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Sylvia Lorek and Joachim H. Spangenberg
Sustainable Europe Research Institute, Grosse Telegraphenstr. 1, 50676 Cologne, Germany
(e-mail: Joachim.Spangenberg@ seri.de)

Wuppertal Institut für Klima Umwelt und Energie, Doeppersberg 19, 42103 Wuppertal, Germany
(e-mail: Joachim.Spangenberg@wupperinst.org)

Abstract: The objective of this paper is to identify those areas of consumption in which private households can make significant contributions to environmental sustainability, and to present a transparent and comprehensive set of indicators for them. The analysis of the environmental impacts of households focuses on consumption clusters that allow different life spheres of private households to be distinguished. Two criteria guided the investigation of the relevance of these clusters: (1) the environmental significance of the consumption cluster in terms of resource consumption, and (ii) the potential influence of households compared with other actors.

Resource consumption was chosen as a simplified but reliable representation of environmental pressure dynamics. Growing resource consumption goes together with growing environmental pressures and vice versa, although not necessarily proportionally, The key resources analysed are energy and material consumption, and land use. Based on this analysis, three consumption clusters were identified as priority fields for action by households: construction and housing, food/nutrition and transport (in this order). All other consumption clusters can be considered environmentally marginal, providing combined saving potentials of less than 10% of the total resource consumption. Finally, from a description of the respective roles of actors based on anecdotal evidence, a semi-quantitative 'actor matrix' is presented, indicating the relative influence of different actors in each consumption cluster.

Keywords: actor-centred approach, indicators, key resources, land-use patterns, material flows, sustainability.

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1 Introduction

Redirecting our societies and economies towards sustainability is a task that cannot be attributed to any subgroup of society but one that needs to involve society at large if it is to be mastered. The involvement of all major groups of society is one of the main institutional innovations that the sustainability discourse and Agenda 21 have brought about.

Households, through their demand side influence on the economy, are potentially one of these major actors, but as long as they do not act in a coherent manner, they will remain a 'sleeping giant'. This is why reliable and easily understandable information is of crucial importance if the already given environmental awareness of households is to become a relevant driving force in the market.

Chapter 4 of Agenda 21 underlines the need to change consumption and production patterns, by stating that 'the major cause of the continued degradation of the global environment is the unsustainable pattern of consumption and production, particularly in industrialised countries. **[...]** Changing consumption patterns will require a multi pronged strategy focusing on demand, meeting the basic needs for the poor, and reducing wastage and the use of finite resources in the production process.' (UN 1993). Economic and social conditions, important as they are for sustainable development, constitute the basis for consumption patterns, whereas the environment is more affected by the impact of consumption. This paper focuses exclusively on the environmental impacts with no desegregation of consumption according to income and social status. The social dimension and the potential policy responses, as demanded by Agenda 21, were analysed in two twinned studies to be published separately.

Chapter 4 calls for the development of indicators for sustainable development as concrete, issue-related guidance for taking and evaluating action. The issues of sustainable consumption and the appropriate indicators have been high on the political agenda ever since (see e.g. VROM, 1994; Miljoverndepartementet, 1995).

However, the consumption indicators included in the set of 134 sustainability indicators proposed by the UN Commission on Sustainable Development (UNCSD) met a number of reservations and have been tested by a number of pilot countries. This finally surfaced in the testing reports, so that — although developing as well as industrialized countries had chosen consumption and production patterns as a priority issue — the UN Division for Sustainable Development (UNDSD) interim analysis had to state that 'gaps were identified in the working list of indicators on complex issues such as **[...]** production and consumption patterns.' (UNDSD, 1999)

The fifth annual meeting of UNCSD (CSD 5) in 1997 called upon the Secretariat and governments to 'develop core indicators to monitor critical trends in consumption and production patterns, with industrialised countries taking the lead.' (UNDESA, 1998, p. 5). The International Work Programme on Changing Consumption and Production Patterns (IWPCCPP), established by the CSD during its third session in 1995, developed a complementary set of sustainable consumption indicators published in 1998 (UNDESA, 1998), focusing on the macro level.

For household consumption, no methodologies have been developed so far. Because most current sets of indicators for the environmental impacts of household consumption cover eclectically selected and widely differing aspects of the issue, the research project that this paper is based on first had to establish a new basic concept. As a second step, a set of indicators for sustainable household consumption was derived, based on a new, actor-centred approach. The proposal presented is based on calculations of resource consumption as the key driving force of current environmental problems, and an estimate of actors' influence. The limited and thus easily communicable number of indicators results from the identification of dominating factors of resource consumption, which are covered by one or a few indicators each. With these methodological innovations, weighing and aggregation problems prevalent in much of the previous work can be overcome.

