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How to measure Europe's resource use

An analysis for Friends of the Earth Europe

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Executive summary

Background

The natural resource base, on which the quality-of-life of our societies is built, is in danger of overexploitation and collapse. Due to growth of world population and continued high levels of consumption in the developed world, combined with the rapid industrialisation of countries such as China, India and Brazil, worldwide demand on natural resources and related pressures on the environment are steadily increasing. Renewable resources, and the ecological services they provide, are at great risk of degradation and collapse. Extraction of many non-renewable resources is already reaching or near a peak.

European environmental policy has focussed on solving problems related to specific pollutants, rather than those related to growing production and consumption. Europe has achieved significant improvement in environmental problems related to specific pollutants and harmful substances in the past 30 years, such as air pollutants, sewage effluents and hazardous wastes. However, environmental problems related to the overall scale of European production and consumption are getting worse: depleting fish stocks, shrinking water reserves, growing waste volumes, growing energy consumption and continued high level of per capita emissions of greenhouse gas (GHG) emissions are part of these persistent environmental problems.

Current EU policies addressing resource use do not have concrete reduction targets and are not coherent. In the EU, issues of resource productivity, environmental impacts of resource use and resource security have significantly gained in policy importance in the past ten years and a number of policy strategies have been launched. However, from a sustainable development perspective, key issues are not being adequately addressed. Concrete targets for increasing resource productivity and decreasing resource use and related environmental impacts are missing in all main EU policies.

Furthermore, EU environmental policies focus on the impacts related to resource use rather than addressing the overall levels of resource use. As adequate indicators measuring these impacts are only currently being developed, the EU has been stuck in a "paralysis by analysis" situation in recent years, which has delayed urgent political action.

In addition, the focus on environmental impacts assumes that technological achievements will allow the reduction of impacts in a situation of high or even growing overall amounts of resource use. However, this technology-optimistic position is not justified by empirical evidence. At current high levels of resource consumption in Europe, substituting a significant share of high-impact resources for lower-impact resources is difficult to implement in an environmentally benign way (e.g. see the debate on biofuels). In addition, industry and trade policies of the EU are focused on maintaining access to resources and do not properly consider other EU policy goals, such as those for poverty alleviation and development.

The set of suggested resource use indicators

Based on an analysis of the current situation in the development of resource use indicators, and a qualitative evaluation of existing indicators against a set of criteria developed by Friends of the Earth, a suggestion for a set of resource use indicators is presented. The indicator set covers the core resource input categories of materials, water and land area plus the output category of GHG emissions. It shall be emphasised that all indicators take a life-cycle perspective. In studies on natural resource use at the national level, a life-cycle perspective implies taking into account the indirect (or embodied) resource requirements of imported and exported products, in order to capture possible shifts of environmental pressures related to domestic production or consumption to other countries and world regions. Table I illustrates the suggested set for two exemplary levels: the product level and the national level.

Table I: The suggested system of resource use indicators on the product and the national level

Resource use category		Product level		National level	
Materials	biotic	Material Rucksack of products	biotic	Material flow-based indicators of countries (including materials embodied in imports and exports)	biotic
	abiotic		abiotic		abiotic
Water		Water Rucksack / Water Footprint of products		Water Rucksack / Water Footprint of countries (including water embodied in imports and exports)	
Land area		Actual land use of products		Actual land use of countries (including land embodied in imports and exports)	
GHG emissions		Carbon Footprint of products		National GHG emissions (including GHG emissions embodied in imports and exports)	

The set of indicators focuses on resource use amounts instead of environmental impacts. While environmental impact indicators deal with issues of substitution of specific environmentally harmful materials and substances, this set of indicator deals with the issue of the overall scale of the human production and consumption system. It can therefore be regarded as the general indicator framework, based on which more specific indicators (for example, on different environmental impacts) can be calculated. The set also permits direct links to be made to social and development issues, which are of key importance for the work of Friends of the Earth, including resource poverty and a fair distribution of global resources among the inhabitants of this planet.

The set of indicators has a strong link to the statistical system. The set includes indicators that are close to real statistical data and do not require transformation and modelling of data (which, for example, is the case with the Ecological Footprint), as a strong link to the statistical system increases the acceptance of indicators by policy makers. The different aspects of resource use are illustrated in the original units (e.g. material consumption and carbon emissions in mass, water use in litres, land area in hectares).

This set of resource use indicators is complementary to indicators measuring the environmental impacts related to resource use. The suggested indicator set complements other impact-oriented indicators (such as the basket of indicators developed by the European Environment Agency (EEA) and the European Commission Directorate-General for the Environment (DG ENV)) through providing the information on the underlying volumes. In several cases, this indicator set is the physical basis for calculating the impact indicators: for example, solid accounts of material consumption of products or countries are one of the main data bases for calculating the Ecological Footprint or the "Environmentally weighted Material Consumption (EMC)" of countries.

Data availability varies between indicators in the set. While international accounting standards exist for some indicators (for example, material flow-based indicators), they are still under development for other categories (for example, indicators on actual land use). Data gaps exist particularly for regarding resources (e.g. land, materials, water, GHG emissions) embodied in internationally traded products.

Sustainability limits for different categories of resource use need to be defined. The identification of sustainability limits for each of the resource use categories in the set is one of the key issues for further development of the suggested set of indicators. A system of limits for each of the categories is necessary in order to properly evaluate trade-offs between different options.

It is important to note that these indicators do not cover environmental impacts relating to pollution or potential pollution, nor do they have a direct link to biodiversity. The pollution-related issues are probably better approached through prevention-based approaches rather than looking at efficiency of use of problematic substances. In the case of biodiversity, the land indicator clearly provides some useful information, but biodiversity impacts can only be established by more detailed analysis of products and where the materials that make them up come from.

The set of indicators should be applied in a number of EU policy processes. The measurement system could play an important role in the revision of the Resource Strategy (due 2010), in the implementation of the Action Plan on Sustainable Consumption and Production and a large number of other policies, including structural and cohesion funds and development aid, and in impact assessment of policy proposals.

Contents

Glossary of terms as used in this paper

Resource use: Use of different types of natural resources (materials, water, land, etc.) for human production and consumption activities.

Environmental impacts of resource use: Different types of negative environmental consequences stemming from the use of natural resources: global warming, ecotoxicity, eutrophication, biodiversity loss, etc.

Resource productivity / resource efficiency: Economic output (in monetary terms) generated per amount of natural resources used in production and consumption.

1. Resource use: a key sustainability issue

The natural resource base, on which the quality-of-life of our society is built, is in danger of over-exploitation and collapse. Due to growth of world population and continued high levels of consumption in the developed world, combined with the rapid industrialisation of countries such as China, India and Brazil, worldwide demand on natural resources and related pressures on the environment are steadily increasing. Renewable resources, and the ecological services they provide, are at great risk of degradation and collapse (see, for example, the latest "Global Environmental Outlook" by UNEP, 2007).

The depletion of these ecological assets is serious, as human society is embedded within the biosphere and depends on ecosystems for a steady supply of the basic requirements for life: food, water, energy, fibres, waste sinks, and other services. At the same time, extraction of many non-renewable resources is already reaching or near a peak; some authors even describe today's situation as "peak everything" (Heinberg, 2007).

Many of today's most pressing environmental problems are caused by the overall growth of production and consumption rather than by specific harmful substances. The past 30 years saw a change in complexity and scope of environmental problems in Europe. Early environmental policy was mainly concerned with the reduction of local or regional environmental degradation through pollution of certain environmentally harmful substances, such as air pollutants, sewage effluents, and hazardous wastes.

In this area, Europe has achieved significant improvements due to technological innovations and substitution of harmful substances and products. This has resulted in better environmental quality of rivers and lakes, decreasing concentrations of pollutants in ground water, successful reduction of acid rain and improved air quality in many cities.

However, since the mid-1980s, another type of environmental problem became increasingly important, associated with global changes in production, trade and consumption patterns. These problems are more difficult to address, as they are complex, international or even global in scope, and involve multi-dimensional cause-effect-impact relationships and time-lags. Issues such as climate change, loss of biodiversity, land cover conversion and high levels of energy and resource consumption are part of this new type of environmental problems. These problems are more closely related to the overall volume (or scale) of economic activities than a result of the specific potential for environmental harm of single substances (Schmidt-Bleek, 1992).

