How does the long-term aging in the soil change terrestrial ecotoxic impacts of anthropogenic metal emissions?

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Human health no-effect levels of TiO2 nanoparticles as a function of their primary size
As engineered nanomaterials are increasingly introduced on the market into a broad range of commodities or nanoproducts, there is a need for operational, reliable tool, enabling to consistently assess the risks and impacts associated with the releases of nanoparticles. The lack of a developed metric that accurately represents their toxic effects while capturing the influence of the most relevant physicochemical properties is one of the major impediments. Here, we investigate the relationships between the toxic responses of nano-sized and micro-sized particles in in vivo toxicological studies and their physicochemical properties. Our results for TiO2 particles indicate statistically significant associations between the primary particle size and their toxicity responses for combined inhalation and ingestion exposure routes, although the numerical values should be considered with care due to the inability to encompass influences from other relevant physicochemical properties like surface coatings. These findings allow for expressing mass-based adverse effect levels as a continuous function of the primary size of particles. This meaningful, exploratory metric can thus be used for screening purposes and pave the way for reaching adaptive, robust risk assessments of nanomaterials, e.g. for setting up consistent threshold levels, as well as consistent life cycle assessments of nanoproducts. We provide examples of such applications.

General information
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Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Department of Informatics and Mathematical Modeling, Department of Environmental Engineering, Michigan State University, Technical University of Denmark, University of Michigan-Dearborn
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Improved comparative toxicity potentials of 23 metallic elements in soils: addressing solid- and liquid-phase speciation in environmental fate, exposure, and effects

General information
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LCA of Soil and Groundwater Remediation

Today, there is increasing interest in applying LCA to support decision-makers in contaminated site management. In this chapter, we introduce remediation technologies and associated environmental impacts, present an overview of literature findings on LCA applied to remediation technologies and present methodological issues to consider when conducting LCAs within the area. Within the field of contaminated site remediation, a terminology distinguishing three types of environmental impacts: primary, secondary and tertiary, is often applied. Primary impacts are the site-related impacts due to the contamination in the ground, secondary impacts are the impacts related to clean-up of the site, and tertiary impacts are the impacts associated with the future use of the site. The major methodological issues to consider when conducting LCA are: (i) defining a functional unit that considers time frame and efficiency of remediation, which are important for assessment or primary impacts; (ii) robust assessment of primary impacts using site-specific fate and exposure models; (iii) weighting of primary and secondary (or tertiary) impacts to evaluate trade-offs between life cycle impacts from remediation and reduced pressure locally; and (iv) comparison with a no action scenario to determine whether there is a net environmental benefit from remediation. Overall, LCA is an important tool for the assessment of the secondary environmental impacts of remediation, and occasionally it has also been used to assess primary and tertiary impacts. In order to obtain robust decisions for the management of contaminated sites, the combination of LCA with other tools is necessary, including multi-criteria decision analysis tools, site-specific fate and exposure models and consideration of stakeholders’ views.

Limitations of experiments performed in artificially made OECD standard soils for predicting cadmium, lead and zinc toxicity towards organisms living in natural soils

Development of comparative toxicity potentials of cationic metals in soils for applications in hazard ranking and toxic impact assessment is currently jeopardized by the availability of experimental effect data. To compensate for this deficiency, data retrieved from experiments carried out in standardized artificial soils, like OECD soils, could potentially be tapped as a source of effect data. It is, however, unknown whether such data are applicable to natural soils where the variability in pore water concentrations of dissolved base cations is large, and where mass transfer limitations of metal uptake can occur. Here, free ion activity models (FIAM) and empirical regression models (ERM, with pH as a predictor) were derived from total metal EC50 values (concentration with effects in 50% of individuals) using speciation for experiments performed in artificial OECD soils measuring ecotoxicological endpoints for terrestrial earthworms, potworms, and springtails. The models were validated by predicting total metal based EC50 values using backward speciation employing an independent set of natural soils with missing information about ionic composition of pore water, as retrieved from a literature review. ERMs performed better than FIAMs. Pearson's r for log10-transformed total metal based EC50s values (ERM) ranged from 0.25 to 0.74, suggesting a general correlation between predicted and measured values. Yet, root-mean-square-error (RMSE) ranged from 0.16 to 0.87 and was either smaller or comparable with the variability of measured EC50 values, suggesting modest performance. This modest performance was mainly due to the omission of pore water concentrations of base cations during model development and
their validation, as verified by comparisons with predictions of published terrestrial biotic ligand models. Thus, the usefulness of data from artificial OECD soils for global-scale assessment of terrestrial ecotoxic impacts of Cd, Pb and Zn in soils is limited due to relatively small variability of pore water concentrations of dissolved base cations in OECD soils, preventing their inclusion in development of predictive models. Our findings stress the importance of considering differences in ionic composition of soil pore water when characterizing terrestrial ecotoxicity of cationic metals in natural soils.

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Web of Science (2007): Indexed yes
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Potentials and limitations of footprints for gauging environmental sustainability

To address the sustainability challenge, a large variety of footprints, aiming at capturing specific impacts of human activities on natural environment, have emerged. But, how do they fit into our addressing of environmental sustainability? Here, we build on a critical literature review to (1) provide an overview of existing footprints; (2) define their roles; (3) position them within the broad spectrum of known environmental problems and control variables of the planetary boundaries; and (4) argue for the need of consistent thresholds to benchmark footprint scores against absolute sustainability measures defined using science-based sustainability targets. Potentials, limitations and research needs are highlighted along these four points.

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Authors: Laurent, A. (Intern), Owsianiak, M. (Intern)
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Advancing absolute sustainability assessments of products with a new Planetary Boundaries based life-cycle impact assessment methodology

The Planetary Boundaries (PB)-framework introduced quantitative boundaries for a set of biophysical Earth System processes. The PBs delimit a ‘safe operating space’ for humanity to act within to keep Earth in a Holocene-like state (Rockström et al 2009). The concept has gained strong interest from companies that want to assess and communicate the environmental sustainability of their products relative to the PBs. However, consistent methods for assessing environmental impacts of products and systems based on the PBs have, to date, not been developed (Ryberg et al 2016).

In this study, we developed an operational life-cycle impact assessment (LCIA) methodology where the definition of the impact categories is based on the control variables as defined in the PB-framework by Steffen et al (2015). This included the development and calculation of characterization factors for the Earth System processes considered in the PB-framework. The characterization factors cover environmental flows contributing to impacts on the Earth System processes (e.g. CO₂ and its precursors contributing to ocean acidification) and are expressed in the units of the PB framework’s control variables (e.g. change in the aragonite saturation state per unit CO₂ emission for ocean acidification). The use of these characterization factors for evaluating the environmental impacts of products in LCA ensures impact scores that are compatible with the PB framework. The impact scores can be related to either the full PBs or an allocated safe operating space. The latter reflect the share of the safe operating space the assessed products can be considered entitled to, thereby, allowing for quantifying the absolute environmental sustainability of the products.

This new Planetary Boundaries based LCIA methodology provides additional and complementary insights which cannot be achieved with traditional LCIA methodologies. The key added value is the ability to relate the impacts of a product to the Planetary Boundaries. This can be used for communicating a product’s environmental performance and for setting reduction targets based on absolute environmental boundaries, thereby, advancing absolute sustainability assessments.

Assessing environmental performance of humidification technology used in supply of fresh fruit and vegetables

Distributions chains in Europe of most fresh fruit and vegetables follow a pattern where fruit or vegetables produced in southern European countries are typically transported to countries in the central or northern parts of Europe. The relatively complex supply and distribution chain with many actors involved (from farmers, through wholesalers, to retailers) highlights the need for minimizing food loss in the post-harvest to optimize the overall environmental performance of agricultural systems in Europe.

