STOTEN (Science of the Total Environment)  
Special Issue Natural Resources: Part II  
The second collection of short papers 
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Editorial

Special Issue about Natural Resources — Part II

Global resource use and its implications for the economy, the environment and the wellbeing of mankind are beginning to get recognition as one of the key challenges in modern economic policy. Increasingly, business leaders are considering how to guide their companies to a future of doing more with less. Government leaders are discussing policy proposals in this direction. NGO leaders and scientists from all over the world are seeking optimal ways to influence this process with the best available insights.

The World Resources Forum (WRF) has established itself as the global science-based platform for sharing knowledge about the economic, political, social and environmental implications of natural resource use. WRF promotes innovation for resource productivity by building bridges among researchers, policymakers, business, SMEs, NGOs and the public. Our flagship activity is the bi-annual WRF Conference.

Inspired by the discussions and scientific contributions at WRF conferences, we decided to collaborate with a high profile scientific journal to publish a Special Issue on Natural Resources. An excellent partnership with Science of the Total Environment (STOTEN) was then established to publish a Special Issue on Natural Resources. We considered a broad range of topics such as “security of supply”, “growth and innovation”, “assessment methods and indicators”, “the social dimension of resources”, as well as “communication and education”. Novel aspects, surprising results and trends, as well as future research needs, are presented in this SI.

After the Fukushima nuclear accident many countries have intensified the search for technological energy alternatives. In this context hydropower plants are seen to have a high potential in the framework of a future renewable energy supply. A common view is that small hydropower stations may be preferable to large ones. However, a contribution in this SI concludes that the material footprint is a suitable approach for assessing Best Available Techniques (BAT) for each process stage. Although, results of such assessments can support decision makers, the tools available are often too complex to be used by non-professionals. For example Environmentally-Extended Multi-Regional Input–Output (EE-MRIO) models provide us with a wealth of data relating to consumption-based environmental impacts. However, this data is not readily accessible, making it difficult to extract and communicate the important messages retrieved. A contribution in this SI presents a task-oriented web based interface which improves the access to environmental and economic data and makes it more relevant to policy makers and civil society.

Technology alone is no longer able to solve global challenges and a further paper in this SI discusses the role of human capital and new social behaviors which are critical factors to combine economic competitiveness and sustainability. In this context, a further study lights up which correlations between resource efficiency, innovation and cultures of trust can be found. It discusses important aspects for the improvement of management instruments and qualification concepts for workplace training, especially for small and medium sized enterprises (SMEs). A decent or sufficient lifestyle is largely considered an important objective in terms of a sustainable future. However, there can be strongly varying definitions of what a decent lifestyle means. A paper in this SI concludes that the material footprint is a suitable approach for defining and measuring a decent lifestyle and provides valuable information on how to dematerialize societies towards sustainability.

With the here presented second set of papers (part II) we are completing the Special Issue about Natural Resources. We thank Damià Barceló and the ELSEVIER technical team for their support during the production of this Special Issue and hope that the content of the papers will be of high interest to the reader of STOTEN.

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A critical view on the eco-friendliness of small hydroelectric installations

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HIGHLIGHTS

• It is believed that a complete shift to renewables will mitigate global warming.
• We show how that belief is questionable, with the example of hydropower.
• Large hydropower, once considered totally clean, is now known not to be so.
• The paper brings out that small hydro, too, is no more clean/green than large hydro.
• There is no basis in the belief of eco-friendliness of small hydro.

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ABSTRACT

Renewable energy sources are widely perceived as ‘clean’, ‘green’, and ‘inexhaustible’. In recent years the spectre of global warming and ocean acidification, which has been primarily attributed to fossil fuel burning, has brought renewable energy at the forefront of most climate change mitigation strategies. There is strong advocacy for large-scale substitution of conventional energy sources with the renewables on the premise that such a move would substantially reduce environmental degradation and global warming. These sentiments are being echoed by scientists and policy makers as well as environmental activists all over the world.

'Small hydro', which generally represents hydroelectric power projects of capacities 25 MW or lower, is one of the renewable energy options which is believed to be clean and sustainable even as its bigger version, large hydro, is known to cause several strongly adverse environmental impacts.