As evidence illustrates (see, for example, the State of the European Environment report by the European Environment Agency, EEA, 2005), Europe has performed much worse in this regard: many species are threatened by extinction, fish stocks are depleted, water reserves are shrinking, overall waste volumes have been growing, urban sprawl transforms fertile land into sealed areas, valuable soil is lost through erosion, energy consumption grows, and Europe is far away from achieving a significant reduction in GHG emissions. Pollution prevention should continue playing an important role in EU policies, but these types of measures need to be complemented by additional strategies tackling the environmental problems related to the overall size of the production and consumption system.

The Environmental Space, which humans can use without causing irreversible damage to the planet, is physically limited and should be distributed equally. The global Environmental Space (Opschoor, 1995; Spangenberg, 2002) can be described as the limited capacity of the biosphere's environmental functions to support human economic activities. It is defined as the total amount of energy (emissions), non-renewable resources, agricultural land, forests etc. that everyone can use without causing irreversible damage to natural systems. The concept of Environmental Space also includes a social dimension, which is given by the principle of "global fair shares" or the "equity principle". This principle assigns to all currently living people a right to achieve a comparable level of resource use, and to future generations a right to an equivalent supply, thus reflecting inter- and intra-generational justice of distribution.

Although the environmental and economic problems related to the current production and consumption system are already fully apparent, only around 25% of world population with high purchasing power benefit from a system of global resource trade; 75% of world population still live in poverty and will (legitimately) demand further growth and material consumption in the future. The generalisation of the resource-intensive economic model in Europe and other developed countries to today's six or even ten billion people in the future is therefore neither environmentally possible nor can it be economically and socially sustained. The issue of resource consumption and material welfare is therefore inseparably linked to global justice and a fair distribution of global natural resources between all inhabitants on our planet.

Resource use and related impacts are a global issue that needs global solutions. Europe and the United States are the world regions with the highest per-capita resource consumption. At current levels of consumption, Europe is appropriating far more than its "fair share" in global resource use. At the same time, the catching-up of other world regions and emerging economies accelerates the rapidly growing demand on non-renewable resources, such as fossil energy and metals.

Precariously, the reserves of many non-renewable resources are located outside of Europe (see Figure 1 for the example of iron ore). This causes Europe to be critically dependant on other countries and regions and extends its responsibility for environmental and social impacts from the national to the global level. In addition to the approaching peak of energy sources such as oil or gas, the expected decline in the availability of precious metals will strongly influence high-tech industries, such as the IT industry. As part of the strategy of absolute reduction, increased rates of recycling (in particular, for metals) will be one important strategy to make European industries more independent from imports of non-renewable resources.

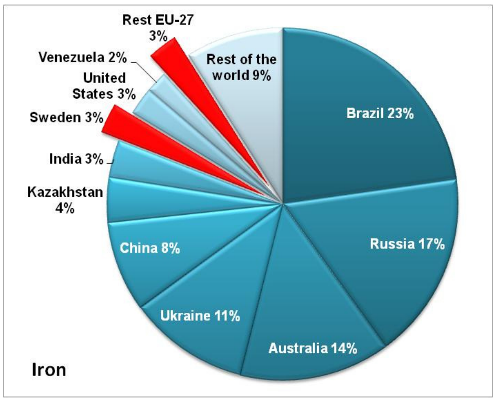


Figure 1: Distribution of worldwide iron ore reserves (Source: USGS, 2008)

The future could see fierce conflicts over natural resources. Conflicts and wars are increasingly being fought over natural resources. Worldwide competition for natural resources will significantly increase in the near future, potentially leading to further serious conflicts related to access to resources. Reducing pressures on the Earth's limited resources is therefore a key strategy to avoid such conflicts. These conflicts affect the poorest parts of world population the most, even though they are currently not involved in the race for resources and therefore do not contribute to the overall problem. For example, the war for tantalum mines in the Democratic Republic of Congo or the war for water in Darfur.

2. Current EU resource policies

Issues of resource productivity, resource consumption and related environmental impacts as well as resource security have significantly gained in policy importance in the past ten years. A number of European and international institutions have established policy processes aimed at increasing resource productivity in different levels of economic activity (products, sectors, and countries) and reducing the negative environmental impacts related to resource use along the whole life-cycle of products and services.

Prominent examples include the creation of the International Panel for Sustainable Resource Management by UNEP in 2006, the adoption of a second "Recommendation on Material Flows and Resource Productivity" by OECD environmental ministers in April 2008, and the OECD publication of improved guidelines for the implementation of material flow accounts in OECD countries. In the EU, a number of policy processes aim at increasing resource efficiency and decoupling and at reducing negative environmental impacts related to resource use.

The EU Sustainable Development Strategy (2001/2006): defining the overarching goals. The Sustainable Development Strategy (SDS), which was adopted by the European Commission at the Gothenburg European Council in 2001 and renewed in 2006, outlines a long-term vision for sustainable development in Europe.

The key objectives for the area of "environmental protection" in the revised EU SDS (p. 3) are to "*safeguard the Earth's capacity to support life in all its diversity, respect the limits of the planet's natural resources and ensure a high level of protection and improvement of the quality of the environment. Prevent and reduce environmental pollution and promote sustainable consumption and production to break the link between economic growth and environmental degradation*".

As operational objectives and targets relevant to the resource use issues, the revised EU SDS lists:
- *"Improving resource efficiency to reduce the overall use of non renewable natural resources and the related environmental impacts of raw materials use, thereby using renewable natural resources at a rate that does not exceed their regeneration capacity*).
- *Gaining and maintaining a competitive advantage by improving resource efficiency, inter alia through the promotion of eco-efficient innovations*.
- *Improving management and avoiding overexploitation of renewable natural resources such as fisheries, biodiversity, water, air, soil and atmosphere, restoring degraded marine ecosystems by 2015*.
- *Avoiding the generation of waste and enhancing efficient use of natural resources by applying the concept of life-cycle thinking and promoting reuse and recycling"* (p. 13).

The EU Resources Strategy (2005): aiming at de-coupling economic growth from the negative environmental impacts related to resource use. The Thematic Strategy on the Sustainable Use of Natural Resources (Resource Strategy), launched in 2005 (European Commission, 2005), is one of seven Thematic Strategies implementing the goals of the Sixth Environmental Action Programme (6th EAP). The overall goal of the Resource Strategy is targeted towards de-coupling, i.e. "*to reduce the negative environmental impacts generated by the use of natural resources in a growing economy*" (p. 5).

In order to achieve the targets, the Strategy aims to undertake the following actions:
- *"improve our understanding and knowledge of European resource use, its negative environmental impact and significance in the EU and globally,*

- *develop tools to monitor and report progress in the EU, Member States and economic sectors,*
- *foster the application of strategic approaches and processes both in economic sectors and in the Member States and encourage them to develop related plans and programmes, and*
- *raise awareness among stakeholders and citizens of the significant negative environmental impact of resource use"* (p. 5/6).

The EU Action Plan on Sustainable Consumption and Production (2008): focusing on energy use and energy efficiency. The "Action Plan on Sustainable Consumption and Production and Sustainable Industrial Policy" (European Commission, 2008), which was launched in July 2008, aims at setting up "*a dynamic policy framework to improve the energy and environmental performance of products and support their uptake by consumers. This includes setting ambitious standards throughout the Internal Market, ensuring that products are improved using a systematic approach to incentives and procurement, and reinforcing information to consumers through a more coherent and simplified labelling framework, so that demand can underpin this policy*" (p. 3). The Action Plan has a strong focus on energy issues and envisages the revision and expansion of several directives to ensure the implementation of the goals: for example, the Ecodesign Directive for energy-using products, the Energy Labelling Directive, the Energy Star Regulation and the Ecolabel Regulation.

Global Europe. Competing in the World (2006): ensuring access to resources through international trade. In October 2006, the Commission published a communication entitled "Global Europe: competing in the world" which aims at integrating trade policy into the European Union's competitiveness and economic reform agenda. The suggested approach comprises one chapter on external policy and one on EU internal policies. The external chapter suggests that the EU should facilitate access to resources such as energy, metals, scrap and primary raw materials in EU partner countries by removing restrictions on access in those countries, except where justified for security or environmental reasons. Regarding energy, Global Europe recommends encouraging energy efficiency, the use of renewable energies, low emission technology and 'the rational use of energy in Europe and globally'.