The suggested indicators are based on significance analysis based on Gennan data. However, given the similarities in economic patterns and consumption styles, they should be applicable to the majority of industrialized countries without major readjustments. It is possible, however, to adapt the system of indicators to the diversity of countries' size, their infrastructure, climate, heating requirements, etc., by tailor-made modification of some of the existing indicators, or by suggesting additional indicators. These could be developed along the same line of thought (consumption statistic derived prioritizing) used in the study presented here. Some further modification of the selection criteria for consumption cluster indicators might be needed for (other, notably) developing countries owing to global differences in wealth, preferences, consumption patterns, culture, etc.

2 The conceptual basis

Although in the industrialized countries in particular there has been an ongoing dispute about the importance and influence of private households, the areas in which they can make a significant contribution to sustainable consumption are still largely unexplored. In order to identify these areas, first the most appropriate kind of accounting system for an actor-centred approach to household consumption ('where can they really make a difference?') is identified.

Any assessment of the environmental impact of household consumption, if intended to guide consumers, must compare the goods and services consumed in terms of their environmental impact. Doing this on the basis of their contribution to the most debated environmental problems, such as climate change, or eutrophication, necessitates the aggregation of environmental effects. This is a highly complex process (most advanced in Eurostat 1999), based on subjective assessments of relative relevance as much as on scientific measurements. For the average consumer, its components and in particular the weighing factors needed for the aggregation procedure are all but transparent. Consequently, the usefulness of any such methodology is limited as regards its everyday use in the shopping mall. Therefore, a transparent and simple, but still directionally safe system of assessing environmental impacts needs to be developed that can be used to identify the relevant aspects of consumer behaviour.

2.1 Frameworks for accounting

Aggregate household consumption is usually assessed either based on macro-level economics (households as final demand), or by micro-level domestic consumption analysis (counting the equipment of a household and accounting for the in-house consumption of energy and water). The first framework focuses on private consumption as represented in the system of national accounts (SNA), the second one deals with individual consumer behaviour within the household. Consequently, in the first framework all upstream environmental impacts are allocated to the consumer/household, whereas the second one includes hardly any upstream analysis.

The SNA-based approach serves the purpose of monitoring the entire life-cycle of the consumption of goods and services from cradle to grave, but gives no hints as to which actors might be in a position to influence the environmentally relevant resource consumption. In this sense, private consumption as defined in the SNA and/or extended

to include state consumption and intermediates (as a means for the supply of goods and services that are finally consumed by the households) is a 'sink category', not an actors' category. It allocates a much higher share of environmental impacts to the households than they are able to actively influence in reality.

The situation is the opposite for the second framework, mainly based on the domestic science approach. Accounting for the goods consumed in households is the standard basis for the educational and consultancy efforts of environment and consumer organizations, but is not capable of quantifying the upstream environmental impacts (see e.g. UBA, 1994; SustainAbility, 1994).

A significant problem arises from the frequent mixture of these two approaches, without explicitly clarifying which one has been used to investigate which aspect of the environmental relevance of household consumption. As a result, e.g. the average energy consumption per capita is reported alongside the households' equipment level with microwaves or other appliances (e.g. in OECD, 1998a). The environmental relevance of such reporting remains unclear or at best non-quantifiable.

Although the macro reporting approach does not deliver advice to the consumer supporting her or his day-to-day decision-making, the approach of accounting for the in-house consumption cannot bridge the gap between counter and kitchen on the one hand and the environment on the other hand. In reality, however, households can do so, at least to a certain degree.

Obviously, the real influence of consumers is somewhere between what is covered by the two different measures described, making a new approach necessary if actor-specific questions are to be dealt with. However, it is not possible to do so by defining a general accounting framework, since the role of consumers, their motivation and thus their influence is too diverse in the different consumption clusters (see e.g. Scherhorn, 1991; Schultz *et al.*, 1999).

On the macro level, the task is then to identify the most environmentally relevant consumption clusters and specify the environmental impact of household consumption accordingly. A necessary tool for this step is a simplified, but directionally secure measure of environmental disturbance.

2.2 Environmental disturbance and resource consumption

Any meaningful assessment of the total human-made environmental distortions, diverse as they are in their nature as well as in their causes and origins, must be based on a life-cycle approach, from resource mining to final disposal. The outputs affecting the environment include

- substances that are deliberately dissipated in the environment for a specific purpose, e.g. pesticides or fertilizers in agriculture or salt on icy roads in winter time,
- emissions and deposition of solid, fluid and gaseous wastes, released into the environment as a result of human activities along the chain of production, consumption and disposal, from e.g. carbon dioxide energy consumption during the manufacture and use of a product, or overburden from mining.

Environmental stresses are usually characterized either by these pressures or by the symptoms that they cause. However, because the list of pressing environmental problems is a long one, because different substances can act in a synergistic way affecting several symptoms, and because linear cause-effect relations are rather the exception than the rule

in ecological systems, for the assessment of aggregate household impacts simplification is needed. Therefore, the authors have chosen to characterize (not measure) environmental stresses by quantifying the main driving forces behind them. Analysing the list of main environmental problems in Europe (EEA, 1999), it has been shown that all of them—except for those based on high toxicity of small volumes of substance — are correlated to the consumption of three groups of resources: energy, material and land (Blazejczak *et al.*, 1998; Lorek and Spangenberg, 1999).