Humidification is an emerging technology that can potentially contribute to minimize post-harvest losses of fruit and vegetables. Humidifiers release a fine mist thereby reducing the difference in water vapour pressure at the surface of the fruit or vegetable and in the air, preventing dry-out of fruits and deterioration. In addition, humidification provides cooling as a result of the evaporation of the droplets into the unsaturated air, without exchange with the environment (adiabatic cooling effect). The overall environmental performance of the humidification technology is expected to be determined by the trade-offs between lower environmental impacts stemming mainly from a reduction in loss and associated agricultural efforts and increased impacts mainly due to the need for new equipment and increased water use.

We assessed environmental performance of humidification technology in the European context. Lettuce produced in Italy and transported to Denmark was chosen as a case study, and sensitivity scenarios considered strawberries, flat peaches, asparagus, and table grapes. The results show that the technology has the potential to reduce life cycle environmental impacts, provided that it allows reducing food loss in the post-harvest. When compared to the conventional supply chain of lettuce without humidification, the impact scores are reduced on
average by 2.6, 6.0 and 7.4% when the total losses of the supply chain are decreased by 2, 5 and 6%, respectively (corresponding to low, medium and high efficiency of the technology). This is true for all impact categories, except resource depletion which is driven by the humidifier production and disposal stages rather than agriculture. Thus, depending on the performance of humidifying units, humidification may have the potential to reduce environmental impacts stemming from supply of fresh fruit and vegetables in Europe.

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**Assessing environmental performance of hydrothermal carbonization of wet biomass at industry-relevant scales**

**General information**

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Organisations: Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Owsianiak, M. (Intern), Ryberg, M. (Intern), Hauschild, M. Z. (Intern)
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**Challenges in implementing a Planetary Boundaries based Life-Cycle Impact Assessment methodology**

Impacts on the environment from human activities are now threatening to exceed thresholds for central Earth System processes, potentially moving the Earth System out of the Holocene state. To avoid such consequences, the concept of Planetary Boundaries was defined in 2009, and updated in 2015, for a number of processes which are essential for maintaining the Earth System in its present state. Life-Cycle Assessment was identified as a suitable tool for linking human activities to the Planetary Boundaries. However, to facilitate proper use of Life-Cycle Assessment for non-global environmental management based on the Planetary Boundaries, there is a need for linking non-global activities to impacts on a planetary level. In this study, challenges related to development and operationalization of a Planetary Boundary based Life-Cycle Impact Assessment method are identified and the feasibility of resolving the challenges and developing such methodology is discussed. The challenges are related to technical issues, i.e., modelling and including the Earth System processes and their control variables as impact categories in Life-Cycle Impact Assessment and to theoretical considerations with respect to the interpretation and use of Life-Cycle Assessment results in accordance with the Planetary Boundary framework. The identified challenges require additional research before a Planetary Boundaries based Life-Cycle Impact Assessment method can be developed. Research on modelling the impacts on Earth System processes and on allocation of and entitlement to the ‘safe operating space’ appear to be most urgent for operationalizing a Planetary Boundaries based Life-Cycle Impact Assessment method. The results of a Planetary Boundaries based Life-Cycle Impact Assessment would be highly relevant and could provide novel insights on the environmental performance and sustainability of products and systems.

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Authors: Ryberg, M. (Intern), Owsianiak, M. (Intern), Richardson, K. (Ekstern), Hauschild, M. Z. (Intern)
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Environmental performance of hydrothermal carbonization of four wet biomass waste streams at industry-relevant scales

Hydrothermal carbonization (HTC) of green waste, food waste, organic fraction of municipal solid waste (MSW), and digestate is assessed using life cycle assessment as a potential technology to treat biowaste. Water content of the biowaste and composition of the resulting hydrochar are important parameters influencing environmental performance. Hydrochar produced from green waste performs best and second best in respectively 2 and 10 out of 15 impact categories, including climate change, mainly due to low transportation needs of the biowaste and optimized pumping efficiency for the feedstock. By contrast, hydrochar produced from the organic fraction of MSW performs best in 6 impact categories, but has high potential impacts on human health and ecosystems caused by emissions of toxic elements through ash disposal. The greatest potential for environmental optimization for the HTC technology is in the use of heat and electricity with increasing plant size, but its overall environmental performance is largely influenced in a given geographic location by the incumbent waste management system that it replaces. Impact scores are within the range of existing alternative treatment options, suggesting that despite being relatively immature technology, and depending on the geographic location of the plant, HTC may be an attractive treatment option for biowaste.

General information
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Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Universidad Politecnica de Valencia
Authors: Owsianiak, M. (Intern), Ryberg, M. (Intern), Renz, M. (Ekstern), Hitzl, M. (Ekstern), Hauschild, M. Z. (Intern)
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BFI (2016): BFI-level 1
Scopus rating (2016): SJR 1.523 SNIP 1.408 CiteScore 5.92
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.381 SNIP 1.338 CiteScore 5.39
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.195 SNIP 1.207 CiteScore 4.3
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
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Source: PublicationPreSubmission
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Evaluating robustness of a diesel-degrading bacterial consortium isolated from contaminated soil

It is not known whether diesel-degrading bacterial communities are structurally and functionally robust when exposed to different hydrocarbon types. Here, we exposed a diesel-degrading consortium to model either alkanes, cycloalkanes or aromatic hydrocarbons as carbon sources to study its structural resistance. The structural resistance was low, with changes in relative abundances of up to four orders of magnitude, depending on hydrocarbon type and bacterial taxon. This low resistance is explained by the presence of hydrocarbon-degrading specialists in the consortium and differences in growth kinetics on individual hydrocarbons. However, despite this low resistance, structural and functional resilience were high, as verified by re-exposing the hydrocarbon-perturbed consortium to diesel fuel. The high resilience is either due to the short exposure time, insufficient for permanent changes in consortium structure and function, or the ability of some consortium members to be maintained during exposure on degradation intermediates produced by other members. Thus, the consortium is expected to cope with short-term exposures to narrow carbon feeds, while maintaining its structural and functional integrity, which remains an advantage over biodegradation approaches using single species cultures.
Structural and functional robustness of an environmental bacterial community degrading diesel fuel

General information
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Organisations: Department of Environmental Engineering, Water Technologies, Poznan University of Technology
Authors: Sydow, M. (Ekstern), Owsianiak, M. (Intern), Smets, B. F. (Intern), Chrzanowski, L. (Ekstern)
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BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.934 SNIP 0.952 CiteScore 2.13
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Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
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BFI (2009): BFI-level 1
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Scopus rating (2008): SJR 0.936 SNIP 1.098
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Scopus rating (2005): SJR 0.685 SNIP 1.097
Scopus rating (2004): SJR 0.72 SNIP 1.043
Scopus rating (2003): SJR 0.626 SNIP 0.938
Scopus rating (2002): SJR 0.653 SNIP 0.666
The development of an operational LCIA-methodology with impact categories based on the control variables in the Planetary Boundaries framework

This study presents a first attempt at an operational LCIA-methodology basing the definition of the impact categories on the control variables as defined in the Planetary Boundaries (PB) framework. The PB-framework introduced a set of biophysical Earth system processes and defined quantitative PBs that have to be respected for Earth to remain in the Holocene state. The concept is attracting a strong interest from industry as companies seek to assess and communicate the environmental performance of their products relative to the PBs. The PB-framework has previously been attempted included in LCA as part of normalization and weighting. The limitations of both attempts are the lack of spatial differentiation for spatially differentiated PBs and the requirement for harmonizing the control variables with indicators already used in life-cycle impact assessment (LCIA). A way to overcome these limitations is to directly use the control variables in the PB-framework as impact categories in LCIA, which is also the objective of this study. This work defines a mathematical framework for a LCIA-methodology where Characterization Factors (CFs) are included for all Earth system processes in the PB-framework, for all substances contributing to effects on the Earth system processes and expressed in the units of the control variables. Except for novel entities and biosphere integrity which are currently excluded from the LCIA-methodology because the former is lacking a planetary boundary metric while a full understanding of the cause-effect chain is missing for the latter. The CFs were estimated by identifying the environmental models needed to model the control variables of the PB-framework and adapting these to fit the LCIA-framework. This work provides a full set of CFs for all the Earth system processes in the PB-framework. The new LCIA-methodology provide additional and complementary insights which cannot be achieved with traditional LCIA-methodologies. The results provide information on the environmental impacts of the assessed products and solves previous problems with approximative links between control variables in the PB-framework and current LCIA impact categories. The new insights can be used for communicating the product's environmental performance and to support definitions of absolute reduction targets relative to the PBs.