The Raw Materials Initiative (2008): strategies of European industries against possible restrictions in resource supply. Amid growing concerns about global resource scarcity and high import dependency, the European Commission's Raw Materials Initiative considers ways for the EU to avoid raw material shortages in the future and to ensure access to raw materials both from within and outside the EU for European industry. The Commission recommends that the EU define critical raw materials and develop an integrated European strategy based on 3 major pillars, namely to: (1) ensure access to raw materials from international markets with no distortion of trade; (2) foster sustainable supplies of raw materials from European sources; and (3) reduce the EU's consumption of primary raw materials.

A large number of other EU policies affect European resource use. Apart from these main environmental and economic policy processes, a large number of other EU policies have important influence on Europe's resource use and resource productivity (for an overview see Rocholl et al., 2006). These policies include general EU policies such as the further implementation of the Lisbon Strategy, the thematic orientation of the EU Structural Funds and Cohesion Funds and EU research policies (e.g. the 7th Framework Programme). As the energetic and the material aspects of resource use are interlinked, EU energy (efficiency) and climate policies also have significant impact on material use. These policies include the further development of the European Emission Trading System (EU ETS), the EU Action Plan on Energy Efficiency and the Biomass Action Plan. Transport policies play a role (e.g. CO_2 taxation of cars or the possible inclusion of aviation in the ETS) as do policies to foster green public procurements or the support for environmental technologies (such as ETAP).

3. A critical evaluation of EU resource policies

Although a growing number of policy processes is being launched in the EU with relevance for natural resource use, important aspects are still missing or have not yet been addressed, but are required to realise more sustainable patterns of resource use in Europe.

Missing targets and policy instruments. Despite widespread support in different EU policy fields for the general ideas of increasing resource and energy efficiency, little concrete action has been taken so far. No quantitative targets have been formulated for increased resource productivity or for a reduction of environmental impact of resource use in any of the main EU policies. Most resource policy documents remain on a general level of declarations of intent, without detailing which concrete policy measures should be implemented to achieve the formulated objectives. A strategy to systematically adjust EU policies to promote resource productivity in the EU is thus still far from being realised.

"Paralysis by analysis" through focus on environmental impacts. The EU's policy focus on impacts is not effective in providing the necessary and urgent action towards an absolute reduction of resource use and related impacts. In the Resource Strategy and other policy documents, it is argued that there is a lack of understanding on the causal relationship between resource use and its environmental impacts and indicators measuring environmental impacts of natural resource use are still missing. The development of these indicators would be the precondition for formulating targets and related policy instruments.

Measuring impacts properly in aggregated indicators is a very challenging task, as these differ depending on the spatial and temporal distribution (where and when the impacts take place – e.g. what sort of ecosystem wood is obtained from) and depending on the material composition of products. Despite recent scientific advances in developing indicators to measure impact, the full implementation of such a measurement system will still take several years. The call for more research focusing on impacts has created a "paralysis by analysis" in the recent years which has delayed urgent political action.

Technology-optimistic assumptions on material substitution and de-coupling possibilities. With its focus on environmental impacts instead of amounts of natural resource use, EU policies assume that an absolute de-coupling of impacts can be achieved at current (or even growing) levels of resource consumption through technological innovation. There exist a few examples which prove that absolute decoupling is possible for individual substances, e.g. the phase-out of lead from gasoline dramatically reduced lead emissions despite increases in transport.

However, most single achievements are outweighed by the continuous growth of overall resource use. Many real cases illustrate that substituting high-impact materials for lower-impact materials at the current levels of consumption is difficult to implement in an environmentally-benign way. For example, some biofuels and other renewable energy sources may improve the carbon balance of one litre of petrol or one kilowatt hour. However, they cannot substitute a significant share of fossil fuels at our current levels of overall energy consumption without causing significant environmental harm, such as the expansion of crop areas at the cost of forest areas, increased use of water, pesticides and fertilizers, etc. (see MacKay 2009). Moreover, as the case of biofuels has shown, it is important to consider not just CO_2 but also other GHGs, such as nitrous oxide (Howarth et al., 2009). Otherwise, expensive policy instruments aimed at decoupling and mitigation may in fact aggravate environmental impacts (such as climate change).

Inadequate integration of development issues. Neither the trade strategy "Global Europe" nor the "Raw Materials Initiative (RMI)" takes development aspects adequately into account. First, the RMI entirely excludes any aspects related to the negative social and ecological consequences of raw materials extraction and trade, such as resource conflicts, land rights violations, environmental damage, biodiversity loss and increased GHG emissions.

Secondly, the RMI challenges the industrial policies of developing countries, i.e. their abilities to develop value-adding activities, for example by denying them the chance to protect infant industries - the same policies that industrialized countries and the Asian "Tiger economies" have used in the past in order to become rich (see Chang, 2002). At the same time, the EU's own indirect trade barriers and distortions such as agricultural trade subsidies are not mentioned. Instead, the EU resource and trade strategies promote a path on which developing countries remain dependent on exporting raw materials.

Third, there is no mention of limited environmental space, resources depletion and issues of fair shares of the planet's limited resources, equity and social justice.

Policy incoherence. The resource policies summarised above generally run against the European Commission's objective of "policy coherence". In the area of environmental policies there is missing integration between the EU Sustainable Development Strategy, the Thematic Strategy on the Sustainable Use of Natural Resources and the Action Plan for Sustainable Consumption and Production.

Moreover, there is a clear contradiction between the mercantilist character of the above mentioned trade and industry strategies and the Commission's commitments towards poverty alleviation and development, including social and environmental policy objectives. Both Global Europe and the RMI ignore commonly agreed development policy principles such as ownership, partnership, and the participation of civil society on which the EU development cooperation policies such as the European Consensus on Development and the Communication on Decent Work (European Commission, 2006) are based.

4. Demands from EU resource policies

Based on the critical review of current EU policies, the following key demands are formulated.

Action can be taken based on the current state of knowledge. Further developing and refining indicators which illustrate the different aspects of environmental impacts is important. However, there is sufficient proven empirical scientific evidence that action is needed to reduce human pressures on European and global ecosystems (EEA, 2005; Millennium Ecosystem Assessment, 2005; UNEP, 2007). The consumption areas with the highest impact on the environment (housing, food, mobility) have been identified in numerous scientific studies, including studies for the European Commission (Tukker et al., 2005). The position of the EU Commission that it is not possible to start acting with the current state of knowledge is therefore unjustified.

The EU could be a positive example for the world. Through ambitious political action, the EU could provide an example for other rich countries, as well as emerging and developing countries, demonstrating how sustainable levels of resource consumption can be achieved whilst maintaining a good quality of life. This could motivate other global players to join such an effort and thus contribute to global processes to achieve more sustainable patterns of resource use.

An absolute reduction of natural resource use in Europe is required as a basis for qualitative changes to reduce the environmental impacts. Realising more sustainable development for all inhabitants requires much more than incremental improvements of the current system; what is needed is a radical change in how we use nature's resources to produce goods and services and generate well-being. In order to allow developing countries to overcome poverty and increase the material welfare of their inhabitants in the future, countries with high levels of per-capita resource consumption need to sharply decrease their share in global resource use in absolute terms.

A Factor 10 improvement in resource productivity, i.e. the economic value produced per unit of natural resources, has been suggested as an overall guiding target for Western countries (Schmidt-Bleek, 2009). So far, there is no empirical evidence that technological improvements could remove the physical limits of the planet's Environmental Space and allow sustaining ever-growing amounts of resource consumption for a growing world population. Therefore, qualitative strategies, such as an increased share of biofuels and biomaterials in total resource consumption, can only be implemented as part of such a quantitative reduction scenario, which avoids overusing the limited capacities of global ecosystems.

Quantitative and binding targets plus concrete timetables for implementation are needed to provide the right incentives. Japan was the first OECD country to introduce a quantitative target for resource productivity in 2003, stating that resource productivity should increase 40% in 2010 compared to the 2000 level (Government of Japan, 2003). Such overall targets are a necessary precondition for achieving an absolute reduction of resource use, as investments in innovative eco-efficient technologies require predictable future market framework conditions.

In addition to overall targets, more specific targets can be added addressing specific categories of resources (renewable resources / biomass, non-renewable resources / fossil fuels, metals and minerals) or specific economic sectors. Along with these targets, binding time frames should be defined, creating a concrete road map to achieve the targets. Targets should also incorporate review dates when the latest evidence can be examined, both on the impacts of our resource use and on technological and other developments that can reduce Europe's resource use.