This paper brings out that the prevailing perception of ‘eco-friendliness’ of small hydro is mainly due to the fact that it has only been used to a very small extent so far. But once it is deployed at a scale comparable to fossil fuel use, the resulting impacts would be quite substantially adverse.

The purpose is not to denigrate small hydro, less so to advocate use of fossil fuels. It, rather, is to bring home the point that a much more realistic and elaborate assessment of the likely direct as well as indirect impacts of extensive utilization of this energy source than has been done hitherto is necessary.

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1. Introduction

All hydroelectric power projects are sources of renewable energy but the larger versions of such projects are not counted among renewable energy sources because, in the general perception, large hydropower projects (LHPs) are not ‘clean’ while other renewables are. Small hydropower projects (SHPs), which include minihydel, microhydel and picahydel units, are considered sources of renewable energy because they are perceived as the ‘clean’ and ‘green’ alternatives to LHPs. Driven by this perception, governments of several countries provide subsidies and other incentives for the promotion of small hydro, even as large hydro is denied that kind of patronage and is subjected to much more intense pre-licence scrutiny.

1.1. LHPs used to be regarded as the most clean, dependable and versatile of all energy sources

Interestingly, till as recently as in mid 20th century, LHPs had a much more favourable image than is commanded by SHPs at present. LHPs had appeared to be the cleanest of all energy sources, as ‘totally clean’ as the sunlight is when it is used directly for obtaining heat or light. Hydropower appeared even more virtual than sunlight for the crucial reason that whereas sunlight is intermittent, hydropower is continuous.

Hydropower had yet another distinguishing feature: its use seemed to provide numerous benefits over and above energy production. The very long roster of the virtues – of cleanliness, dependability, and versatility of hydropower as were perceived then – included the following:
Publisher’s Note

Publisher note to “Resource efficiency potential of selected technologies, products and strategies”

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The Publisher apologizes for any inconvenience this may have caused.
Resource efficiency and culture — Workplace training for small and medium-sized enterprises

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HIGHLIGHTS

• Enterprises being successful with resource efficiency have a specific corporate culture.
• Depth analyses, a survey and 17 field studies underline the role of “ResourceCulture”.
• To enable actors to support “ResourceCulture”, qualification is needed.
• Resource efficiency consultants therefore need “soft skills”.
• A qualification module has to deal with issues like “trust”.

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ABSTRACT

Although there are already some qualification offers available for enterprises to support resource efficiency innovations, the high potentials that can be identified especially for small and medium sized enterprises (SMEs) have not been activated until now. As successful change lies in the hands of humans, the main aim of vocational education has to be the promotion of organisational and cultural changes in the enterprises. As there is already a small but increasing number of enterprises that perform very well in resource efficiency, innovations one question arises: What are typical characteristics of those enterprises? Leaning on a good-practice approach, the project “ResourceCulture” is going to prove or falsify the hypothesis that enterprises being successful with resource efficiency innovations have a specific culture of trust, which substantially contributes to innovation processes, or even initially enables them. Detailed empirical field research will light up which correlations between resource efficiency, innovation and cultures of trust can be found and will offer important aspects for the improvement of management instruments and qualification concepts for workplace training. The project seize qualification needs that were likewise mentioned by enterprises and consultants, regarding the implementation of resource efficiency.

This article – based on first empirical field research results – derives preliminary indications for the design of the qualification module for the target groups resource efficiency consultants and managers. On this basis and in order to implement “ResourceCulture” conceptual and methodological starting points for workplace training are outlined.

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1. Introduction

The project ResourceCulture (period 09/2009 to 04/2013) is a joint research project of the Wuppertal Institute and the artec — Research Centre for Sustainability (University of Bremen). It is part of the funding programme “Working, Learning, Developing Competence — Being innovative in a Changing Working Environment” of the German Federal Ministry of Education and Research (BMBF).