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Assessing comparative terrestrial ecotoxicity of Cd, Co, Cu, Ni, Pb, and Zn: The influence of aging and emission source

Metal exposure to terrestrial organisms is influenced by the reactivity of the solid-phase metal pool. This reactivity is thought to depend on the type of emission source, on aging mechanisms that are active in the soil, and on ambient conditions. Our work shows, that when controlling for soil pH or soil organic carbon, emission source occasionally has an effect on reactivity of Cd, Co, Cu, Ni, Pb and Zn emitted from various anthropogenic sources followed by aging in the soil from a few years to two centuries. The uncertainties in estimating the age prevent definitive conclusions about the influence of aging time on the reactivity of metals from anthropogenic sources in soils. Thus, for calculating comparative toxicity potentials of man-made metal contaminations in soils, we recommend using time-horizon independent accessibility factors derived from source-specific reactive fractions.
Opportunities and challenges for including Planetary Boundaries in Life-Cycle Assessment

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Main Research Area: Technical/natural sciences
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**Persistence of selected ammonium- and phosphonium-based ionic liquids in urban park soil microcosms**

Knowledge about biodegradability of ionic liquids (ILs) in terrestrial systems is limited. Here, using urban park soil microcosms spiked with either ammonium- or phosphonium-based ILs [didecyldimethylammonium 3-amino-1,2,4-triazolate, benzalkonium 3-amino-1,2,4-triazolate, trihexyl(tetradecyl)phosphonium chloride, or trihexyl(tetradecyl)phosphonium 1,2,4-triazolate], we studied their (i) 300-day primary biodegradation, and (ii) influence on CO2 evolution from the microcosms. The primary biodegradation ranged from 21 to 33% of total compound in the dissolved phase. The evolution of CO2 from spiked microcosms was either lower or within the range of background soil respiration, indicating no or small mineralization of the parent compounds and/or their metabolites, and their negligible or small toxicity to soil microorganisms. Our results suggest the potential for persistence of the four studied ILs in urban park soils. •Primary, 300-day biodegradation ranged from 21 to 33%. •CO2 evolution from the spiked soils was within the range of background respiration. •The studied ILs show potential for long-term persistence in urban park soils.

**General information**

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Scopus rating (2014): SJR 0.881 SNIP 1.389 CiteScore 2.53
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ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.004 SNIP 1.27
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Scopus rating (2009): SJR 1.114 SNIP 1.382
Power generation from chemically cleaned coals: do environmental benefits of firing cleaner coal outweigh environmental burden of cleaning?

Power generation from high-ash coals is a niche technology for power generation, but coal cleaning is deemed necessary to avoid problems associated with low combustion efficiencies and to minimize environmental burdens associated with emissions of pollutants originating from ash. Here, chemical beneficiation of coals using acid and alkali–acid leaching procedures is evaluated as a potential coal cleaning technology employing life cycle assessment (LCA). Taking into account the environmental benefits from firing cleaner coal in pulverized coal power plants and the environmental burden of the cleaning itself, it is demonstrated that for a wide range of cleaning procedures and types of coal, chemical cleaning generally performs worse than combustion of the raw coals and physical cleaning using dense medium separation. These findings apply for many relevant impact categories, including climate change. Chemical cleaning can be optimized with regard to electricity, heat and methanol use for the hydrothermal washing step, and could have environmental impact comparable to that of physical cleaning if the overall resource intensiveness of chemical cleaning is reduced by a factor 5 to 10, depending on the impact category. The largest potential of the technology is observed for high-ash lignites, with initial ash content above 30%, for which the environmental benefits from firing cleaner coal can outweigh the environmental burden of cleaning for some impact categories. Overall, we recommend to policy makers that coal cleaning using acid or alkali–acid leaching procedures should not be considered for direct implementation as a coal beneficiation technology. We encourage further research on chemical cleaning and its optimization, however, as chemical cleaning has advantages that might make it attractive for cleaning of difficult to treat coals when compared to the less efficient option of physical cleaning.

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Main Research Area: Technical/natural sciences

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Strengthening the Link between Life Cycle Assessment and Indicators for Absolute Sustainability To Support Development within Planetary Boundaries

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The need for an established allocation method when assessing absolute sustainability on a product level

Assessment of absolute sustainability within life cycle assessment (LCA) framework is operational on the country scale. However, it is difficult to apply the existing approaches to products, which are typically the scope of LCAs. How should we assess whether a chair is (absolutely) sustainable? If we assess the life cycle and relate the impact scores to the remaining capacity available for impacts, there is a risk that all products are seen absolutely sustainable. In addition, how should we decide on who can use the remaining capacity? To address these issues an allocation method is proposed for dividing the remaining capacity between and within product groups. The method is a two-step method developed based on the annual consumption pattern of an average person in the country and share of product sub-groups in the group. For example, in the first allocation step, the remaining capacity share allocated to furniture should correspond to the share of an average person’s income that is spent on furniture. In this way the impact of the chair is related to the remaining capacity allocated to this particular product group. In the second step, allocation is done between product sub-groups using allocation keys specific to each product group, e.g. mass for furniture, or economic revenue for IT. The proposed method facilitates assessment of absolute sustainability of products within the LCA framework.

Assessing the environmental impacts of using demineralized coal for electricity generation

The energy sector is the source of two-thirds of global greenhouse-gas emissions, and is the main target of climate policies among authorities and governments. The share of fossil coals (hard coal and lignite) in world total net electricity generation is 40% in 2010. Demineralization or ash removal of the coal is thought to be beneficial for reducing ash-related problems, such as slagging and fouling in the combustion chamber, increasing the heating value, increasing thermal efficiency and reducing airborne emissions. A novel method for removing ash is alkali-acid leaching where the coal is washed in alkaline and acidic solution to dissolve and remove the ash. This process is well-studied on lab scale but has only to a small extent been tried on a full scale. This assessment is conducted as an aid for further developing the technology, allowing for early identification of environmental impacts and possible improvements. Experimental studies conducted so far have shown better performance of demineralized coal than its original raw coal during combustion, gasification, and coke making process. However a thorough analysis of the impacts from demineralization has not yet been conducted. We take a life cycle perspective, to assess the environmental impacts from removing ash in coal, and assess how this affects the combustion in terms of higher thermal efficiency. We assess 260 different data points applying alkali-acid leaching or acid leaching and assess how the treatment and subsequent energy generation will affect the environment. The results showed that demineralization in some cases were beneficial for regional impacts such as particulate matter formation because emission of particles and SO2 were reduced. In the contrary global impacts such as climate change did not benefit from demineralization because of the large energy use for running the demineralization process. Local and regional environmental impacts were shown to improve from demineralization because of the high quality coals as the additional energy required for removing the ash outweighs the benefits from the increase thermal efficiency.
Biodegradation of diesel/biodiesel blends in saturated sand microcosms

The aim of the study was to evaluate the biodegradation extent of both aromatic and aliphatic hydrocarbon fractions in saturated sandy microcosm spiked with diesel/biodiesel blends (D, B10, B20, B30, B40, B50, B60, B70, B80, B90 and B100, where D is commercial petroleum diesel fuel and B is commercial biodiesel blend) augmented with a bacterial consortium of petroleum degraders. The biodegradation kinetics for blends were evaluated based on measuring the amount of emitted CO2 after 578 days. Subsequently, the residual aromatic and aliphatic fractions were separated and determined by employing GC-FID and GC–GC–TOF-MS. Additionally, the influence of biodiesel-amendment on the community dynamics was assessed based on the results of real-time PCR analyzes. Our results suggest that the biodegradation extents of both aliphatic and aromatic hydrocarbon were uninfluenced by the addition of biodiesel, regardless of the concentration used. This observation leads to the conclusion that blending with biodiesel does not impact the long-term biodegradation of specific diesel oil fractions. © 2013 Elsevier Ltd. All rights reserved.
Elucidating differences in metal absorption efficiencies between terrestrial soft-bodied and aquatic species