This is not surprising, because every human activity needs material as its physical basis, energy to go ahead and a realm where it takes place, i.e. area. Material flows, energy consumption and land use are the primary inputs of the production system. Obviously a decline in resource 'throughput' (Daly, 1991) would ceteris paribus reduce hazards and risks on the output side by 'slimming' the industrial metabolism (Ayres and Simonis, 1994). Environmental pressures were bound to decrease as long as the specific toxicity for humans and the environment per ton of substance throughput would not increase enough to overcompensate the reduction of pressures resulting from the diminished throughput. Given the current knowledge about the detrimental effects of substances, however, it seems quite plausible that such an increase in substance-specific risks can be avoided. If not so, then the alternative approach of focusing environmental policies on specific pollutants would stand even less chance of solving our problems. The total pressure, therefore, should decrease significantly with reduced throughputs. This kind of target is called *directionally secure* because with decreasing inputs, the level of environmental damages will be decreasing with a high probability. In addition, toxic substances must be covered by health and safety regulations and should be banned from the sphere of the consumer rather than being taxed and labelled, thus becoming an issue of consumer responsibility.

Shifting the focus of concern from the reduction of emissions to resource consumption, from industrial chimneys towards the sales point, is also changing the role of households from being a victim of environment hazards to being a co-producer. This growing attribution of environmental responsibility to households calls for their empowerment as actors, in particular by equipping them with reliable information and meaningful indicators about the resource intensity of the goods and services on supply. Providing this kind of simplified, directionally secure and transparent information for the consumer could be instrumental in order to activate the power of demand-side environmentalism.

Characterizing environmental pressures and their trends by analysing the input side by its very character cannot result in a quantitative description of the various damages. However, it indicates which pressures have to be reduced and which corresponding changes in consumption clusters are needed in order to minimize (if not cure) the known environmental damages and as well minimize or prevent future ones (Spangenberg *et al.*, 1999).

2.3 Consumption clusters where households can make a difference

In order to analyse the life-cycle-wide environmental impact of household consumption, the total energy and material flows activated by final demand, including public services consumption, are assessed. Household consumption is then desegregated into ten consumption clusters frequently quoted in the literature (see Table 1). These are analysed regarding their resource consumption to identify the most environmentally relevant ones.

This is quite a complete analysis of resource-relevant consumption, since the ten clusters represent more than 95% of the resource consumption activated by private households' final demand.

Clusters will be considered of prior environmental importance as fields of household decision-making if they are both environmentally relevant and accessible to significant influences by consumers' choices. The latter is here assessed by means of plausible reasoning, without a detailed sociological or political science analysis.

Three clusters can be identified which primarily consist of public consumption: health care (hospitals, rehabilitation institutions,...), education/training (kindergartens, schools and universities,...), and social life (including the police, the military and other public services). In these sectors households as customers have limited influence regarding how frequently they make use of the services provided and hardly any on the resource consumption per service. Consequently, these clusters will be omitted from the further analysis of priorities for consumer action, regardless of their undisputed environmental significance.

When analysing the seven remaining clusters regarding their share in key resource consumption, it turns out that the total requirement of construction and housing, food and transport adds up to about 70% of material extraction, energy consumption and land use. Each of these three represents more than *15%* of energy and material consumption.

Table 1 Where households can make a difference (source: Lorek and Spangenberg, 1999).

Consumption clusters	Influence of private households	Environmentally relevant
Clothing	x	
Education/training		x
Food	x	x
Health care		x
Construction/housing	x	x
Hygiene	x	
Cleaning	x	
Recreation	x	
Social life		x
Transport	x	x

The other four clusters (hygiene, clothing, cleaning and recreation without transport) that can be influenced by households, account for less than 5% of resource consumption each. Given the relatively small share in resource consumption and the limited although undeniably existing influence of households, e.g. on the resource intensity of clothing or cleaning agent production, the conservatively estimated maximum reduction potential in these four sectors together is estimated to be about 10% of total resource consumption. Although this is not a quantity to be ignored, these sectors are considered as environmentally secondary (maybe not so from a sociological or psychological point of view: Section 4).

The indicator development will therefore concentrate on the three environmentally dominant areas identified as *priority fields of action:* construction and housing, food and nutrition, transport and mobility (see Table 1).

3 The indicators

In order to develop conclusive and communicative indicators for household use, the three priority fields of action are analysed to identify the dominant factors driving resource consumption. The data used originate from Germany, but a comparable situation can be assumed for most industrialized countries (see also the other contributions in this issue).

Based on existing data, for each priority field a few consumption issues are identified offering the most significant potential for reducing resource consumption. These will be presented as 'why households can make a difference' and characterized by indicators. The relative influence of the different actors on the resource consumption in each consumption cluster, including private households, is presented titled 'actors involved', with 0 = little influence, + = significant influence, and ++ = strong/dominating influence).