The central research hypothesis of the project is the following: businesses that enact innovations in resource efficiency display specific work and trust cultures that may be part of value oriented and value appreciative business structures. As a necessary precondition for innovative ability of businesses, such culture has positive effects on the implementation of strategies for resource and material efficiency as well as on the positioning in the growing market of resource efficiency technologies. The aim of the project is to investigate possible links between resource efficiency, innovation and cultures of trust by doing detailed empirical field research. Target of the project is to establish a significant added value for resources management by the development and piloting of instruments, methods and a qualification module (summed up in a toolbox). The qualification module in particular aims at the promotion of qualifications to enable people in charge for the
Application of stochastic approach based on Monte Carlo (MC) simulation for life cycle inventory (LCI) to the steel process chain: Case study

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HIGHLIGHTS

• The benefits of Monte Carlo simulation are examined.
• The normal probability distribution is studied.
• LCI data on Mittal Steel Poland (MSP) complex in Kraków, Poland dates back to 2005.
• This is the first assessment of the LCI uncertainties in the Polish steel industry.

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ABSTRACT

The purpose of the paper is to present the results of application of stochastic approach based on Monte Carlo (MC) simulation for life cycle inventory (LCI) data of Mittal Steel Poland (MSP) complex in Kraków, Poland. In order to assess the uncertainty, the software CrystalBall® (CB), which is associated with Microsoft® Excel spreadsheet model, is used. The framework of the study was originally carried out for 2005. The total production of steel, coke, pig iron, sinter, slabs from continuous steel casting (CSC), sheets from hot rolling mill (HRM) and blast furnace gas, collected in 2005 from MSP was analyzed and used for MC simulation of the LCI model. In order to describe random nature of all main products used in this study, normal distribution has been applied. The results of the simulation (10,000 trials) performed with the use of CB consist of frequency charts and statistical reports. The results of this study can be used as the first step in performing a full LCA analysis in the steel industry. Further, it is concluded that the stochastic approach is a powerful method for quantifying parameter uncertainty in LCA/LCI studies and it can be applied to any steel industry. The results obtained from this study can help practitioners and decision-makers in the steel production management.

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1. Introduction

Life cycle assessment (LCA) is an environmental management technique, which has a very wide application (Kulczycka and Hencik, 2009). It is a relatively new (Kowalski et al., 2007) and developing (Finnveden et al., 2009) environmental management technique described in international ISO standards, which has been developing since the mid-1980s.

The purpose of this paper is to describe the results of research on the implementation of Monte Carlo (MC) simulation proposed for stochastic study of life cycle inventory (LCI) concerning the steel process based on the data from Mittal Steel Poland (MSP) complex in Kraków, Poland (case study). In order to assess the uncertainty, the software CrystalBall® (CB), which is associated with Microsoft® Excel spreadsheet model, is used. The total production of steel, coke, pig iron, sinter, slabs from CSC, sheets from HRM and blast furnace gas was analyzed and used for MC simulation of the LCI model. The framework of the study was originally carried out for 2005 data because important statistics are available for this year and also because it represents the data, which is the foundation for the MSP Environmental Impact Report, collected (as of 2005) and evaluated annually (Mittal Steel Poland, 2007). MSP was the largest steel producer in Poland. Today, ArcelorMittal Poland (AMP) (previously MSP) boasts a full production system — from pig iron to final, highly processed steel products. At present steel production capacities reach 7.6 million tons of crude steel and about 6.5 million tons of rolled products per year. AMP plants are located in: Kraków, Dąbrowa Górnicza, Sosnowiec, Świętochłowice and Chorzów (ArcelorMittal Poland, 2012). In Poland, crude steel is produced at a rate of 8.8 million tons per year, an increase of 9.8% from that of 2010 (Burchart-Korol, 2013).