It is unknown whether metal absorption efficiencies in terrestrial soft-bodied species can be predicted with the same metal properties as for aquatic species. Here, we developed models for metal absorption efficiency from the dissolved phase for terrestrial worms and several aquatic species, based on 23 metal physicochemical properties. For the worms, the absorption efficiency was successfully related to 7 properties, and is best predicted with the ionic potential. Different properties (8 in total) were found to be statistically significant in regressions predicting metal absorption in aquatic species, with the covalent index being the best predictor. It is hypothesized that metal absorption by soft-bodied species in soil systems is influenced by the rate of metal supply to the membrane, while in aquatic systems accumulation is solely determined by metal affinity to membrane bound transport proteins. Our results imply that developing predictive terrestrial bioaccumulation and toxicity models for metals must consider metal interactions with soil solids. This may include desorption of a cation bound to soil solids through ion exchange, or metal release from soil surfaces involving breaking of metal–oxygen bonds. © 2014 Published by Elsevier Ltd.

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How does the choice of ILCD recommended practice for characterization modelling change the assessment of environmental impacts in LCA of products?

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How does the choice of ILCD’s recommended methods change the assessment of environmental impacts in LCA of products?

The European Commission has launched a recommended set of characterization methods for application in life cycle impact assessment (LCIA). However, it is not known yet whether the choice of the recommended practice, referred to as the ILCD, over existing LCIA methodologies matter for interpretation of LCA results. Here, we compare the ILCD with two of the most frequently used LCIA methodologies, IMPACT 2002+ and ReCiPe 2008, focusing on characterization at midpoint, by applying them on a case study comparing four window design options. First, to see whether the choice of ILCD matters for identification of product with the lowest environmental burden, ranking of the four window options was done for each impact category within each of the three methodologies. Next, impact scores calculated using each of the three methodologies were converted into common metrics for each impact category to see whether the choice of ILCD matters for total impact scores. Results show that apart from toxic impacts on human health and ecosystems, all three methodologies consistently identify the same window option as having the lowest and the highest total environmental impact. This is mainly because production of heat dominates the total impacts and there is large difference in demand for heat between the compared options. Yet, there were significant differences in impact scores for some of the impact categories after conversion to common metrics: above 3 orders of magnitude for impacts from ionizing radiation on human health and impacts from land use on natural environment; between 1 and 3 orders of magnitude for metal depletion and for toxicity-related impact categories; and within 1 order of magnitude for the remaining impact categories. These differences are caused by the differences in underlying characterization models and/or substance coverage, depending on the impact category. In summary, we showed that different LCIA methods, including the ILCD, are likely to point to the same conclusion with respect to identifying the product with the lowest environmental burden, if one process is driving environmental impacts and there is large difference in demand for output from that process between the compared options. Nevertheless, the choice of ILCD matters the most for assessment of impacts from ionizing radiation, land use, resource depletion (minerals), and all toxicity-related impact categories, where differences between ILCD and alternative methodologies are large.

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IMPACT 2002+, ReCiPe 2008 and ILCD’s recommended practice for characterization modelling in life cycle impact assessment: a case study-based comparison

Purpose The European Commission has launched a recommended set of characterization models and factors for application in life cycle impact assessment (LCIA). However, it is not known how this recommended practice, referred to as the ILCD 2009, performs relative to some of the most frequently used alternative LCIA methodologies. Here, we compare the ILCD 2009 with IMPACT 2002+ and ReCiPe 2008, focusing on characterization at midpoint based on a case study comparing four window design options for use in a residential building.

Methods Ranking of the four window options was done for each impact category within each methodology. To allow comparison across the methodologies both in terms of total impact scores and contribution patterns for individual
substances, impact scores were converted into common metrics for each impact category.

Results and discussion Apart from toxic impacts on human health and ecosystems, all studied methodologies consistently identify the same window option as having the lowest and the highest environmental impact. This is mainly because few processes, associated with production of heat, dominate the total impacts, and there is a large difference in demand for heat between the compared options. Despite this general agreement in ranking, differences in impact scores are above 3 orders of magnitude for human health impacts from ionizing radiation and ecosystem impacts from land use, and they lie between 1 and 3 orders of magnitude for metal depletion and for toxicity-related impact categories. The differences are somewhat smaller (within 1 order of magnitude) for the impact categories respiratory inorganics and photochemical ozone formation, and are within a factor of 3 for the remaining impact categories. The differences in impact scores in our case study are brought about by the differences in underlying characterization models and/or substance coverage, depending on the impact category.

Conclusions In spite of substantial differences in impact scores for the individual impact categories, we find that the studied LCIA methods point to the same conclusion with respect to identifying the alternative with the lowest environmental burden and ascribe this to the fact that few processes are driving the main environmental impacts, and there is large difference in demand for output from these processes between the compared options. Even though the overall conclusions remain the same for our case study, the choice of the ILCD’s recommended practice over the existing alternatives does matter for the impact categories ionizing radiation and land use and all toxicity-related impact categories.

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Comparative toxicity potentials (CTP), in life cycle impact assessment also known as characterization factors (CF), of copper (Cu) and nickel (Ni) were calculated for a global set of 760 soils. An accessibility factor (ACF) that takes into account the role of the reactive, solid-phase metal pool in the soil was introduced into the definition of CTP. Geographic differences in fate, accessibility, bioavailability, and terrestrial toxicity were assessed by combining the USEtox characterization model, empirical regression models, and terrestrial biotic ligand models. The median CTPs for Cu and Ni with 95% geographic variability intervals are 1.4 × 10³ (1.7 × 10² to 2.0 × 10⁴) and 1.7 × 10³ (2.1 × 10² to 1.1 × 10⁴) m³/kg·day, respectively. The geographic variability of 3.5 orders of magnitude in the CTP of Cu is mainly associated with the variability in soil organic carbon and pH. They largely influence the fate and bioavailability of Cu in soils. In contrast, the geographic variability of 3 orders of magnitude in the CTP of Ni can mainly be explained by differences in pore water concentration of magnesium (Mg²⁺). Mg²⁺ competes with Ni²⁺ for binding to biotic ligands, influencing the toxicity. Our findings stress the importance of dealing with geographic variability in the calculation of CTPs for terrestrial ecotoxicity of metals.

**Addressing Geographic Variability in the Comparative Toxicity Potential of Copper and Nickel in Soils**

Comparative toxicity potentials (CTP), in life cycle impact assessment also known as characterization factors (CF), of copper (Cu) and nickel (Ni) were calculated for a global set of 760 soils. An accessibility factor (ACF) that takes into account the role of the reactive, solid-phase metal pool in the soil was introduced into the definition of CTP. Geographic differences in fate, accessibility, bioavailability, and terrestrial toxicity were assessed by combining the USEtox characterization model, empirical regression models, and terrestrial biotic ligand models. The median CTPs for Cu and Ni with 95% geographic variability intervals are 1.4 × 10³ (1.7 × 10² to 2.0 × 10⁴) and 1.7 × 10³ (2.1 × 10² to 1.1 × 10⁴) m³/kg·day, respectively. The geographic variability of 3.5 orders of magnitude in the CTP of Cu is mainly associated with the variability in soil organic carbon and pH. They largely influence the fate and bioavailability of Cu in soils. In contrast, the geographic variability of 3 orders of magnitude in the CTP of Ni can mainly be explained by differences in pore water concentration of magnesium (Mg²⁺). Mg²⁺ competes with Ni²⁺ for binding to biotic ligands, influencing the toxicity. Our findings stress the importance of dealing with geographic variability in the calculation of CTPs for terrestrial ecotoxicity of metals.