3.1 Construction and housing

3.1.1 Why households can make a difference

Energy consumption of housing accounts for 32% of the total demand, with heating representing 49% of the total households' energy consumption, including passenger transport (GRE, 1997, p. 10). A reduction in the energy demand for heating would thus significantly contribute to sustainable household consumption.

Construction and housing causes 29% of the total material consumption. This includes all raw materials and resources needed for the construction, extension and maintenance of apartments and houses, including heating, as well as materials that become necessary at the end of the life-cycle in order to demolish the building. Annually in Germany 500 millions of tons of sand, gravel and stones are mined (1990, data for Western Germany, Adriaanse *et al.*, 1997), and 143 million of the 338 million tonnes of waste in Germany (1993, data from UBA 1997) originate from the construction industry (including road construction). To this, a significant share of the 68 million tonnes of overburden from mining per year has to be added, plus some of the production waste (total 78 million tonnes) and the domestic waste (total 44 million tonnes).

The construction sector is the main contributor to the increasing sealing off of land, with 85% of the approved building projects in 1994 dedicated to housing. In a business-as-usual scenario, the total settlement area will increase by 370 km^2 until 2010 (Enquetekommission, 1998), and 84% of this area will be used for single family houses.

Thus the housing sector offers significant opportunities for savings regarding land use, material flows and energy consumption.

3.1.2 Indicators

Indicator 1: Heating energy consumption ($kWh/m^2/a$)

This indicator is already established in expert discussions and is supposed to be an essential part of an 'energy passport' for real estate that will be introduced in 2001 (GRE, 1997, p. 96). Quality benchmarks already exist for different types of building.

In practice, the indicator can be used by architects and investors to check their investments and plans, and by households as a selection criterion for the new flat or house when a household has to move.

Aside from the construction phase, however, it does not indicate specific action to be taken but can be a means to monitor whether thermal insulation work undertaken by the tenant has been successful.

Indicator 2: Resource intensity (kg/m^2/a)

The total material flows can be diminished considerably through reduced resource intensity in the sector of housing construction by using recycled materials and those that can be easily rebuilt or demolished. Technological achievements, such as the ultrasonic recycling of concrete decomposing it into the re-usable single materials sand, gravel and cement, will hopefully lead to even more significant reduction in future.

Indicator 3: Living space (m^2/cap)

A valid calculation of individual resource consumption cannot be achieved by means of heating energy consumption and resource intensity measured in kg/m^2. A single person will presumably consume less energy than a four-person household in an equal-sized flat. The living space per person provides additional information necessary in order to avoid misinterpretations.

Empirically, energy and material consumption is correlated to the living space area per capita (Enquetekommission, 1998). Currently, the living space per capita tends to increase with the age and income of a person, and in each age group grows over time. This is a reason for environmental concern regarding future resource consumption, in particular when taking demographic change into account.

Indicator 4: Relation of private investment in existing houses to the erection of new buildings (dimensionless)

Modernizing existing flats and houses to the standard of modern housing equivalent to that of new constructions significantly reduces material flows and land use per unit of functionally identical output (Enquetekommission, 1998). The indicator monitors the trend in private household expenditure relevant to this alternative.

Currently, the Federal Republic heavily subsidizes new private house construction, but still the future owner has to contribute significant matching funds. Thus the indicator also reflects the flow of subsidies, and in case their priority should be changed from erecting new buildings to maintaining existing ones as suggested by the Federal Parliament's Enquete (Enquetekommission, 1998), it monitors the degree to which households react to such changes in financial incentives.

indicator 5: Settlement area (m^2/cap)

Settlement area is one of the main contributors to sealing off land, together with transport and production infrastructure. Measuring the development of land use for settlement purposes will therefore serve to indicate the sustainability of our settlement patterns.

The indicator measures the long-term trends in housing; although only to a limited degree attributable to day-to-day consumption decisions, it is driven by consumer choices as regards the flat or house they rent, buy or build. It thus characterizes one important aspect of our overall lifestyles and consumption patterns.

3.1.3 Actors involved

Housing is characterized by a high diversity of actor-specific, but frequently overlapping potentials for influencing energy consumption and material flows as well as land use. Private households are important actors for a number of reasons:

- Nearly all housing expenditures (monetary and physical) can be attributed to private households, either as users or as property owners. In Germany, 38.7% of all flats are freehold property; in houses consisting of one or two flats, the share of freehold property is 71%. In these cases, the households are owners as well as residents, with the influence increased accordingly.

- Private households play an important role with respect to decisions on sustainable housing modernization. They influence to a considerable extent the amount of material, energy and water needed for construction and residence, in particular by deciding about the apartment size (even if socio-economic constraints are taken into account).

- As owners, they determine heating energy consumption by deciding about thermal insulation, the choice of more or less efficient heating systems and the like.

