum of environmental impacts from different perspectives. Each tool is constructed to illustrate particular environmental impacts in a consistent and robust manner. A basket of tools and related indicators thus produces results of higher quality than one single aggregated indicator, which aims at covering all impact categories.

2. **Dedicate resources to further improve the basket**. All four tools suggested for the basket are of high relevance for the objectives of the Resource Strategy and improvement of the quality of results is one key task. The main priorities for improving the Footprint are formulated in Annex 1: *Agenda for short/medium term improvements to the basket and its individual indicators: The Ecological Footprint*. As the EMC is the tool in the basket that covers the largest number of impact categories and applies life-cycle assessment (LCA) as one key approach to measure environmental impacts of products, further improvement of EMC and related LCA approaches should receive high priority. EMC requires particular improvement regarding the calculation of the amounts of different materials being consumed in a national economy as well as increasing the transparency and quality of the factors representing the life-cycle wide impacts of different materials. Priority focus in improvement of HANPP should be put on increasing data quality regarding potential and actual net primary production as well as application of land cover and land use data from LEAC to calculate a detailed HANPP indicator for Europe. The main objectives for future improvement of the LEAC system are to increase availability of data on land use for socio-economic purposes corresponding to certain types of land cover as well as to further develop macro-indicators regarding human pressures on land cover change and ecosystem integrity. Some of the indicators in the basket partly overlap in their coverage (e.g. energy use and greenhouse gas emissions play an important role both in the EF and in EMC). Further development of the different

tools and indicators should thus aim at integrating some of the suggested indicators in the basket and thus reduce their number.

3. **Create joint data infrastructure on the European level**. The four tools suggested for the basket could significantly profit from the creation of joint and harmonised European databases. The three currently established data centres on natural resources, waste and products at Eurostat will play a key role with this regard. These data centres should develop into the core data provider on extraction, production, trade and consumption of different materials and products for the calculation of combined indicators on the impacts of material consumption.
4. **Cooperate closely with the LCA community**. It is recommended to carry out all future efforts to improve the LCA-oriented indicators in the basket in close cooperation with the Joint Research Centres' *European Platform on Life Cycle Assessment* and other institutions in the LCA community. In particular, the currently established European Reference Life Cycle Data System at the JRC should be continued as the main provider of consistent and quality-proved information on life-cycle wide impacts of different materials and products.
5. **Feed in project results into Eurostat Task Force on Impacts**. In 2007, Eurostat initiated a Task Force on Impacts, with the explicit objective to develop indicators for monitoring the objectives of the Resource Strategy. Apart from defining long-term, strategic objectives for further research and data compilation, the Task Force has the mandate to quickly conclude on recommendations for indicators, which could already be applied in 2008. It is recommended that the results of this project are fed into ongoing discussions in the Task Force as one suggestion, how existing indicators informing about environmental impacts could be applied in the short run.
6. **Create a joint data infrastructure**. The four tools suggested for the basket could significantly profit from the creation of joint databases on the European level. The following table illustrates the data requirements necessary for the calculation of indicators derived from the four tools.

Table III: Data requirements for calculating the different indicators in the basket

Data	EF	EMC	HANPP	LEAC
Production and consumption of materials and products	X	X	X	
Life-cycle wide environmental impacts of materials and products		X		
Generation of emissions and waste	X	X		
Land cover / Land use	X	X	X	X
Productivity of ecosystems / Biocapacity	X		X	X