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Aquatic toxicity testing of silver nanoparticles – a matter of timing
In recent years, the ecotoxicity of silver nanoparticles (AgNPs) has been studied intensively due to their high toxicity and extensive use in consumer products. However, the field of aquatic nanotoxicology is generally challenged by poor reproducibility, lack of dose-response relationships, and difficulties in controlling and/or describing the characteristics of the tested NPs. These issues may be related to the widespread approach of using freshly prepared stock solutions for ecotoxicity testing, as the introduction of NPs into aqueous media initiates time-dependent processes that possibly interfere with the toxicity testing, e.g. dissolution, speciation, aggregation, sedimentation and interactions with media components. The aim of this study was to investigate whether suspension of AgNPs in test media 24h prior to algal toxicity testing (a pre-suspension step) affects the toxicity and the reproducibility of the test. Ultimately, the aim is better control of the AgNPs in the algal test system and improved prerequisites for describing their toxicity to algae. The underlying hypothesis is that a large part in the variability of AgNPs toxicity to algae can be explained by the kinetics of dissolution and speciation of Ag ions in the test media. To reduce the amount of time in which changes to NPs may occur during testing, the exposure period was minimized. A recently proposed short-term (2h) algal test was applied, using 14C incorporation during photosynthesis as toxic endpoint [1]. For citrate coated spherical AgNPs with a nominal size of 30 nm, the resulting dose-response relationships from tests without (A) and with (B) the pre-suspension step are illustrated in figure 1. Without the pre-suspension step, poorly reproducible results were obtained and it was not possible to produce comparable EC50 values from the three test runs. Introduction of the presuspension step resulted in a higher degree of reproducibility and in more comparable EC50 values, indicating better control of the processes affecting AgNPs during the 2h testing. Moreover, the algal toxicity of AgNPs increased when extending the pre-suspension step period from 24 to 48h, suggesting that ionic dissolution of AgNPs into the media takes part in AgNP toxicity. Our results stress the importance of dealing with the time-dependent processes that NPs undergo in aquatic media when investigating their toxicity.

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Assessing Environmental Sustainability of Remediation Technologies in a Life Cycle Perspective is Not So Easy
Integrating sustainability into remediation projects has attracted attention from remediation practitioners, and life cycle assessment (LCA) is becoming a popular tool to address the environmental dimension. The total number of studies has reached 31 since the first framework for LCA of site remediation was published in 1999,1 and has almost doubled compared to number of studies in two reviews published in 2010.2,3 However, our analysis shows an increasing frequency of examples with serious methodological problems (compared to requirements in ISO standards or authoritative guidelines). Figure 1 shows that numerous studies have no or an incomplete definition of the functional unit, omit an appropriate quantification of primary impacts, or fail to include all relevant secondary impact categories. We will illustrate how ignoring these methodological challenges can lead to a misleading conclusion about the environmental sustainability of remediation technologies.

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Mapping and characterization of LCA networks

Purpose: The aims of this study were to provide an up-to-date overview of global, regional and local networks supporting life cycle thinking and to characterize them according to their structure and activities.

Methods: Following a tentative life cycle assessment (LCA) network definition, a mapping was performed based on (1) a literature search, (2) a web search and (3) an inquiry to stakeholders distributed via the two largest LCA fora. Networks were characterized based on responses from a survey.

Results and discussion: We identified 100 networks, of which 29 fulfilled all six criteria composing our tentative network definition (the remaining fulfilled four to five criteria). The networks are mainly located in Europe and the USA, whilst Africa, the Middle East and Central Asia are less covered regions. The survey results (from 25 network responses) indicate that LCA networks appear to be primarily small- to medium-sized (<100 members) and to include a large proportion of academia and industries, including small- and medium-sized enterprises, with much less involvement of authorities and non-governmental organisations. Their major activities relate to knowledge sharing and communication, support of case studies, and development of life cycle inventories and impact assessment methods. Networks in developing economies have different structures and activities than networks in developed economies and, for instance, more frequently have members from non-governmental organisations. Globally, an increasing trend in the formation of LCA networks over time is observed, which tends to correlate with the number of LCA scientific publications over the same time period. Continental distributions of networks also show a correlation with the number of LCA publications from the same region.

Conclusions: The provided list of LCA networks is currently the most comprehensive, publicly available mapping. We believe that the results of this mapping can serve as a basis for deciding where priorities should be set to increase the dissemination and development of LCA worldwide. In this aim, we also advocate the creation of an online, regularly updated database of LCA networks supplemented by an online platform that could facilitate network communication and knowledge sharing.
Defining and mapping LCA networks: Initial results

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Evaluation of spatial variability of metal bioavailability in soils using geostatistics

Soil properties show significant spatial variability at local, regional and continental scales. This is a challenge for life cycle impact assessment (LCIA) of metals, because fate, bioavailability and effect factors are controlled by environmental chemistry and can vary orders of magnitude for different soils. Here, variography is employed to analyse spatial variability of bioavailability factors (BFs) of metals at the global scale. First, published empirical regressions are employed to calculate BFs of metals for 7180 topsoil profiles. Next, geostatistical interpretation of calculated BFs is performed using ArcGIS Geostatistical Analyst. Results show that BFs of copper span a range of 6 orders of magnitude, and have significant spatial variability at local and continental scales. The model nugget variance is significantly higher than zero, suggesting the presence of spatial variability at lags smaller than those in the data set. Geostatistical analyses indicate however, that BFs exhibit no significant spatial correlation at a range beyond 3200 km. Because BF is spatially correlated, its values at unsampled locations can be predicted, as demonstrated using ordinary kriging method. Similar approach can be employed for analyzing spatial variability of terrestrial ecotoxicity characterization factors of metals. Predicted maps can be used to provide a set of regionalized factors at spatial scales that are both scientifically relevant and practically feasible in LCIA.

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A Methodology for Inclusion of Terrestrial Ecotoxic Impacts of Metals in Life Cycle Impact Assessment

Terrestrial ecotoxicity is in most cases not addressed or to a very limited extent in life cycle assessment (LCA). We are developing a new method for calculating terrestrial ecotoxicity characterization factor (CF) of metals for application in life cycle impact assessment (LCIA). The method takes into account metal speciation and interactions with soil organic constituents, because these mechanisms control metal bioavailability and influence their toxic properties. Transfer functions and geochemical speciation models are employed to calculate reactive and available fractions of metals in 1300 soils spanning a wide range of properties and pore water chemistry. Site-specific fate factors (FF), bioavailability factors (BF) and effect factors (EF) are then calculated for these soils. The biggest variability is observed for BF, which can vary from 2 to 6 orders of magnitude for the cases of Ni and Cu, respectively. These variations are a result of variability in soil properties such as pH, organic carbon or clay content. Published terrestrial biotic ligand models (TBLM) and free ion activity models (FIAM) are next employed in order to derive terrestrial ecotoxicity EFs. Median EFs predicted with TBLMs for Cu and Ni correspond to average ecotoxicity (range) of 12.4 (6.6 – 364) and 1194 (62 – 42164) μg/L, respectively. EFs derived with FIAMs turn out to be 6.5 (Cu) and 7.5 (Ni) times higher than those derived with TBLMs. Ecotoxicity ratio of Cu to Ni is accurately predicted with both models and the contribution of EF to the CF is within the same order of magnitude or lower compared to that of the BF. Thus, FIAMs can be employed to calculate EFs for metals for which TBLMs are not available. A set of spatially explicit CFs, site-generic CFs can be derived at global or continental scales. For applications in LCIA, the tradeoff between the level of geographical detail and the level of uncertainty in both spatially explicit and site-generic CFs remains to be investigated. The method highlights the importance of taking into account variability of soil properties in deriving operational characterization factors for terrestrial ecotoxicity of metals.
at what spatial scale the FIAMs are a good alternative to TBLMs in evaluating metal toxic impacts in terrestrial environments.