- The patterns of airing and heating, and the preferred room temperature influence household energy consumption significantly, at an equivalent level of living comfort (up to a factor of 2 according to different consumption behaviour). This way, residents can determine the amount of heating energy consumed by their behaviour (and through minor renovations, e.g. for the sealing of joints).

A similar pattern of influence to that of private owners is attributable to public or corporate owners of rentable flats. One important difference, however, is the investor—user dilemma that occurs if the house owners' investments, e.g. in energy saving, benefit the resident and his/her energy bill, but not the investor. In these cases, energy service providers can help through contracting arrangements, i.e. by paying for and managing the investment and, in return, reaping the benefits by charging the consumer a stable price, although the costs are decreasing. The resulting surplus makes up for the profit of the contractor, the owner has a modernized (and thus value-increased) property, and the households benefit from stable energy payments below market prices.

Local authorities significantly influence land use by dedicating specific areas for housing purposes and defining standards associated with building permits. Regional planners and architects influence settlement structures (living area) as well as the standards of construction (resource intensity). They do so by providing low energy consumption and resource-efficient housing, and they could help by offering flats of flexible size which permit a regular adaptation of living area to the changing size of a family.

Loans banks define funding criteria and thus influence the standard of housing — a capacity that could easily be extended to energy and material efficiency standards.

Political regulation frameworks and subsidies strongly influence if not determine households' decisions whether to invest in the construction of new houses or whether to renovate old ones. Taxation of living area, material input and energy taxation, and energy consumption standards play significant roles, as do criteria for granting subsidies. In Germany, public support for new developments was 27.1 billion DM in 1996, compared with 8.4 billion for upgrading existing houses.

Table 2 illustrates the diversity of actors involved as well as their different but overlapping spheres of influence, according to the reasoning above. These results are based on common sense and anecdotal evidence; for a validation of these estimates or even for their quantification, detailed social science studies would be required.

Table 2 Construction and housing indicators (source: Lorek and Spangenberg, 1999).

	Private households						
	Resident	Property owners	Communes	Corporate owners	Politics	Planning	Services
Heating energy consumption	+	+	0	+	+	+	+
Resource intensity	0	+	0	+	+	+	+
Living space	++	0	+	+	+	+	0
Relation of private investment in existing houses to erection of new buildings	0	++	+	0	+	0	0
Settlement area	0	+	++	+	++	+	+

3.2 Food

3.2.1 Why households can make a difference

In Germany, the food chain's share of energy and material consumption runs at 20%. Agricultural area, 97.9% of which was intensively farmed in 1999 (SÖL, 1999) covers 56% of Germany's total land area. It furthermore has a considerable water pollutant and eutrophication impact, as 38% of the total nitrogen input and nearly 40% of the phosphorus input originate from agriculture (Burdick, 1998). Detrimental impacts on the soil are caused by erosion and pesticides.

The output of greenhouse gases, measured as CO_2 equivalent, is significant. In order to feed Germany's 80 million citizens, 260 million tonnes of CO_2 equivalent are emitted per year, i.e. 3.2 tonnes per inhabitant (Enquetekommission, 1994). Table 3 provides the data desegregated by sectors involved.

Table 3 Greenhouse gas emissions from the food chain (source: Enquetekommission, 1994).

Sector	CO_2 equivalent (million tonnes)	Percentage
Farming, crops	20	7.7
Farming, livestock	115	44.2
Food industry	15	5.7
Trade, other distribution	35	13.5
Consumer activities	75	28.9
Total	260	100

According to the methodology of this study, however, the calculation has to be adjusted by eliminating transport and heating to avoid double accounting (transport for shopping purposes, heating of kitchen and dining room). With this adjustment of 33 million tonnes, which, for the sake of simplicity, we fully count on its main cause, i.e. consumer activities, the food sector's total CO_2 equivalent emission is at 227 million tonnes. On the other hand, the resulting consumers activities' share of 42 million tonnes or 18.5% (75 million tonnes given in Table 3 minus the adjustment of 33 million tonnes) underestimates their influence, because households could influence environmental resource consumption in the production phase significantly by selecting particular food, e.g. organic produce, or by adopting a less meat-intensive diet.

3.2.2 Indicators

Indicator 6: Meat consumption (kg/cap/a)

From a healthcare point of view, a reduction in meat consumption has a number of positive effects, but these will not be dealt with in this paper. Here we refer to the environmental significance of meat production:

- The emissions of the livestock production sector of 115 million tonnes CO_2 equivalent are six times higher than those of the crops sector (20 million tonnes; see Table 3).

- To produce meat, large areas of land are needed. In Germany 60% of the farmland is used for the cultivation of livestock, and additional feed is imported from the EU and from overseas.

- Ammonia emissions caused by pork breeding contribute significantly to regional acidification and eutrophication.

- Dung water contributes to groundwater pollution (in some areas, the majority of natural wells are no longer suitable for drinking water purposes owing to high nitrate concentrations), and it contributes to the nitrogen input to fragile ecosystems via water and air.