An LCI analysis usually requires a large amount of data. The uncertainty of these parameters directly affects the outcome of any environmental impact method (Sonnemann et al. 2004). The overall uncertainty of an LCI is usually dominated by a few major uncertainties (Bieda and Tadeusiewicz, 2008). The use of stochastic model helps to characterize the uncertainties better than a purely...
Analysis of the slaughterhouses in Galicia (NW Spain)

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HIGHLIGHTS

• A general view of the slaughterhouse sub-sector into the food and drinking industry in Galicia
• Methodology for improving the sustainability of slaughterhouses
• Exhaustive description and analysis (qualitative and quantitative) of the industrial process of any slaughterhouse
• Application of the pollution prevention and control philosophy in this type of installations
• Inventory of best available candidate techniques for any slaughterhouse

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Best available technique (BAT)
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Slaughterhouses

ABSTRACT

In the last five years, slaughterhouses in Galicia have been producing more than 350,000 tonnes of carcass per year (Ministry of Environmental and Marine and Rural Media (MARM), 2013). The main environmental problems derived from this economic activity are the high consumption of water, the generation of wastewater with a high organic load and the intensive use of energy (electricity and fuel) (European Commission, 2005). In this region of Spain, there are seventy-one slaughterhouses but only 10 to 15% of them have a carcass production capacity exceeding 50 tonnes per day (Casares et al., 2006), consequently needing an environmental permit according to the requirements set by the IPPC (Integrated Pollution Prevention and Control) Directive (European Commission, 2008).

The slaughterhouses can be specialized in one livestock type, such as pigs, cattle, sheep, goats or rabbits, or they can be polyvalent. In 2009, the most important meat productions were from porcine, poultry and bovine, as they represented 96% of total production in Spain (AICE, 2011).

This paper presents a general view of this important sub-sector (according to the Spanish CNAE, National Classification of Economical Activities) of the food and drinking industry in Galicia. The work considers general information about the activity, an exhaustive description of the industrial process (including preliminary operations, processing, final and auxiliary operations), environmental aspects about consumption and emission levels, and finally a proposal of technique candidates to be BAT (best available techniques) for each process stage. This structure has permitted to obtain an inventory of pollution prevention and control techniques, as well as qualitative data of incomes and outcomes of consumptions and emissions respectively. The methodology, which has already been used in previous works (Barros et al., 2008), has been proved to be appropriate to optimize the process considering environmental factors as well as the pollution prevention and control philosophy.

1. Introduction

Fifteen years ago, the Council of the European Union (EU) adopted the Directive 96/61/EC (European Commission, 1996), the so-called IPPC Directive, concerning Integrated Pollution Prevention and Control. Though recently updated by Directive 2008/1/EC (European Commission, 2008), its objective is still the same: achieving a high level of protection of the environment taken as a whole, especially the prevention or, where not practicable, the reduction of environmental problems avoiding transfer from one medium to another (air, water and land), including measures concerning waste.

All the industrial processes included in the Annex I of the IPPC Directive must obtain an environmental permit. It includes, among others, the emission limit values (ELV) for the most relevant pollutants, fixed by the competent authorities taking into account the best available techniques (BAT). Both BAT and ELV must be checked and periodically updated so that the latest technical developments can be considered.

Annex I gathers a great variety of industrial activities, including the slaughterhouse sector, as stated in epigraph 6.4 (a): “slaughterhouses with a carcase production capacity greater than 50 tonnes per day.”
Improving the policy application of footprint indicators to support Europe’s transition to a one planet economy: The development of the EUREAPA tool

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HIGHLIGHTS

• We developed a consumption-based environmental impact tool.
• We used participatory development processes based on agile software development.
• The web-based tool allows users to interrogate data from a range of perspectives.
• Users can also create scenarios of future change to consumption and production.

ABSTRACT

Environmentally extended multi-regional input–output (EE-MRIO) models provide us with a wealth of data relating to consumption-based environmental impacts at a national level. The results can identify the categories of consumption and sectors of production that contribute most to environmental impact allowing policy makers to prioritise intervention into particular areas. However, these data are not readily accessible to policy makers and civil society, making it difficult to extract and communicate the important messages it contains.

The web-based tool — EUREAPA — was created as a usable, task-oriented interface to improve access to environmental and economic data held within a complex EE-MRIO model and make it more relevant to policymakers and civil society. The project team of scientists and IT specialists used an iterative, agile and participatory approach to engage potential end-users in the specification and testing of the tool.