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**Can freshwater toxicity models (FIAM and BLM) be applicable to marine ecosystem?**

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**Comparison of metal toxic impacts between aquatic and terrestrial organisms: is the free ion concentration a sufficient descriptor?**
Characterization of metal toxic impacts in comparative risk assessment and life cycle impact assessment (LCIA) should take into account metal speciation and interactions with soil/water organic constituents, because these mechanisms control metal bioavailability and may influence their toxic properties. In a comparative context we are faced with the need to characterise thousands of substances, but the limitation of the available data calls for reliable indicators suitable for extrapolation from the limited data that is available. Indeed, free metal ion concentration has in some cases been shown to be a sufficient indicator of metal toxicity for both aquatic and terrestrial species. With the aim of deriving extrapolations to predict terrestrial toxic impacts of metals from aquatic effect data, we compared copper toxicity of aquatic organisms with that of terrestrial organisms, testing the hypothesis that the free metal ion is an appropriate "general" descriptor of metal toxicity. Results for 128 laboratory tests on Daphnia magna exposed to copper ions (Cu2+) in water show that variation of several orders of magnitude are observed between the toxicity tests. These variations may be a result of the inability of the free metal ion concentration to reflect toxicity, as the presence of protons and other cations reacting with biological binding sites has been shown to affect the toxicity of copper to D. magna. Similar patterns, albeit with smaller variations, are observed for terrestrial organisms. Up to three orders of magnitude difference occur for the extreme case of barley (Hordeum vulgare). Given the scarcity of terrestrial effect data compared to aquatic data, reliable and transparent, mechanistic-based predictions of terrestrial toxic impacts from aquatic effect data would be an important step ahead in the context of LCIA or comparative risk. Here we demonstrate that the overall ability of the free metal ion to reflect toxicity of metals for aquatic and terrestrial organisms is limited. This has consequences if potential terrestrial toxic effects are based on extrapolations from aquatic data, because the use of more sophisticated models such as the Biotic Ligand Model (BLM) would be required. However, extrapolation models based on an improved free ion approach might still be a good proxy, particularly when the comparative nature of life cycle assessment is taken into account.
Interactions between rhamnolipid biosurfactants and toxic chlorinated phenols enhance biodegradation of a model hydrocarbon-rich effluent

Surfactant-mediated treatment increases hydrocarbon solubilization and potentially facilitates biodegradation, unless toxic co-contaminants inhibiting microbial activity are present in the hydrocarbon mixture. We assessed the effect of rhamnolipids on the performance of a bacterial consortium degrading diesel fuel employed as a model hydrocarbon-rich effluent, co-contaminated with toxic phenol, 4-chlorophenol (4-CP) or 2,4-dichlorophenol (2,4-DCP). This approach led to the unexpected finding that rhamnolipids reduced toxicity of 4-CP and 2,4-DCP to the hydrocarbon-degrading cells. The facts that rhamnolipids decreased diesel fuel - water partition coefficient (KFW) of 4-CP and 2,4-DCP and modified aggregate size distribution profiles of the dispersed diesel fuel - chlorinated phenols solutions, suggest the existence of specific interactions between rhamnolipids and the co-contaminants. Due to the polar nature of 4-CP and 2,4-DCP, possible explanations involve adsorption of 4-CP and 2,4-DCP on the surface of biosurfactant aggregates. This property of rhamnolipids is of interest to those using biosurfactants for microbial treatment of hydrocarbon-rich wastewaters co-contaminated with toxic compounds.

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LC-IMPACT Deliverable 2.1. Terrestrial ecotoxicity

General information
State: Published
Organisations: Quantitative Sustainability Assessment, Department of Management Engineering
Authors: Owsianiak, M. (Intern), Rosenbaum, R. K. (Intern), Hauschild, M. Z. (Intern)
Number of pages: 28
Publication date: 2011

Publication information
Original language: English
Series: EU FP7 project, deliverable
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 277541
Publication: Research - peer-review › Report – Annual report year: 2011

LC-IMPACT Deliverable 5.3. First policy brief

General information
State: Published
Organisations: Quantitative Sustainability Assessment, Department of Management Engineering
Authors: Owsianiak, M. (Intern), Rosenbaum, R. K. (Intern)
Relative quantitative PCR to assess bacterial community dynamics during biodegradation of diesel and biodiesel fuels under various aeration conditions

The degradation of diesel fuel, B20 blend and biodiesel in liquid cultures by a seven-member bacterial consortium was compared under conditions with full aeration or with limited aeration with nitrate added as main electron acceptor. Community dynamics was assessed employing real-time PCR and the ddCt method for relative quantification. Biodegradation rates increased with increasing biodiesel content, but were significantly reduced under conditions with nitrate. Despite large variations in biodegradation rates, magnitude changes in population numbers were typically observed only from zero to one order, regardless the type of fuel and electron acceptor. Only Comamonadaceae and Variovorax sp. distinctly preferred aerobic conditions, and during aerobic growth showed suppression as fuel contained more biodiesel. Thus, the consortium is relatively stable and most of the degraders can shift their metabolism from hydrocarbons to biodiesel. The stability of the consortium is of interest in the context of biodiesel-mediated biodegradation of petroleum hydrocarbons.

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Rola rhamnolipidów w środowisku naturalnym

Rhamnolipids are glycolipidic surfactants of bacterial origin. In the past 20 years rhamnolipids were often associated with the mediation of uptake of hydrophobic substrates by bacterial cells. Recent research has provided evidence that rhamnolipids primarily play a role in surface-associated modes of bacterial mobility and are involved in biofilm development. This review gives an insight into the current state of knowledge on these roles of the rhamnolipid biosurfactants.
Biodegradation in a Partially Saturated Sand Matrix: Compounding Effects of Water Content, Bacterial Spatial Distribution, and Motility

Bacterial pesticide degraders are generally heterogeneously distributed in soils, leaving soil volumes devoid of degradation potential. This is expected to have an impact on degradation rates because the degradation of pollutant molecules in such zones will be contingent either on degraders colonizing these zones or on pollutant mass transfer to neighboring zones containing degraders. In a model system, we quantified the role exerted by water on mineralization rate in the context of a heterogeneously distributed degradation potential. Alginate beads colonized by Pseudomonas putida KT2440 were inserted at prescribed locations in sand microcosms so that the initial spatial distribution of the mineralization potential was controlled. The mineralization rate was strongly affected by the matric potential (decreasing rate with decreasing matric potential) and by the initial distribution of the degraders (more aggregated distributions being associated with lower rates). The mineralization was diffusion-limited, as confirmed with a mathematical model. In wet conditions, extensive cell dispersal was observed for the flagellated wild type and, albeit to a lesser extent, for a nonflagellated mutant, partially relieving the diffusion limitation. Dry conditions, however, sustained low mineralization rates through the combined effects of low pollutant diffusivity and limited degrader dispersal.

General information
State: Published
Organisations: Department of Environmental Engineering, Quantitative Sustainability Assessment, Department of Management Engineering, Universite de Bretagne-Sud
Authors: Dechesne, A. (Intern), Owsianiak, M. (Intern), Bazire, A. (Intern), Grundmann, G. L. (Ekstern), Binning, P. J. (Intern), Smets, B. F. (Intern)
Pages: 2386-2392
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Environmental Science & Technology (Washington)
Volume: 44
ISSN (Print): 0013-936X
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.538 SNIP 1.889
Evaluation of Bioaugmentation with Entrapped Degrading Cells as a Soil Remediation Technology

Soil augmentation with microbial degraders immobilized on carriers is evaluated as a potential remediation technology using a mathematical model that includes degradation within spatially distributed carriers and diffusion or
advection-dispersion as contaminant mass transfer mechanisms. The total volume of carriers is a critical parameter affecting biodegradation performance. In the absence of advection, 320 and 20 000 days are required to mineralize 90% of the herbicide linuron by Variovorax sp. SRS16 encapsulated in 2 mm beads with 5 and 20 mm spacings, respectively. Given that many pesticide degraders have low intrinsic degradation rates and that only limited carrier to soil volume ratios are practically feasible, bioaugmented soils are characterized by low effective degradation rates and can be considered fully mixed. A simple exponential model is then sufficient to predict biodegradation as verified by comparisons with published experimental data. By contrast, the full spatially distributed model is needed to adequately model the degradation of faster degrading contaminants such as naphthalene and benzene which can be mass-transfer limited. Dimensionless Damköhler numbers are proposed to determine whether the spatially distributed model is required. Results show that field scale applications of immobilized degraders will be limited by the amount of carriers required to reach acceptable degradation rates.