An effective policy mix is required to achieve the targets. A well designed strategy for absolute reduction of resource use needs to include policy instruments on different governance levels and must address all key economic sectors (Giljum et al., 2005). The most effective approach is based on the use of a mix of the available policy options. Market-based instruments play a key role in a resource policy set, as they provide price incentives and allow private and public economic actors to achieve environmental objectives in a cost-effective way. Market-based instruments are also drivers for technological innovation.

Within a redesigned framework of taxes, subsidies and certificates oriented towards an absolute reduction of natural resource use and related environmental impacts, investments in higher eco-efficiency are economically rewarding, even beyond fixed limits. Coherence between the different instruments is another key criterion for effective implementation. The implementation should also be accompanied by regular monitoring and review mechanisms, including appropriate indicators, in order to effectively assess the success or failure of specific policies.

Aspects of resource use should be fully integrated in a number of EU policies. Achieving substantial improvement requires the integration of aspects related to resource use in the design and evaluation of a large number of policies. EU Impact Assessment would be one key area, where a proper analysis of the expected impacts of EU policies on resource use would be of high importance. Had a proper resource measurement system already been in place, the biofuels debate in the EU would probably have gone into another direction with a much earlier awareness of the environmental consequences of increasing consumption of biofuels in Europe.

5. Why measurement is important

"You can't manage what you can't measure". Measuring resource use and its environmental, economic and social impacts through appropriate indicators is the prerequisite for monitoring progress towards defined targets. What is not measured often gets ignored in policy processes. While standards for measuring GHG emissions have been developed within the UN framework convention on climate change (UNFCCC), such standards on the international level are only beginning to be introduced for the issue of measuring resource use.

Clear communication in an understandable way is key to reach target audiences. On the one hand, communication on a country's resource use must address what amounts of resources are available and how much is at everybody's disposal, and on the other hand, whether and how far we are beyond the physical limits, i.e. to what extent we are 'overshooting' the Earth's capacities.

It is essential to illustrate the (likely) consequences of this over-exploitation, to underline the relevance of human behaviour. Knowing this gap, it is easier to realise the challenges society is facing and to elaborate strategies to tackle them. Here, an important issue to emphasise is the interrelation between resource consumption and climate change issues. For both aspects one crucial approach is to create a positive vision for the future. Reducing our environmental impact brought about by resource consumption and GHG emissions does not imply that people have to reduce their level of wellbeing.

Targets can only be defined based on clear measurement systems and robust indicators. The EU has a tradition of setting binding targets in many policy areas; however, such targets are largely missing with regard to the issue of resource use and resource productivity (see above). If such targets were defined and implemented through a set of policy instruments, this would create a major driver for eco-efficient innovation in production, for the establishment of new resource-extensive business models, and for changes in consumption patterns of Europeans.

Policy makers demand solid information to design appropriate policy responses. Decision makers on the EU and member state level require well-founded information and analysis, in order to design policy measures to address the most urgent environmental concerns. This information includes issues such as the main (economic and social) drivers for resource consumption, the identification of the most resource intensive economic sectors, the contribution of different types of product consumption to overall environmental pressures, the quantification of potential for increased eco-efficiency and its cost, and possible shifts of environmental burden to other world regions through changes in international trade patterns.

Increasing efficiency is useful and required, but not sufficient. In the past 20 years, Europe has achieved increasing resource productivity (or eco-efficiency) in production and consumption processes. For each Euro of economic value, less and less energy and raw materials are needed (this is also called relative de-coupling of environmental pressures from economic growth). However, in many cases increased efficiency has also caused lower prices of products and services and in turn higher demand (mobile phones are a good example). This phenomenon is known as the "rebound effect". The related increase in production and consumption may in the worst case more than offset the drop in demand from the original efficiency gain.

As a result, the condition of the environment can still worsen in a situation of relative de-coupling. In addition to measuring the increase of eco-efficiency on the micro level (companies, households and products), it is key to implement measurement systems and policy instruments on the economy-wide (macro) level, which allow monitoring and limiting the *overall* growth of material and energy use. The main policy goal is therefore absolute de-coupling, i.e. a decreasing absolute level of environmental pressures even in a situation of further economic growth.

Changes of consumption levels and consumption patterns are one key step towards a more sustainable resource use. The above mentioned "rebound effect" along with increased average income has caused increasing environmental pressures related to the consumption of products and services in Europe. Measuring resource use is an important element in communicating the issue of environmental responsibility to the general public, and to emphasise that each European can make his or her personal contribution.

Better data on the environmental pressures related to products is also the empirical basis for the implementation of comprehensive labels on products, which assist consumers to select the most environmentally-benign option. Currently developed "Carbon Footprints" of products are one first step in that direction, but such labels should also include issues of resource use, such as the consumption of biotic and abiotic materials, water or land.

The use of physical units of measurement is a crucial requirement for addressing the resource use issue. Pure monetary approaches to measure environmental consequences of human activities are not appropriate as they possess a number of shortcomings. These include the fact that markets do not exist for many ecosystem services, that markets insufficiently reflect resource scarcities, that markets tend to have a systematic bias against the future due to so-called discounting practices, and that markets assume that natural capital (such as ecosystems and resources) can be substituted by man-made capital (e.g. infrastructure, machines, etc.), which is in general not the case.

For all those reasons, alternative measurement systems have been developed, which use units of measurement other than money (these methods are also called "physical accounting" approaches). These approaches to measuring sustainable development are reflected in the European sustainable development indicator systems, as well as those used by many Member States, where different issues are measured and reported in the most appropriate units. Regarding the issue of resource use, the most common units of measurement are mass units (kilograms), energy units (joules), area units (hectares) or units which reflect the negative environmental impacts of resource use on human health (e.g. healthy life years).

6. Existing measurement systems and indicators

The past 15 to 20 years saw rapidly increasing interest in the quantitative assessment of the interrelations between society and nature. This chapter provides a short review of existing measurement systems and resource use indicators. The evaluation against the criteria listed above will be carried out in the following chapter.

The UN environmental-economic accounting system "SEEA": the international framework for collecting environmental data and calculating resource use indicators. The most relevant international framework for measuring resource use (and more generally, for assessing the interactions between the economy and the environment) is the "System for integrated Environmental Economic Accounting" (SEEA) by the United Nations (for the latest version see United Nations, 2003), which sets guidelines for integration of environmental data into the statistical system and the standard economic "System of National Accounts". The SEEA system is currently being revised and will be published in an updated and revised version in 2012.

Methodologies to measure resource use

Five main categories of resource inputs. Five basic categories of natural resources serve as inputs to production and consumption processes: biotic materials, abiotic materials, air (for combustion processes), water and land area (see also United Nations, 2003). For each of these categories, different methodologies have been developed.

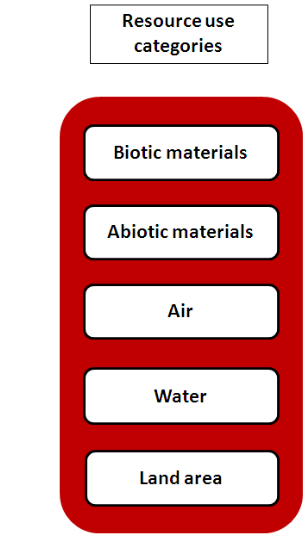


Figure 2: Basic categories of resource inputs to production and consumption

Biotic and abiotic materials: material flow accounting and analysis (MFA). Material flow accounting and analysis (MFA) is an approach, which focuses on the use of different materials by human activities. MFA builds on concepts of material and energy balancing, which were introduced more than 30 years ago. The basic unit for MFA calculations is weight (kilograms or tonnes). Based on national or international statistical data, MFA calculates the domestic extraction of resources, as well as physical imports and exports. Biotic materials cover production from agriculture, forestry, fishery, and hunting; abiotic materials cover minerals (metal ores, industrial and construction minerals) and fossil energy carriers (coal, oil, gas, peat).