The engagement process identified two principal functions that were essential for the EUREAPA tool: viewing data and creating scenarios. The viewing data function allows users to analyse the wealth of data held within the model and present results from a range of perspectives. This helps to understand the causes of environmental pressure and identify priorities for policy intervention. The scenario function helps to communicate how changes in consumption and production might affect the future environmental impact of citizens of the EU, and facilitates long-term planning.

Through this dialogue process the project has been able to ensure EUREAPA is relevant, user-friendly and fit-for-purpose. It is intended that EUREAPA will be adopted by policy makers and civil society as an important policy planning and assessment aid in the complex field of sustainable consumption and production.

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1. Introduction

The European Environment Agency recognises that the current patterns of consumption and production in Europe are unsustainable (EEA, 2010) and that our social and economic systems need to be transformed if they are to be sustained within planetary boundaries (Rockström et al., 2009). This transformation will require us to tackle a complex range of highly interconnected factors including lifestyle, technological innovation, economic development, global trade and local infrastructure. Many of these factors are critical in shaping consumption and production patterns (Baiocchi and Minx, 2010). Given this complexity, it can be hard for policy makers to identify priorities and effective policy interventions.

The European Commission FP7-funded One Planet Economy Network: EU (OPEN:EU) project aimed to further improve the use and application of the sustainable consumption and production evidence base to support the transition to a one planet economy in Europe. This was
Technological innovation, human capital and social change for sustainability. Lessons learnt from the Industrial Technologies Theme of the EU’s Research Framework Programme

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HIGHLIGHTS

• The EU’s strategy focuses on competitiveness and sustainability. R&D plays a critical role.
• The EU industry is challenged by the disconnection of knowledge creation and production.
• Human capital, a core EU competitive advantage, is challenged by current reforms.
• Innovation needs educating on cooperation and creativity, instead of standardisation.
• A sustainable society requires a social change and, therefore, social innovation.

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ABSTRACT

Europe is facing a twofold challenge. It must maintain or even increase its competitiveness, a basic requirement in a globalised economy and under the current demographic threat. It needs also to tackle the so-called “grand challenges”, especially environmental issues, through a sustainable model of production and consumption. Such challenges should lead to new business and industrial models, based on more sustainable production and consumption chains, from design to end of life. This implies a need for new industrial materials and processes, new skills and, indeed, new values and life-styles. Sustainability and innovation are key elements of EU’s Research and Innovation Framework Programmes, particularly in the field of industrial technologies (nanotechnologies, materials and industrial technologies), which objective is to “improve the competitiveness of the European industry and generate knowledge to ensure its transformation from a resource intensive to a knowledge intensive industry”. Sustainability and innovation are interrelated challenges for R&D. Research can develop technical solutions to tackle environmental or societal challenges, but such technologies need to be successfully commercialised to have a real environmental impact. Several socio-economic studies carried out by the European Commission show not only the emerging technological and industrial trends, but they also emphasise the need for linking sustainable technologies with social change. Human capital and new social behaviours are critical factors to combine economic competitiveness and sustainability: technology alone is no longer able to solve global challenges. But what kind of human capital (skills, behaviours, and values) are we referring to? How to encourage the shift towards a greener society through human capital? Which reforms are needed in education systems to move towards a sustainable economy? Are there examples of social innovation to be extrapolated and/or generalised?

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1. Introduction

“The times they are a-changin’”.

Almost half a century after he composed his classical song, Bob Dylan could add an adjective to the refrain: “fast” or “quickly”. He may even say “too fast” or “too quickly”. It is becoming difficult to remember historical events that happened recently: Tunisian and Egyptian Revolutions, nuclear crisis in Japan, Libyan civil war, Escherichia coli food crisis, killing of Bin Laden,...

In parallel to such spectacular events, other radical changes are ongoing, even if they do not appear in the cover pages of newspapers and magazines. The World is evolving at a speed without precedents. We are increasingly conscious about the so-called “grand societal challenges”, in particular environmental issues (e.g. climate change, environmental degradation, scarcity of food, energy and raw materials).
Becoming sustainable: Human determinants of change

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HIGHLIGHTS

• Sustainable behavior is shaped by five different types of knowledge.
• Each one of these types is based on specific experiential rules.
• By interacting reciprocally they form an overarching knowledge regime.
• Learning to become sustainable therefore is a self-organizing systemic endeavor.