**General information**

**State:** Published  
**Organisations:** Quantitative Sustainability Assessment, Department of Management Engineering, Department of Environmental Engineering, Geological Survey of Denmark and Greenland  
**Authors:** Owsianiak, M. (Intern), Dechesne, A. (Intern), Binning, P. J. (Intern), Chambon, J. C. C. (Intern), Sørensen, S. R. (Ekstern), Smets, B. F. (Intern)  
**Pages:** 7622-7627  
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**Main Research Area:** Technical/natural sciences

**Publication Information**

**Journal:** Environmental Science & Technology (Washington)  
**Volume:** 44  
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**Ratings:**  
BFI (2017): BFI-level 2  
Web of Science (2017): Indexed Yes  
BFI (2016): BFI-level 2  
Scopus rating (2016): CiteScore 6.26 SJR 2.538 SNIP 1.889  
Web of Science (2016): Indexed yes  
BFI (2015): BFI-level 2  
Scopus rating (2015): SJR 2.584 SNIP 1.828 CiteScore 5.61  
Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 2  
Scopus rating (2014): SJR 2.777 SNIP 2.017 CiteScore 5.5  
Web of Science (2014): Indexed yes  
BFI (2013): BFI-level 2  
Scopus rating (2013): SJR 2.956 SNIP 2.103 CiteScore 5.52  
ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes  
BFI (2012): BFI-level 2  
Scopus rating (2012): SJR 3.146 SNIP 2.056 CiteScore 5.17  
ISI indexed (2012): ISI indexed yes  
Web of Science (2012): Indexed yes  
BFI (2011): BFI-level 2  
Scopus rating (2011): SJR 3.178 SNIP 1.953 CiteScore 5.16  
ISI indexed (2011): ISI indexed yes  
Web of Science (2011): Indexed yes  
BFI (2010): BFI-level 2  
Scopus rating (2010): SJR 2.964 SNIP 1.729  
Web of Science (2010): Indexed yes  
BFI (2009): BFI-level 2  
Scopus rating (2009): SJR 2.835 SNIP 1.803  
Web of Science (2009): Indexed yes  
BFI (2008): BFI-level 2  
Scopus rating (2008): SJR 2.943 SNIP 1.942
Modelling bioaugmentation in unsaturated porous media: The linuron herbicide example

To protect groundwater resources against pesticides, bioaugmentation with microorganisms immobilized in solid carriers has been considered as a soil remediation strategy. We have developed a mathematical model to assess this bioremediation approach to remove the pesticide linuron from soils at various water saturation levels. A bacterium mineralizing linuron is heterogeneously distributed within a 3-D model domain in spherical hotspots of 2-mm diameter size. Diffusion and advection due to infiltration are the transport processes, and microbial growth follows first order kinetics. Without advection, a bead spacing distance of 5 mm at saturated conditions is required to achieve a bioremediation goal of 90% linuron mineralization in 1 year. The gas phase is an important parameter affecting the transport of linuron, however, linuron biodegradation is growth kinetics limited within a broad water saturation range. It is hypothesized that the selection of faster degraders can compensate for high amounts of required beads.

Towards successful bioaugmentation with entrapped cells as a soil remediation technology: Effects of the water content and cell dispersal.

Soil remediation technologies are proposed that rely on inoculation with degrading microorganisms entrapped in protective carriers. A mathematical model developed to model entrapped cell bioaugmentation describes the 3-D diffusion-driven mass transfer of benzoate, and its mineralization by Pseudomonas putida KT2440 entrapped in alginate beads spatially distributed in a sandy matrix. The model is validated against experimental data where one, three, and nine degradation hotspots are spatially distributed in sandy microcosms. The lowest mineralization rates are observed in dry conditions...
(water saturation 7%) and agree satisfactory well with model predictions. In contrast, much larger mineralization rates are measured for wet conditions (water saturation of 68%). This discrepancy originates from extensive cell dispersal, not accounted for in the model, which occurs in wet conditions but is restricted in dry conditions, as confirmed by performing cell counts. This highlights the potential of entrapped cells when they act as seeds for soil colonization.

**General information**

State: Published  
Organisations: Quantitative Sustainability Assessment, Department of Management Engineering, Department of Environmental Engineering  
Authors: Owlsianiak, M. (Intern), Dechesne, A. (Intern), Binning, P. J. (Intern), Smets, B. F. (Intern)  
Pages: TU-18  
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Publisher: IAHS Press  
Main Research Area: Technical/natural sciences  
Source: orbit  
Source-ID: 264917  
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2010

**Adsorption of Sodium Dodecylbenzenesulphonate (SDBS) on Candida maltosa EH 15 Strain: Influence on Cell Surface Hydrophobicity and n-alkanes Biodegradation**

The effect of exogenously added sodium dodecylbenzenesulphonate (SDBS) surfactant on biodegradation of a mixture of straight-chain aliphatic hydrocarbons (dodecane and hexadecane) and resulting cell surface hydrophobicity changes of Candida maltosa EH 15 were investigated. Results indicated that up to 75 mg/L SDBS improves the biodegradation potential of examined yeast. A decrease in hydrophobicity was observed when SDBS was supplemented in higher concentrations, having strong impact on biodegradation rates. Phase distribution of surfactant molecules was investigated using methylene blue active substances method (MBAS), accompanied by surface and interfacial tension measurements. Studies showed that portion of SDBS molecules adsorbed on cell surface may play significant role in interaction between anionic surfactant and yeast cells, having influence on biodegradation rates.

**General information**

State: Published  
Organisations: Poznan University of Technology, Helmholtz Centre for Environmental Research  
Authors: Chrzanowski, Ł. (Ekstern), Owlsianiak, M. (Intern), Wyrwas, B. (Ekstern), Aurich, A. (Ekstern), Szulc, A. (Ekstern), Olszanowski, A. (Ekstern)  
Pages: 345–353  
Publication date: 2009  
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Water, Air and Soil Pollution  
Volume: 196  
ISSN (Print): 0049-6979  
Ratings:  
BFI (2017): BFI-level 1  
Web of Science (2017): Indexed Yes  
BFI (2016): BFI-level 1  
Scopus rating (2016): CiteScore 1.77  
BFI (2015): BFI-level 1  
Scopus rating (2015): CiteScore 1.7  
Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 1  
Scopus rating (2014): CiteScore 1.8  
BFI (2013): BFI-level 1  
Scopus rating (2013): CiteScore 1.8  
ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes
Biodegradation and surfactant-mediated biodegradation of diesel fuel by 218 microbial consortia are not correlated to cell surface hydrophobicity

In this study, we elucidated the role of cell surface hydrophobicity (microbial adhesion to hydrocarbons method, MATH) and the effect of anionic rhamnolipids and nonionic Triton X-100 surfactants on biodegradation of diesel fuel employing 218 microbial consortia isolated from petroleum-contaminated soils. Applied enrichment procedure with floating diesel fuel as a sole carbon source in liquid cultures resulted in consortia of varying biodegradation potential and diametrically different cell surface properties, suggesting that cell surface hydrophobicity is a conserved parameter. Surprisingly, no correlations between cell surface hydrophobicity and biodegradation of diesel fuel were found. Nevertheless, both surfactants altered cell surface hydrophobicity of the consortia in a similar manner: increased for the hydrophilic and decreased for the hydrophobic cultures. In addition to this, the surfactants exhibited similar influence on diesel fuel biodegradation: Increase was observed for initially slow-degrading cultures and the opposite for fast degraders. This indicates that in the surfactant-mediated biodegradation, effectiveness of surfactants depends on the specification of microorganisms and not on the type of surfactant. In contrary to what was previously reported for pure strains, cell surface hydrophobicity, as determined by MATH, is not a good descriptor of biodegrading potential for mixed cultures.