Since the beginning of the 1990s, when first material flow accounts on the national level were presented, MFA has been a rapidly growing field of scientific interest, and major efforts have been undertaken to harmonise methodological approaches developed by different research teams. In international working groups on MFA, standardisation of the methodology for accounting and analysing material flows on the national level was achieved and published in guidebooks by Eurostat (2007a) and the OECD (2007b). In many EU and OECD countries, MFA is already part of the official environmental statistics reporting system. MFA data is also available for an increasing number of emerging and developing countries (see OECD, 2007a).

In addition to the accounting of material flows on the economy-wide level (global, national, regional), MFA-based approaches have also been developed and applied for products. The concept of "Material Input per Service Unit (MIPS)" was developed at the Wuppertal Institute for Climate, Environment and Energy in Germany and aims at illustrating material inputs required along the whole life-cycle of a product: from resource extraction (e.g. mining) and refining via manufacturing and trade to consumption and finally treatment or disposal (Schmidt-Bleek, 1992). These lifecycle-wide material inputs (also known as the ecological rucksack of a product) visualise the cumulated environmental pressures, which are in general invisible to final consumers.

Air accounts as the link to greenhouse gas emissions. Air is a key resource input to combustion and other processes and serves as a balancing item to establish material balances e.g. for the use of fossil fuels, producing CO_2 from O_2 in the air and carbon in the fuels. For indicators such as the Ecological

Footprint or the Carbon Footprint (see below), this category of resource input is therefore of importance in the underlying accounting method.

Water accounts on the national and the product level. The use of water is an issue with increasing policy relevance. Water accounts are included both in statistical systems on the national level (for example, Olsen, 2003) and in studies on the so-called "Water Footprint of Nations" (Chapagain and Hoekstra, 2004). Also an increasing number of "Water Footprints" are calculated on the product level (for example, Chapagain and Hoekstra, 2007). However, Water Footprint data for non-agricultural products is still scarce.

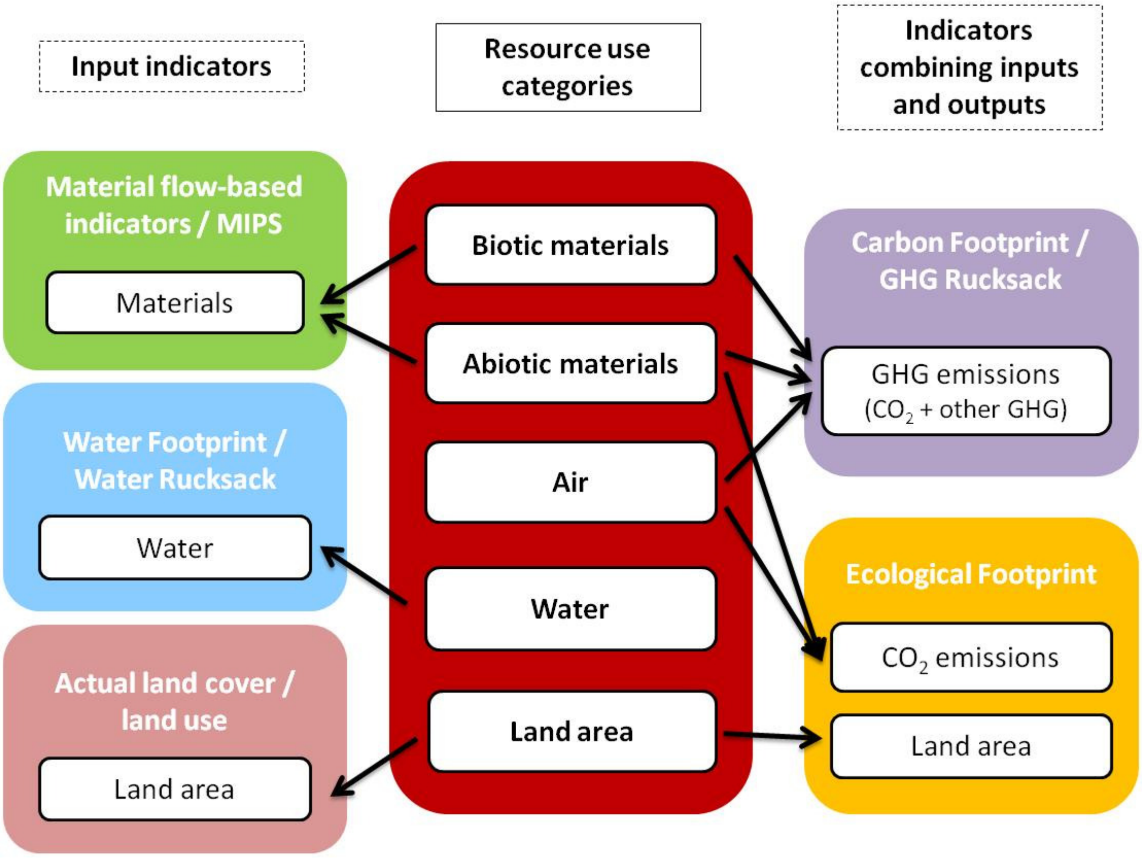
Water accounts often distinguish between withdrawals of water from rivers, lakes and aquifers (surface and ground water) that are used in agriculture, industry and for domestic purposes ("blue water"), as well as water from rainfall that is used to grow crops ("green water"). The impact of water withdrawals depends largely on where and when water is extracted. A link to the renewable water stocks for the specific geographic region or country is particularly useful for an appropriate interpretation of water flow-based indicators.

Land area: land cover and land use accounts. Land cover accounts are generally established from satellite images applying a certain resolution (grid system). For example, the EU Corine (Coordination of Information on the Environment) land cover (CLC) system, which is used by the European Environment Agency (EEA) for producing and reporting land cover change accounts, is based on satellite images in a 100 m x 100 m grid (EEA, 2006). Such systems aim at describing the geographical patterns of different land cover types across a country or region, the way they change over time and the processes that drive these transformations. Recently, there has been increasing interest in quantifying the land area embodied in internationally traded products (Würtenberger et al., 2006).

Indicators based on the core categories of resource use

Based on this system of five main categories of resource inputs, a number of indicators can be derived. Two main types of indicators can be distinguished: input indicators (left side of the diagram in Figure 3 on page 17) and indicators, which combine inputs and parts of the generated outputs, in particular GHG emissions (right side of the diagram).

Figure 3: The system of resource use indicators derived from the core resource use categories



Source: Giljum et al, 2009

Input-oriented indicators include indicators derived from MFA accounts. **Material flow-based indicators** on the economy-wide level comprise input, consumption, trade and productivity indicators and are expressed in mass units. Material flow-based indicators have been integrated in the EU's Structural Indicator Set, which evaluates progress of the Lisbon Strategy, and provide the headline indicator for the theme "Sustainable Consumption and Production" in the EU set on Sustainable Development Indicators (Eurostat, 2007b). On the level of single products, the indicator MIPS is applied.

There are also current attempts to link quantitative data on the amounts of resources consumed (from material flow accounts) with information on the specific environmental harm (global warming, toxicity, land intensity, etc.) of different types of materials. These impact factors are derived from so-called "Life Cycle Assessment (LCA)" data bases. The most advanced indicator presented so far is called "Environmentally-weighted Material Consumption (EMC)" and was presented by the University of Leiden in the Netherlands (see van der Voet et al., 2005).

Water indicators, such as **Water Footprints** and **Water Rucksacks**, account for the water input of production or consumption processes in the unit of litres. Conceptually similar to the Ecological Footprint, the Water Footprint shows the extent of water use linked to consumption. The Water Footprint of a country is defined as the volume of water needed for the production of the goods and services consumed by the inhabitants of a country. The Water Footprint concept was developed by academics and has been applied in a number of studies, including reports from the UN Environment Programme (UNEP).

Indicators on **actual land cover and land use** (expressed in hectares or m²) and related changes illustrate the actual land area required to produce a product or service (micro level) or all the goods produced or consumed in a region or country (macro level). Particularly valuable are indicators, which illustrate the change of land cover and land use from one year to another (e.g. expansion of built-up land on the cost of agricultural land) (see EEA, 2006).

The **Ecological Footprint** is an indicator that combines both resource input aspects and parts of the resource outputs generated (CO_2 emissions). The Footprint is defined as the total biologically productive land and water areas required to produce the resources a population consumes, and to assimilate the waste it generates. Its purpose is to answer the question of how much regenerative capacity of the biosphere is occupied by the resource consumption of the inhabitants of different countries (Wackernagel et al., 1999). The Ecological Footprint provides a bookkeeping system of biocapacity: by comparing the land appropriation of the population of a country with the ecological capacity available within a country or world-wide, national (or global) ecological deficits or ecological reserves can be quantified.