This indicator is also used in the draft set of OECD sustainable consumption indicators (OECD, 1998a).

Indicator 7: Organic products (% market share of food products)

Organic agriculture leads to a considerable reduction in pollution as no pesticides and less fertilizer are used. Thus, the pesticide and nitrate leakage into groundwater is diminished, and the biodiversity of accompanying plant and neighbouring ecosystems is significantly higher than on intensively farmed land. Furthermore, the volume of erosion caused by organic agriculture is significantly smaller than for sustainable development.

Adequate animal breeding is not only an ethical issue, it also lowers the amount of pollutant substances released. Furthermore, the volume of erosion caused by organic agriculture is significantly smaller than in intensive farming.

The energy consumption of organic fanning is only slightly less than that of conventional farming (Haas and Köpke, 1994). The advantage from not using synthetic fertilizers or importing supplementary feedstock is partly compensated by the lower output (Jungbluth, 2000). Organic livestock production needs about 15% less energy than conventional meat production, depending on the kind of animal (Kramer and Moll, 1995).

Indicator 8: Food transportation (km/kg)

The distribution of food is, after livestock production and consumption activities, the third biggest factor contributing to resource consumption in the food sector, with increasing tendency. The growing average transport distances are increasing the demand for transport infrastructure, in particular through increasing road transport (here only transport to the retailer is accounted for; the transport from the shop to the home is covered by the mobility indicators).

The preferable indicator would thus be based on product-specific transport analysis, including domestic and foreign intermediate products and services, packaging, etc. Given the existing restrictions on data availability, the total domestic transport effort for food and feed is taken as an approximation, since these data are available in the German national statistics. For other countries, similar proxy indicators may be suitable.

3.2.3 Actors involved

By expressing their preferences at the shopping counter, households have a significant influence on the kind of food produced, the mode of production and thus the environmental impacts. Their influence is frequently limited, however, as regards the transport intensity of the food purchased, partly owing to the lack of information (labelling), partly owing to the absence of substitutes.

For this aspect, traders and retail companies are more influential, but the supply structures (e.g. limitations in regional organic food provision) are equally important. They can be improved by the farming sector, but this is at least partly dependent on the market conditions and cost structures determined by politics, in this case particularly by the EU's Common Agricultural Policy (CAP). Food industries and restaurants are additional actors on the supply side, with the latter having similar choices to private households regarding the menus they offer, but restricted by market demand (see Table 4).

Table 4 Nutrition indicators (source: Lorek and Spangenberg, 1999).

	Private households	Trade/ marketing	Farming	Food industry	Gastronomy	Politics
Meat consumption	++	+	+	+	+	+
Organic products	++	+	++	+	++	+
Food transportation	+	+	0	+	+	+

3.3 Transport

3.3.1 Why households can make a difference

The growth of transport volumes and distances is still closely linked to economic development, and the trend in modal split is towards more environmentally unsustainable modes, such as road or air transport. Although transport volumes are reaching the limits of capacity of the road system, transport infrastructure has become a major driving force in land degradation and ecosystem fragmentation (a UK headline indicator for sustainable

development; DETR, 1997). Although not yet the sector with the highest greenhouse gas emissions in Germany (unlike New Zealand, for example), transport is the sector with the highest annual emission growth rates. Fifty per cent of the global mineral oil consumption is for gasoline, accounting for one-fourth of the total greenhouse effect. In Germany this rate is 30% (Petersen and Schallaböck, 1995). In the OECD member countries, 32% of primary energy consumption occurs in the transport sector, with the United States at 37.4% and the European OECD states at 27.2% (OECD, 1998b). Not included in these numbers are the CO_2 amounts (including CO_2 equivalent of other greenhouse gases) caused by the production and maintenance of vehicles and infrastructure, So far, all efforts to curb transport growth have failed (Akademie, 1997).

In Germany, private households contribute 96.4 million tonnes CO_2 (directly) and 68.3 million tonnes CO_2 (indirectly) to the emissions from transport (StBA, 1997). The share of transport and of road transport emissions in particular is given in Table 5:

Table 5 Share of total emissions caused by transport (source: Akademie, 1997).

Emissions	Share of all transport	Share of road transport
CO_2	20%	16%
NO_2	60%	30%
hydrocarbons	33%	10%

Regarding land use, 4.6% of the total area of Germany is occupied by transport infrastructure (StBA, 1997), more area than for housing. This figure excludes non-road infrastructure, such as petrol stations, repair shops and private parking areas, and indirect land occupation by noise corridors, etc.

About 83% of emissions can be attributed to passenger transport and 17% to freight. Still the amount of hazardous substances released from diesel trucks should not be underestimated. Compared with the total volume of transport, truck transport has a share of only 15—20% but it causes approximately half of all nitrogen emissions of the total transport sector and an even higher percentage of soot emissions (the contributions to road damage and maintenance as well as all other non-environmental impacts are not discussed here). Between 1990 and 1995 an increase in goods transport by 15% could be observed as a result of a strong increase in goods transport by road (+50%) and the simultaneously diminishing importance of goods transport by rail (—32%) (Akademie, 1997).