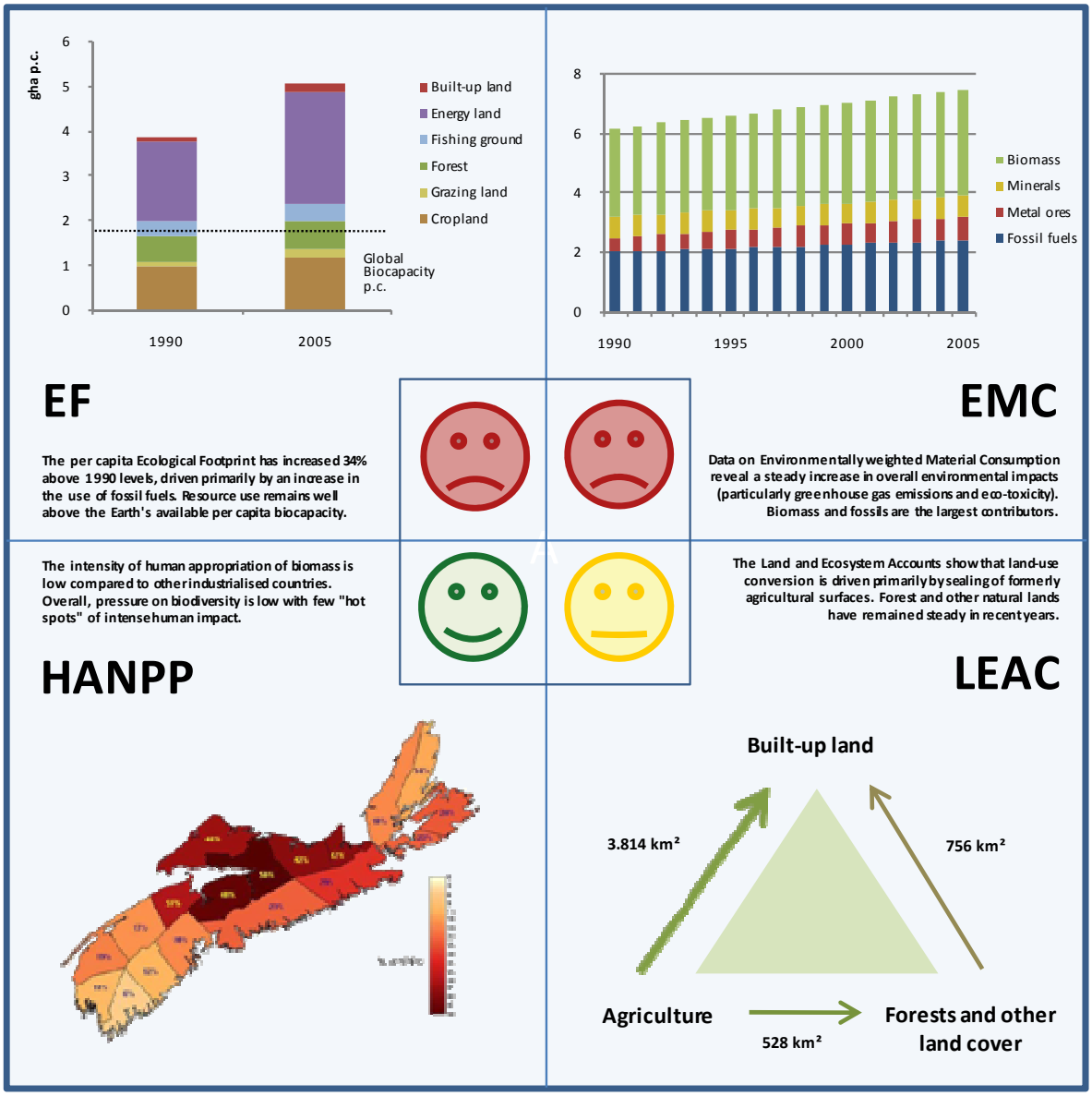
Except for the part of the LEAC system which is built upon the data base of European land cover, all the tools/indicators require information on the physical production and consumption

of materials and products. One major need therefore is to create a harmonised data base for the different indicators in the field of material and product use. This data base should build on the methodological recommendations for material flow accounting as published by Eurostat (2001a; 2007). However, in addition to the economy-wide material flow accounts, which regard the economic systems as a "black box", the data base should include data on the production and consumption of specific materials and products, in order to enable linking this information to LCA impact factors.

Illustrative presentation of the basket

The following figure illustrates how the four different tools in the basket could be visually presented. We suggest presenting each of the four indicators separately instead of aggregating them into one overall number or figure. On the one hand, this form of illustration avoids weighting of the different indicators of the basket against each other. If desired by the Commission, establishing such a weighting scheme would need to be performed in a large forum including academic experts, policy makers and civil society organisations. Creating an ad-hoc weighting scheme by the project team would be beyond the scope of this project and not deliver a broadly accepted result. On the other hand, the disaggregated form of presentation allows keeping important detail information that would be lost when aggregating to one overall figure.

Figure II: Illustrative presentation of the basket of indicators



Note: HANPP map adapted from O'Neill et al. 2006

... Positive trend ... Mixed trend ... Negative trend

Suggested Research Agenda

As part of the project, a short- to medium-term research agenda was developed for each of the indicators in the basket. The following table summarises the key topics identified as needing further research. The shortcomings for each indicator/tool that have been identified and listed in the table are recommended to improve and fill out the gaps of the basket. The listed tasks for the tools are considered in a coherent manner to maximise complementarities.

Table III: Suggested tasks in the research agenda of the basket of tools

Tool	Tasks	Time frame
EF	1. Accounting anthropogenic carbon and other greenhouse gas emissions with the Ecological Footprint	short to medium term
	2. Accounting traded goods and services with the Ecological Footprint, instead of using sector data alone.	
	3. Documenting the Ecological Footprint methodology	
	4. Development and calculation of Ecological Footprint equivalence factors	
	5. Improving the utility of the Ecological Footprint for policy-makers	
	6. Evaluating the robustness, validity and accuracy of source data used to derive the National Ecological Footprint Accounts	
	7. Accounting sustainable land use with the Ecological Footprint	
	8. Evaluating and testing the key constant assumptions of the National Ecological Footprint Accounts	
	9. Testing the sensitivity of the National Ecological Footprint Accounts	
EMC	1. Improvement of material consumption data	short term
	2. Validating EMC results against national statistical data	short term
	3. Increasing transparency and robustness of life-cycle inventory data	short to medium term
	4. Geographical expansion and regular update of the life-cycle inventory data	medium term and beyond
	5. Improving methods to calculate the overall environmental impact (incl. weighting schemes)	medium term
HANPP	1. Improving the data base for HANPP calculations	short to medium term
	2. Calculation of HANPP embodied in traded products	short term
LEAC	1. Further development of aggregated indicators based on LEAC data	short to medium term
	2. Specification of the relations between land cover and land use	medium term
	3. Further development towards integrated ecosystem accounts (physical and monetary)	medium term