National Ecological Footprint accounts build to a large extent on data from national material flow accounts and land use accounts (see above). They start from a population’s resource consumption (domestically harvested resources plus imports minus exports) expressed in mass flows (tonnes per year). These physical flows are then converted into area equivalents, expressed in an artificial unit of so-called “global hectares” (these are hectares with world-average biological productivity).

This approach is repeated for six major “land types”: crop land, pasture, fisheries area, forest land, built-up area and energy land. Built-up area is typically calculated based on land cover and land use accounts. The last category of energy land illustrates the amount of biologically productive land (forests) that is required to absorb the excess CO_2 released by these nations.

Ecological Footprint calculations have been carried out for almost all countries of the world by Global Footprint Network (WWF et al., 2008). The Footprint approach is also widely used for regional and local sustainability assessments. Standards for Ecological Footprints on the national level have been elaborated; those for products are currently being developed.

Finally, the **Carbon Footprint** (or GHG rucksack) assesses carbon emissions (CO_2 and other GHGs) throughout the complete supply chains of goods and services consumed in a region or country utilising a lifecycle approach (normally measured in grams or kilograms of CO_2 equivalents). The Carbon Footprint concept is currently being applied in a number of projects aiming to develop a new labelling system for products informing about the climate impacts of consumption (BSI, 2008).

7. Suggesting a set of resource use indicators for Friends of the Earth

In a series of workshops, Friends of the Earth defined 10 key criteria for resource measurement systems and indicators:

- Providing a good basis for policy making and evaluation
- Easy communication of directionally safe information
- Universal application with reasonable effort
- Informing about physical limits
- Integrating issues of equity and social justice

- Covering all relevant resource use categories
- Measuring resource use on different scales
- Illustrating the international dimension
- Illustrating past, present and future aspects of resource use
- Rooted in the statistical system

The detailed explanation of the criteria and the evaluation of existing indicators against this set of criteria are described in the Annex to this paper. Taking into account this qualitative evaluation, we suggest the following set of complementary resource use categories and related indicators. The set covers the core resource input categories of materials, water and land area plus the output category of GHG emissions. We illustrate the suggested set for two levels: the product level and the national level.

This indicator set can also be used for analysis of at other levels, for example companies or economic sectors, etc.). All the proposed indicators take a life-cycle perspective, taking into account the indirect resource requirements of imported and exported products. This approach ensures that the system does not report lower resource use just because a product is made outside the boundaries of the country or region being analysed.

Table 1: The suggested system of resource use indicators on the product and the national level

Resource use category		Product level		National level	
Materials	biotic	Material Rucksack of products	biotic	Material flow-based indicators of countries (including materials embodied in imports and exports)	biotic
	abiotic		abiotic		abiotic
Water		Water Rucksack / Water Footprint of products		Water Rucksack / Water Footprint of countries (including water embodied in imports and exports)	
Land area		Actual land use of products		Actual land use of countries (including land embodied in imports and exports)	
GHG emissions		Carbon Footprint of products		National GHG emissions (including GHG emissions embodied in imports and exports)	

Source: Based on Giljum et al, 2009

For the categories of ***biotic and abiotic materials***, the concept of the Ecological Rucksack is suggested for the product level, following the calculation guidelines of the MIPS concept (see above). On the macro level, a large number of indicators can be derived from national material flow accounts (OECD, 2007b). We suggest using material consumption indicators such as Total Material Consumption (TMC) as the main headline indicator. This will allow an aggregation across countries without double counting, and the incorporation of indirect flows from product import and export, unlike the simpler Domestic Material Consumption (DMC) which does not incorporate indirect flows. DMC is already part of the EU Sustainable Development Indicator set, while TMC is the targeted indicator for the future, once data are available (Eurostat, 2007b).

On the product level, ***water*** inputs can be accounted applying the concept of Water Rucksack or Water Footprints. In addition to blue water (see above), the Water Footprint concept also includes green water. Water Rucksacks or Water Footprints can also be calculated on the national level. In parallel to the calculation of material flow-based indicators, national indicators on water consumption add the water embodied in imports to the water extracted domestically and subtract water embodied in exports to other countries.

The actual ***land area*** of products reflects the life-cycle wide demand on actual land area for the production of goods or services. National land cover and land use inventories allow analysis of the land use of countries. However, it is also necessary to add the actual land use of imported products and subtract the land use of exported products in order to calculate a national indicator of actual land use from a consumption perspective.

The category of ***GHG emissions*** refers to the concept for calculating Carbon Footprints, a life-cycle-wide GHG balance at the product level (see, for example, BSI, 2008). On the national level, the current system of Kyoto GHG inventories represents a production (or territory) accounting principle. Also regarding this category, consumption-based indicators can be calculated through considering GHG emissions embodied in internationally-traded products (Peters, 2008).

Explanation for suggesting this set of indicators

A set of indicators delivers more solid information than a single indicator. Key criteria in the evaluation were the coverage of all relevant categories of resource use in order to monitor shifts of environmental pressure, and provide a well-founded basis for policy making and target setting. These criteria can be better fulfilled by applying a set of indicators instead of only one indicator (e.g. Carbon Footprint). A set of indicators covers resource use in a complementary manner and allows setting resource-specific targets and evaluating specific resource policies.

This approach has also been applied in the original Environmental Space (ES) studies in the 1990s, which assessed ES separately in different categories of resource use (non-renewable raw materials, wood, energy, water, land use). The suggested set of indicators avoids counting the same resources twice (with the exception of fossil fuels and biotic material inputs, which produce GHG emissions other than CO_2 and thus are accounted as part of the Carbon Footprint).

The set of indicators focuses on resource use amounts instead of specific environmental impacts. In a world which increasingly faces limits on ecosystem capacities and resource scarcity, reducing the amounts of natural resources used becomes the central determining factor for sustainable global development. While environmental impact indicators deal with issues of substitution of specific environmentally harmful materials and substances, this set of indicators deals with the issue of the overall scale of the human production and consumption system. It thus points to reduction rather than substitution. This set of indicators also allows the establishment of direct links to social and development issues, which are of key importance for the work of Friends of the Earth. These issues include resource poverty and a fair distribution of global resources among the inhabitants of this planet.

For acceptance by policy makers, a strong link to the statistical system is desirable. We suggest including measurement methods and indicators, which have a strong link to the statistical system, on the Member State and EU level. The example of MFA-based indicators (included in the EU sets of Sustainable Development and Structural Indicators) illustrates that indicators with a solid statistical background are more accepted in policy spheres than indicators which have been developed outside the statistical system of environmental accounting. This set of indicators is therefore close to real statistical data and does not require transformation and modelling of data.

The Ecological Footprint is not included in the set of indicators. The suggested indicator set does not include one overall indicator of resource use, which would integrate several categories into one number. Such indicators enable an easier communication of overall results, as a large number of complex interrelations between the economy and the environment are illustrated in easily understandable terms; the Ecological Footprint is the most prominent example of this type of indicator. However, at the same time, this approach entails a number of important disadvantages, which shall be discussed using the example of the Ecological Footprint:

- Some resource categories cannot be measured, or are only measured indirectly. GHG emissions other than CO_2 are currently not accounted in the Footprint, and abiotic materials are only indirectly accounted through the demand for energy and land area for extraction and processing.
- Important information is lost in the data transformation procedure. For example, actual land demand of a product or country cannot be analysed with the Footprint.
- Strong assumptions have to be applied, in order to transform different types of primary data (e.g. material flows, land use, CO_2 emissions) into one common unit of calculation. For example, CO_2 emissions are transformed into the hypothetical forest area which would be required to sequester these emissions – this approach is frequently criticised, given that the sequestration is not actually happening (if it was then atmospheric CO_2 concentrations would not be increasing).

We therefore suggest using the original units to measure and illustrate the different aspects of resource use (e.g. material consumption and carbon emissions in mass, water use in litres, land area in hectares), without transforming them into a single artificial unit of measurement.

This set of resource use indicators is complementary to the basket of indicators which is being developed to measure the environmental impacts related to resource use. The EU Natural Resources Strategy from 2005 primarily aims to de-couple the environmental impacts of resource use from GDP. In 2007, DG Environment funded a project to evaluate different indicators of resource use regarding their suitability to illustrate the related negative environmental impacts.