3.3.2 Indicators

Indicator 9: Shopping and recreation transport distances (km/cap/a)

Transport activities for shopping and recreation purposes are not only strongly dominated by passenger car use, they also account for more than half of the kilometres covered per person (see Table 6). Even if these transport activities are not 'voluntary', private households have at their disposal significant potentials for choosing more sustainable means of transport.

Changing framework conditions, such as increasing individualization of lifestyles partly made possible by increased mobility, the growing number of single-person households, suburban shopping centres and transport-intensive leisure activities, all

contribute to growing transport distances covered by private households, while commuting is decreasing in its relative importance. Settlement structures induce transport activities by increasing or diminishing the distances. So do the means of transport available, while the mobility rate (the number of trips) as well as the time used for commuting has remained quite constant in Germany for more than 50 years (Petersen and Schallaböck, 1995).

Table 6 Passenger car transport: distances and person-kilometres per transport purpose (source: Petersen and Schallabock, 1995).

Transport purpose	Distance (%)	Person-kilometres (%)
Shopping	27	11
Recreation	40	40
Occupational	0.2	9

The category of 'leisure mobility', however, is problematic as far as it is a residual entity in transport statistics for mobility not induced by paid labour. It includes transport from reproduction and voluntary work (Spitzner and Aumann, 1995). This kind of transport, however, is characterized by quite low levels of elasticity regarding the mode of transport (Spitzner and Beik, 1996).

The indicator proposed focuses on the distance covered, because societal trends such as shorter job duration, longer educational or unemployment phases, and the trend towards higher female employment participation resulting in increasing numbers of working couples with two distant workplaces, lower the private households' possibilities to avoid transport. However, as regards occupational and educational transport activities, private households are free to select the means of transport they use, at least as long as sufficiently convenient choices are available.

Indicator 10: Modes of transport for vocational purposes (share of cars, rail and other public transport, non-motorized transport)

In recent years, the functional separation into inner-city working and outer-city living areas has led to an ever-increasing number of commuters. Their mode of transport has a significant influence on the resource consumption for transport. For commuting, this is to a significant degree open to consumer decisions, whereas the frequency and distance of trips is overwhelmingly beyond their influence. Vocational purpose transport is dominated by cars, with still increasing shares (in Germany except for educational purposes).

As the frequency of transport activities for occupational, educational/training and business purposes by and large cannot be influenced by private households, the indicator refers to the transport activities for shopping and recreation purposes. Indicators such as 'commuter rate' and 'commuting distances' are regarded as good for planning purposes, but less suitable for indicating consumer behaviour.

Indicator 11: Modes of transport for shopping and recreation purposes (share of cars, rail and other public transport, non-motorized transport)

Factors that decisively influence the selection of transport means are subjective needs, individual preferences and values. Sustainable consumption behaviour at the present state

of the art can be predominantly expected in those consumption clusters that require the least personal effort (low cost hypothesis). However, some studies indicate that individuals regard the transport sector as a high cost one, resulting in a comparably low elasticity as regards car use.

As pointed out already, the environmental impact of transport is determined by the frequency of trips, the distance per trip and the mode of transport. Since the transport distance for recreation and shopping is already covered by another indicator, this one monitors the modes of transport. Thus the environmental sustainability of consumption is strongly influenced by the modes of transport chosen.

Indicator 12: Number of passenger cars and share of households owning at least one car (%)

Empirical studies show that even proven environmental awareness does not significantly influence the mobility behaviour of car owners. Once a car is available, it is used as frequently as in other car owner households.

On the other hand, environmental concerns are instrumental in the decision whether to buy a car not, opting e.g. for a combination of car sharing, rental cars and public transport. The indicator also provides information on non-car households, which are significantly discriminated by the current mobility system (a social criterion).

Indicator 13: Holiday flights (km/cap/a)

Despite the still relatively small environmental resource consumption of aviation, it needs to be monitored due to the current trend for more people to use air transport to fly more frequent flights to ever more distant destinations. This corresponds to a steep increase in energy and resource consumption, which is not sustainable in the long run.

Indicator 14: Average energy consumption of new cars (litres gasoline/100 km)

From the users' point of view the use of the private passenger car is actually the quickest, most comfortable and economically attractive means of transport, especially as the costs for the railway network are included in the ticket price whereas the costs for the road network are independent of distance travelled. The car will remain a predominant means of transportation unless there is a change of circumstances.

Some 24% of the energy consumption by households is caused by transport, and 60% of this by gasoline consumption (StBA, 1999). Besides the transport distances, frequencies and the mode of transport, the efficiency of the cars used has a major impact on energy consumption. This efficiency is determined by two factors: the technical efficiency of the car itself, and the style of driving. This indicator focuses on the former, which can be influenced mainly in the phase of buying a new car.