1. Introduction

Cultural sustainability without any doubt is grounded in human experience and behavior. Some people are on a journey of exploration to develop increasingly sustainable lifestyles, whereas others are not. Hence the question of global resource use cannot be exclusively reduced to technological solutions and their political constraints. It also has to take the human condition and its successful change towards an appropriately adjusted, green life style into account. Sustainability is a matter which has economic, political, technical and human implications. The paper deals with the human implications of responsible global resource consumption focusing on the following key problem: what are the main parameters of change seen from a human perspective of individual experience?

The traditional answer to this question says: learning to act in a sustainable way is an educational issue. We have to educate ourselves towards a green attitude. But what does this actually mean? If education is the key to a sustainable life style, which type of education do we intend to establish? Modern education predominantly deals with rational understanding. To learn means to learn to do things in a logical way; logical in the rational sense. Western school curricula emphasize on a scientific i.e. rational kind of knowledge. Is this type of rational education sufficient with respect to a global problem that has at least partly resulted from an ecologically inadequate life-style? Do life style issues not go far beyond the pure rational aspect of human life? And as a consequence of this, shouldn't we rather develop a more holistic approach...
Resource use of low-income households — Approach for defining a decent lifestyle?

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HIGHLIGHTS

• We studied the material footprints of 18 low-income single households in Finland.
• The natural resource use of the participating households was lower than average.
• 2/3 had a smaller footprint than the “decent minimum” defined by a consumer panel.
• The footprint of all households is higher than ecological sustainability requires.
• We conclude that the material footprint is useful for defining a decent lifestyle.

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ABSTRACT

A decent, or sufficient, lifestyle is largely considered an important objective in terms of a sustainable future. However, there can be strongly varying definitions of what a decent lifestyle means. From a social sustainability point of view, a decent lifestyle can be defined as the minimum level of consumption ensuring an acceptable quality of life. From an ecological sustainability point of view, a decent lifestyle can be defined as a lifestyle that does not exceed the carrying capacity of nature in terms of natural resource use.

The paper presents results of a study on the natural resource use of 18 single households belonging to the lowest income decile in Finland. The yearly “material footprint” of each household was calculated on the basis of the data gathered in a questionnaire and two interviews. The results show that the natural resource use of the participating households was lower than the one of the average consumer. Furthermore, 12 of 18 households had a smaller material footprint than the “decent minimum” reference budget defined by a consumer panel. However, the resource use of all the households and lifestyles studied is still higher than long-term ecological sustainability would require. The paper concludes that the material footprint is a suitable approach for defining and measuring a decent lifestyle and provides valuable information on how to dematerialize societies towards sustainability.

1. Introduction

In social science a decent lifestyle necessary for preventing poverty is often defined in relation to the average consumption level without paying attention to the fact that the present average consumption in western welfare states is ecologically unsustainable (see e.g. Halleröd et al., 2006). On the other side, when environmental scientists argue that the level of natural resource use or CO2 emissions should be reduced, their message often omits a profound understanding about the implications in people’s lifestyles the changes would bring (see also Druckman and Jackson, 2010). Therefore, in this study, we will apply a methodology where both aspects of decent lifestyle are concerned.

Environmental research about a sustainable future evidently proves that the present level of consumption in Western countries is ecologically unsustainable (e.g. Schmidt-Bleek, 2009; Bringezu, 2009; Ewing et al., 2010). An ecologically sustainable lifestyle would require natural resources without exceeding the long-term carrying capacity of nature. In this paper, we call this sustainable level of natural resource use as an “ecological maximum”.

From a social sustainability perspective, this “ecological maximum” level of resource use still needs to be sufficient for ensuring that people have possibilities to achieve a decent lifestyle. In this paper, “decent minimum” refers to the sufficient level of resources to fulfill needs, participate in society and ensure human dignity. Decent minimum is...