The research team, including SERI, suggested a basket of four indicators, which should be further improved and integrated: the Ecological Footprint illustrating the impacts on biocapacity and (global) carrying capacity, Environmentally-weighted Material Consumption (EMC) reflecting the specific environmental impacts of materials and products, Human Appropriation of Net Primary Consumption (HANPP) indicating the intensity of ecosystem use and Land and Ecosystem Accounts (LEAC) illustrating the drivers for land cover and land use changes, which have implications for biodiversity and ecosystem services.

The indicator set suggested in this paper complements this basket of impact indicators through providing the information on the underlying volumes; in fact, in several cases, the indicator set is the physical basis for calculating these impact indicators (for example, accounts of material consumption of products or countries is one of the main databases for calculating the Ecological Footprint or the EMC of countries).

The current status of the suggested indicators, and the research needed to improve them

The accounting standards for the indicators already exist or are currently being developed. Some of the accounting methods underlying the suggested set of indicators already exist in an internationally standardised format, including material flow-based indicators on the product and the country level, Carbon Footprint and Kyoto inventories of GHGs. The accounting method for other categories, in particular for water and land, are currently being developed. As the measurement systems covering different types of resource use have been developed separately, further methodological harmonisation is still required, in order to improve the comparability of the results. In particular this requires defining common system boundaries for accounting of resource use.

For some of the suggested indicators, data is already available for both products and countries. Data on material consumption in the EU countries is collected by Eurostat (2007a) and MIPS calculations on the product level exist for a variety of products (see www.mips-online.org). Water Footprints exist for a large number of countries as well as for (mostly agricultural) products (see www.waterfootprint.org). Data on actual land cover and land use is available for Europe through the European Environment Agency (EEA, 2006), while data on land demand of products is very patchy, with the exception of biomass products, for which the UN Food and Agricultural Organisation maintains a data base (see http://faostat.fao.org).

Data gaps exist, particularly regarding resources embodied in internationally traded products. The data base for calculating those parts of resource use, which relate to indirect (or embodied) environmental effects, is still weak in all areas of the suggested indicator set. Some first data sets are available for the categories of materials, water and GHG emissions. Data on indirect land imported through the consumption of products is almost completely missing.

The Eurostat Data Centres, which are currently being created, will greatly improve availability of data on resource use. Eurostat is currently setting up a Data Centre on Natural Resources and Products, which will cover all resource categories described in this paper. This database will be a key step towards better availability of data for all the indicators suggested in the indicator set, as consistent data will be collected from the product level via the sector level to the country level.

Sustainability limits for different categories of resource use need to be defined. The identification of sustainability limits for each of the resource use categories is one of the key issues for further development of the suggested set of indicators. For GHG emissions, a per capita target of around 2 tons of CO_2 (equivalents) per inhabitant has been formulated. Other such targets need to be defined on a basis which is as scientific as possible. These targets could refer to the maximum amount of biomass extraction from a given area of crop lands and forests or the maximum uptake of fresh water, given the limited capacity for water renewal. With a system of limits for each of the categories, trade-offs between different options can be properly evaluated (see below).

Applying the set of indicators in practice

Data should be illustrated in aggregated and disaggregated form. The suggested indicators can be applied as an aggregated number (headline indicator), but also be disaggregated into components, such as different abiotic materials in the material flow-based indicators or different categories of land areas (agricultural land, forest land, built-up land, etc.). Disaggregation is often necessary, in order to link the resource use indicators closer to specific environmental problems and ensure a proper evaluation of results and trends. Also the links to related impact indicators can be established on a disaggregated level. Such environmental problems include the expansion of built-up land for transport infrastructure, the expansion of agricultural land for production of bioenergy and biomaterials or the substitution of metal ores by new compound materials or biomaterials.

The regional/local context should be considered in the interpretation of the indicators. When interpreting resource use indicators, the regional or local context should be taken into account as far as possible. In particular, indicators on water use depend critically on the local or regional availability of renewable water; a certain Water Footprint of a product could be problematic in one country, but sustainable in another.

Trade-offs can be identified with the set of indicators and related sustainability limits. In a system of indicators illustrating the different types of resource use plus sustainability limits for each of the categories, trade-offs between different options can be analysed. For example, higher production of biofuels would likely decrease the abiotic resource indicator (less fossil fuels) and, depending on the type of biofuels, also the related GHG emissions. On the other hand, this would translate into increased demand for land area and water. The set of indicators and related limits can illustrate, whether an improvement in one category leads to an unsustainable situation in another category.

On the national level, indicators of production *and* of consumption should be calculated. In the traditional environmental accounting frameworks (such as the one applied in the Kyoto protocol), environmental pressures are accounted according to a territory principle (production principle), i.e. accounted where it occurs. In contrast, a consumption perspective is necessary to illustrate the global environmental pressures related to the final consumption of goods and services by a given population. However, methods to account the global resource use related to consumption in one country are still under development and refinement, due to the lack of data on embodied environmental factors in international trade (see above).

The set of indicators should be applied in EU policy processes. The measurement system could play an important role in the revision of the Resources Strategy (due in 2010) and help in setting concrete targets for different types of resources. Such targets and related policies are also required for an effective implementation of the Action Plan on Sustainable Consumption and Production. Empirical evidence generated with this indicator set should also provide evidence to show that overall *levels* of resource use in Europe must be addressed in order to achieve a substantial reduction of the negative environmental impacts related to Europe’s resource use. The indicator set should also play a role in EU impact assessments and sustainability impact assessments, when a number of policy options are compared. Other policy areas where this indicator set could be useful are green public procurement, structural and cohesion funds and development aid.

8. Conclusions

This paper develops a set of resource use indicators for use by Friends of the Earth Europe in campaigns at the European level. In the context of resource use, Friends of the Earth aims to address environmental problems related to the overall scale of production and consumption in Europe and its global implications. The suggested set of indicators therefore focuses on the absolute amounts of resource use instead of specific environmental impacts.

For some of the indicators, data is already available for both products and countries. The suggested set of indicators can therefore be implemented in a reasonable time frame. However, resources should be devoted to improving data availability particularly for indicators related to land and water use as well as for natural resources embodied in internationally traded products. The upcoming Eurostat data centre on natural resources and products will considerably increase the availability of data for the indicator calculation. In order to allow a proper evaluation of these indicators and their trade-offs from a sustainability point of view, the identification of sustainability limits for each of the different resource categories should be a high priority in the near future. The set of indicators should then feed into a number of EU policy processes and help to better assess the impact of EU policies on natural resources, both within Europe and globally.

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Annex: Evaluation of existing indicators against FoE criteria

In the course of several workshops, Friends of the Earth developed a number of criteria that should be fulfilled by resource use measurement systems. This section evaluates the proposed measurement systems against these criteria.

Criterion	Descriptive evaluation
Providing a good basis for policy making and evaluation	
Measurement systems and the derived set of resource use indicators should be policy relevant: an indicator set should enable setting different types of targets (for the whole economy, for specific production sectors or for consumption); it should allow monitoring and evaluation of the implementation of macro policies (e.g. the implementation of an environmental tax reform or of trading systems to increase energy and resource productivity) as well as more specific (sectoral and cross-sectoral) policies related to resource use (e.g. energy, transport, trade, agriculture policies).	As all indicators can be applied on different scales of economic activity (see below), these indicators are suited to evaluate policies on different levels (product, sectoral or macro policies). Each of the indicators is suited to set resource-specific targets. Such targets could, for example, refer to the aggregated per capita material consumption or aggregated Ecological Footprint in one country or the maximum water use or Carbon Footprint for the production of a specific product. However, it should be stressed that no single indicator alone can provide a meaningful target for overall resource use; a set of targets is required. The concrete policy implication of an agreed target can be more easily identified if the indicator can be split into its components (e.g. types of materials; types of Footprint components, etc.).
Easy communication of directionally safe information	
Resource use indicators should be easy to communicate in order to provide relevant information not only to experts, but to a large number of policy makers as well as actors from civil society. Indicators should allow providing directionally safe information, i.e. whether a country or world region is moving towards reductions in natural resource use and related negative environmental impacts or whether one type of product or technology is using resources more efficiently than a comparable product or technology. Results of the measurement should therefore be expressed with simple numbers that anyone can easily understand. This should help to bring more attention to the issue of resource use and enable it to compete with other environmental issues and policy priorities (in particular, climate change).	In terms of communication, the Ecological Footprint is the indicator with most coverage in non-expert circles so far. Its particular communication strength stems from the fact that the Footprint accounting methodology itself allows derivation of an upper limit for sustainable resource use (through comparison with available bio-capacity). Such information on limits is still missing for some other indicators, such as material use and water use, and have to be developed externally to the measurement system. All indicators allow presentation of results in simple – and if desired – aggregated numbers. However, careful interpretation of the detailed results is always required to ensure that the derived implications are directionally safe, i.e. leading to more sustainable resource use patterns. Incorrect environmental policy conclusions could result in negative effects, for example if material consumption is decreasing due to a substitution from a material with less environmental impact to a material with higher