Decreasing energy consumption of new cars (and thus a decrease for the next decade) can be achieved only if the current trend towards bigger, faster, more comfortable and thus heavier cars is either overcome or at least overcompensated by efficiency gains.

3.3.3 Actors involved

In Germany, 58% of all households own a private car; additionally 23% own two or more, but 56% of all West German and 66% of all East German citizens have not used

railways in the last year (BMU, 1998). There are 41.4 million cars registered in Germany (StBA, 1997). Aviation shows the highest annual increases (7.5%) of all transport activities, with holiday flights playing an important role. Regardless of external constraints, households dominate the decision on the mode of transport, but the availability of suitable and convenient alternatives is important as well. Local authorities and service providers can do a lot in this respect, by offering or reducing the supply of infrastructures for mobility (public transport, parking areas, etc.) and by increasing or reducing the need for mobility through planning and more or less centralized service availability. Employers influence commuting behaviour by financial and administrative incentives.

Travel agencies and tourism companies influence holiday transport, and car-sharing providers do so for the rest of the year. Political decisions can increase or decrease the cost of mobility, thus setting incentives for more or less resource consumption for transport purposes. Thus the legislative and administrative authorities are important actors for the development and implementation of a new policy in this sector, Finally, the efficiency of the means of transport is determined by industry as well as by their customers. Table 7 illustrates the overlapping spheres of influence.

Table 7 Transport indicators (source: Lorek and Spangenberg, 1999).

	Private households	Recreation sector	Local authorities	Politics	Industry	Services	Employer
Shopping/recreation transport distance	+	+	+	+	0	+	0
Modes of transport for vocational purposes	+	0	+	+	0	+	+
Modes of transport for shopping and recreation purposes	++	+	+	+	0	+	0
Number of passenger cars/share of households	+	0	+	+	+	+	0
Average energy consumption of new cars	+	0	0	+	+	+	0
Holiday flights	++	+	0	+	0	0	0

4 Discussion

The 14 new indicators for environmentally sustainable household consumption suggested in this paper are based on consumption clusters that have been demonstrated to cover the vast majority of key resources consumption. The indicators themselves monitor the main driving forces inside the clusters. They can be used by consumer organizations to focus their advice on the environmentally most relevant issues. For example, no quantifiable environmental difference could be found between deep frozen and fresh vegetables from comparable locations, synthetic fibres are not quantifiably better or worse than natural

ones, and clothing and fashion in general are no reason for serious environmental concern (that may be different from a lifestyle point of view, where the symbolic function of consumption counts more than the direct environmental impact).

The identification of relevant actors should be useful for policy purposes, permitting joint activities for sustainable household consumption. These could include voluntary or mandatory labelling schemes and consumer information, and also financial incentives, such as resource consumption taxes, to make environmentally sustainable consumption economically reasonable.

Only recently, more empirical information has become available on the linkage of resource consumption and economic growth (e.g. in a number of papers presented at the conference of the European Society for Ecological Economics, Vienna, May 2000):
growth results in high resource consumption levels due to affluence, rather than in low levels as a result of high quality, expensive but eco-efficient consumption as the environmental Kuznets curve hypothesis suggests (Spangenberg, 2001). The indicators developed in this paper can be applied to such questions and illustrate the significantly higher environmental disturbance potential caused by affluence under the current consumption patterns (Lorek and Spangenberg, 2001). Geographically, this applies to Europe in the first instance: the indicators were developed based on German data, and they can be applied all over Europe and probably in most OECD countries.

With the resource input based approach developed in the paper for monitoring trends in environmental pressures, hazardous impacts on human health caused by the environment will not be recorded. These include, above all, chemicals toxic to humans, i.e. cancerous, teratogenic, mutative, allergic and endocrinological substances, but also ecotoxically doubtful, hardly biodegradable or bio-accumulating substances. As long as goods and services contain such substances, their avoidance is an essential aspect of health-conscious consumer behaviour. The protection of humans against toxic substances is, however, rather the task of national legislation in order to legally prohibit harmful goods and substances, than one of individual consumer choices. Thus toxicity concerns are a subject of sustainable production patterns rather than one of sustainable household consumption.

Whereas the importance of a specific good or service for sustainability is, in general, only minor, numerous goods and services have a symbolic function besides their utility function. Some of them indicate membership of a certain social or lifestyle group, serve as a symbol of status or for compensatory consumption (Scherhorn, 1991). The importance for environmental sustainability and the perceived symbolic value of the products or services consumed need not be matching at all. This lack of congruence, however, does not reduce the validity and importance of the communicative function. On this basis, selected goods and services can be singled out that might serve as *icon indicators*, which, owing to their communication and social distinguishing function, play an important role in sociological and psychological consumption analysis, although less in the environmental one. From an environmental point of view, in these cases the results of this paper could still be used to check the relevance of the consumption clusters to be communicated by the icon indicators, thus avoiding a misallocation of political and communicative efforts.

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