	impact, or if the Ecological Footprint is shrinking due to the intensification of agriculture. The Ecological Footprint only covers such negative effects indirectly (e.g. increasing use of fertilizers and pesticides).
Universal application with reasonable effort	
The measurement system should be applicable on a large scale, i.e. it should be possible to calculate resource use for all countries of the world or for a large number of products. This implies that the method can be implemented with a reasonable effort in terms of data processing capacity and required financial resources; for example, it should be possible to calculate resource use for all countries of the world within the next 2-5 years. In order to use synergies and avoid duplicating work, as far as possible the system should build on existing data and existing (or currently being developed) measurement approaches (see last criterion).	On the country level, all indicators can be compiled with reasonable effort within a time horizon of a few years. Some indicators (such as the Ecological Footprint or the Water Footprint) already exist for most countries and parts of other data sets are already available on the global level (e.g. material extraction data for all countries). In a global perspective, land use is the aspect with the largest data gaps. The evaluation of universal applicability on the product level is rather equal for all indicators. The most significant gap, which is relevant for all types of indicators, is that a product data base on the different aspects of resource use has not been developed so far (although work is underway to include resource use indicators in existing data bases on life cycle assessment).
Informing about physical limits	
One central pillar of FoEE's work is the concept of "Environmental Space", which states that the natural resources and ecosystem services, which humans can use without causing irreversible damage to the biosphere, are physically limited. A resource use measurement system and derived indicators should therefore be able to reflect those limits and inform where these limits are and whether we are already beyond these limits and thus living in an unsustainable situation. Indicators should help in defining and proving what overconsumption of resources means and enable identification of gaps between the (limited) supply of resources and the growing (future) demand.	As mentioned above, the Ecological Footprint is currently the only indicator which directly includes information on sustainability limits. However, there are also critics stating that the current calculation of overshoot (i.e. caused mainly by the land area calculated to sequestrate CO_2 – which is also problematic since this sequestration is not, in reality, happening) is just one (very land intensive) option to consider CO_2 emissions in resource use indicators. Also for other categories, such limits can be derived, i.e. from IPCC targets (e.g. 2° global warming) for the Carbon Footprint, from calculations of the renewable water resources available in different countries for the Water Footprint or from the maximum sustainable production of biomass for biotic materials (taking into account constraints, such as a desired share of national reserves and protected forests). Defining such limits for all resource use categories is one key task for the near future, in order to better quantify the gaps between current and sustainable levels of resource use.
Integrating issues of equity and social justice	
As the concept of Environmental Space also includes a social dimension, i.e. demanding a fair distribution of resource use across all	All indicators can help with illustrating current inequalities in different aspects of resource use (in terms of use of materials, water, land, etc.),

people on the planet, the measurement system should allow integration of issues of equity and social justice. It should help illustrate how inequitable current patterns of resource use are and should help define environmental and social standards. It should help illustrate the social impacts both within Europe and in other world regions of current and possible future patterns of resource use.	as they can be related either to the production or the consumption of products and services in different countries and world regions. Resource consumption indicators can also be related to different income levels within and between countries. However, none of the indicators can directly illustrate the social impacts. These have to be addressed by additional indicators.
Covering all relevant resource use categories	
A measurement and indicator system should account for all relevant categories of resource use and must ensure that possible shifts of environmental pressures between different types of resources can be identified and illustrated. The measurement system should allow identification of trade-offs between different categories of resource use (e.g. increased production of biofuels and biomaterials demands larger land areas). Therefore it should be possible to avoid "false solutions", which solely shift the problem from one sphere to another, and to identify priority areas of action towards real solutions.	None of the single indicators is able to cover all relevant resource use categories. It is therefore essential that a set of indicators is compiled, which allows different aspects to be covered in a complementary way. This can then help avoid "false solutions", which only shift the problem from one resource type to another (see, for example, the recent discussion on the increased share of biofuels in transportation). This approach has also been applied in the original Environmental Space (ES) studies in the 1990s, which assessed ES separately in different categories of resource use.
Measuring resource use on different scales	
Systems measuring resource use should be applicable on different levels of economic activities and thus inform about who is consuming which resources (per product, per industry, per person, per country). Assessments should quantify resource use and resource productivity of products, single persons and organisations. Resource use and resource productivity should also be measured for specific economic sectors (mining, chemicals, iron and steel, etc.). Macro-level studies measure resource use of countries and the world as a whole. Measurement systems and derived indicators of resource use and resource productivity should be designed in a consistent manner across different scales, in order to aggregate or disaggregate resource use indicators from products via sectors to countries.	All indicators are applicable on different levels of economic activity (products, sectors, economy) and can in principle be aggregated from the micro to the macro level. However, some indicators have so far mainly been discussed at the product level (such as the Carbon Footprint), others have mainly been applied on the macro level (such as indicators on land cover and land use).
Illustrating the international dimension	
The future of many developing countries depends on how the developed world deals with natural resources. Any resource measurement system on the national, sectoral or product level should therefore apply a life-cycle perspective. This requires including the resource requirements along the whole	The different resource use indicators already apply or can be linked to a life-cycle perspective, taking resource use into account not only in the country itself, but also the indirect impacts on other countries related to imports and exports. The "Ecological Rucksacks" of traded products can be calculated for each of the resource

production, consumption and waste treatment/recycling chain, independent from where on the planet the environmental consequences occur. Consequently, the so-called “ecological rucksacks” of imports and exports (i.e. the indirect resource requirements along the production chain) should be included, in order to capture possible shifts of environmental pressures related to domestic production and consumption to other countries and world regions. The indicators should therefore help illustrate the environmental (and entailed social) impacts of European resource use on the global level and identify areas of resource use with potential for conflict in the future.	categories: materials, water, land, carbon and also for the Ecological Footprint. Data availability is in general still not satisfactory, but intensive research and data work regarding all categories is ongoing, in order to improve the empirical knowledge of the indirect environmental impacts related to international trade.
Illustrating past, present and future aspects of resource use	
In addition to the analysis of developments in the past, a measurement system for resource use should enable formulation and quantification of possible future scenarios. In analogy to the debate on climate change, which is to a large extent driven by scenarios and results from climate models, possible future paths for resource use should be described and illustrated. In particular, it should be communicated which economic, social and environmental consequences can be expected, if no action to reduce resource use is taken.	Most data available so far has been produced in ex-post analyses, as the production of (international) statistical data entails a time-lag of one to three years. In order to calculate scenarios on future resource use, these indicators have to be integrated in other models (such as system-dynamic models or econometric models), in order to analyse possible future developments. The integration of data into models is easier if separate categories of resource use are available (e.g. separate data for use of water, materials, land or carbon emissions).
Rooting in the statistical system	
In order to be a widely accepted measurement system, as far as possible the calculated indicators should be based on and connectable to the statistical systems on the national and EU level. Such a system should be compatible with the economic “System of National Accounts (SNA)” as implemented in the UN System of integrated Economic and Environmental Accounts/SEEA or the European NAMEA (National Accounting Matrix including Environmental Accounts) approach. This allows a consistent analysis of the interaction between the economy and the environment and the assessment of the environmental implications of different patterns of production and consumption.	Some of the methods, in particular material flow accounting, have been developed in accordance with integrated systems of economic and environmental accounts. Therefore, material flow accounts have been integrated in a number of national systems of environmental statistics. Other approaches, such as the Ecological Footprint and the Water Footprint, have been developed outside the statistical system and are therefore not (yet) officially recognised in national or EU indicator systems. However, efforts are ongoing to integrate these approaches better into the overall accounting framework on the national level.