General information
State: Published
Organisations: Poznan University of Technology
Authors: Owsiannik, M. (Intern), Szulc, A. (Ekstern), Chrzanowski, Ł. (Ekstern), Cyplik, P. (Ekstern), Bogacki, M. (Ekstern), Olejnik-Schmidt, A. K. (Ekstern), Heipieper, H. J. (Ekstern)
Pages: 545–553
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: Applied Microbiology and Biotechnology
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ISSN (Print): 0175-7598
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.57 SJR 1.177 SNIP 1.173
Biodegradation of diesel/biodiesel blends by a consortium of hydrocarbon degraders: Effect of the type of blend and the addition of biosurfactants

Biodegradation experiments for diesel/biodiesel blends in liquid cultures by-petroleum degrading microbial consortium showed that for low amendments of biodiesel (10%) the overall biodegradation efficiency of the mixture after seven days was lower than for petroleum diesel fuel. Preferential usage of methyl esters in the broad biodiesel concentration range and diminished biodegradation of petroleum hydrocarbons for 10% biodiesel blend was confirmed. Rhamnolipids improved biodegradation efficiency only for blends with low content of biodiesel. Emulsion formation experiments showed that biodiesel amendments significantly affected dispersion of fuel mixtures in water. The presence of rhamnolipids biosurfactant affected stability of such emulsions and altered cell Surface properties of tested consortium. (c) 2008 Elsevier Ltd. All rights reserved.

General information
State: Published
Organisations: Poznan University of Technology, Poznan University of Life Sciences, Helmholtz Centre for Environmental Research
Authors: Owsianiak, M. (Intern), Chrzanowski, L. (Ekstern), Szulc, A. (Ekstern), Staniewski, J. (Ekstern), Olszanowski, A. (Ekstern), Olejnik-Schmidt, A. K. (Ekstern), Heipieper, H. J. (Ekstern)
Number of pages: 4
Pages: 1497-1500
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication Information
Journal: Bioresource Technology
Volume: 100
Issue number: 3
ISSN (Print): 0960-8524
Ratings:
BFI (2017): BFI-level 2
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.94 SJR 2.191 SNIP 1.91
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.255 SNIP 1.908 CiteScore 5.47
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.41 SNIP 2.104 CiteScore 5.3
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.412 SNIP 2.503 CiteScore 5.97
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.389 SNIP 2.465 CiteScore 5.25
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.314 SNIP 2.508 CiteScore 5.56
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.086 SNIP 2.355
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.912 SNIP 2.231
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.734 SNIP 2.732
Biodegradation of diesel fuel by a microbial consortium in the presence of 1-alkoxymethyl-2-methyl-5-hydroxypyridinium chloride homologues

Fast development of ionic liquids as gaining more and more attention valuable chemicals will undoubtedly lead to environmental pollution. New formulations and application of ionic liquids may result in contamination in the presence of hydrophobic compounds, such as petroleum mixtures. We hypothesize that in the presence of diesel fuel low-water-soluble ionic liquids may become more toxic to hydrocarbon-degrading microorganisms. In this study the influence of 1-alkoxymethyl-2-methyl-5-hydroxypyridinium chloride homologues (side-chain length from C-3 to C-18) on biodegradation of diesel fuel by a bacterial consortium was investigated. Whereas test performed for the consortium cultivated on disodium succinate showed that toxicity of the investigated ionic liquids decreased with increase in side-chain length, only higher homologues (C-8-C-18) caused a decrease in diesel fuel biodegradation. As a result of exposure to toxic compounds also modification in cell surface hydrophobicity was observed (MATH). Disulphine blue active substances method was employed to determine partitioning index of ionic liquids between water and diesel fuel phase, which varied from 1.1 to 51% for C-3 and C-18 homologues, respectively. We conclude that in the presence of hydrocarbons acting as a solvent, the increased bioavailability of hydrophobic homologues is responsible for the decrease in biodegradation efficiency of diesel fuel.

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Chrzanowski, L. (Ekstern), Stasiewicz, M. (Ekstern), Owsianiak, M. (Intern), Szulc, A. (Ekstern), Piotrowska-Cyplik, A. (Ekstern), Olejnik-Schmidt, A. (Ekstern), Wyrwas, B. (Ekstern)
Pages: 661-671
Publication date: 2009
Main Research Area: Technical/natural sciences
Phenol and n-alkanes (C_{12} and C_{16}) utilization: influence on yeast cell surface hydrophobicity

This study was focused on the role of two types of diametrically different carbon sources, n-alkanes represented by a mixture of dodecane–hexadecane, and phenol on modification of the cell surface hydrophobicity. Capabilities of using either solely hydrocarbons or hydrocarbons in the mixture with phenol as well as phenol itself by yeast species Candida maltosa, Yarrowia lipolytica and Pichia guilliermondii were investigated. Studies were complemented by cell biomass formation measurements. The corresponding cell surface hydrophobicity was assessed by microbial adhesion to the
hydrocarbon test (MATH). Degradation of phenol was examined using GC-SPE technique, whereas hydrocarbons were extracted prior to gravimetric determination. Results obtained indicated that the hydrophobic or hydrophilic nature of the carbon source had significant influence on the cell surface hydrophobicity. Although the results differed for some individual yeast strains, the generalization can be made that there is the correlation between the best hydrocarbon and phenol degradation and corresponding cell wall properties of the yeast examined.

General information
State: Published
Organisations: Poznan University of Technology
Authors: Chrzanowski, Ł. (Ekstern), Bielicka-Daszkiewicz, K. (Ekstern), Owsianiak, M. (Intern), Aurich, A. (Ekstern), Kaczorek, E. (Ekstern), Olszanowski, A. (Ekstern)
Pages: 1943–1949
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: World Journal of Microbiology and Biotechnology
Volume: 24
ISSN (Print): 0959-3993
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.603 SNIP 0.903 CiteScore 1.99
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.641 SNIP 0.936 CiteScore 1.83
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.608 SNIP 1.057 CiteScore 1.83
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.554 SNIP 0.891 CiteScore 1.64
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.585 SNIP 1.025 CiteScore 1.56
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.604 SNIP 1.051 CiteScore 1.68
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.551 SNIP 0.762
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.525 SNIP 0.701
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.472 SNIP 0.69
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.379 SNIP 0.617
Scopus rating (2006): SJR 0.323 SNIP 0.549
Scopus rating (2005): SJR 0.375 SNIP 0.653
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.377 SNIP 0.588
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.382 SNIP 0.614
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.307 SNIP 0.46
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.3 SNIP 0.489
Scopus rating (2000): SJR 0.34 SNIP 0.672
Projects:

**Climate tipping indicators for improved environmental sustainability assessment of bioplastics**

Department of Management Engineering  
Period: 01/09/2017 → 31/08/2020  
Number of participants: 3  
Phd Student: Fabbri, Serena (Intern)  
Supervisor: Hauschild, Michael Zwicky (Intern)  
Main Supervisor: Owsianiak, Mikolaj (Intern)

**Financing sources**  
Source: Internal funding (public)  
Name of research programme: Samfinansieret - Andet  
Project: PhD

**Integration of boundaries for selected planetary threads into life cycle assessment**

Department of Management Engineering  
Period: 15/12/2014 → 29/03/2018  
Number of participants: 3  
Phd Student: Ryberg, Morten (Intern)  
Supervisor: Owsianiak, Mikolaj (Intern)  
Main Supervisor: Hauschild, Michael Zwicky (Intern)

**Financing sources**  
Source: Internal funding (public)  
Name of research programme: Institut stipendie (DTU)  
Project: PhD

**Development of a methodology for inclusion of terrestrial ecotoxic impacts of metals in life cycle impact assessment**

Department of Management Engineering  
Period: 01/04/2010 → 12/12/2013  
Number of participants: 6  
Phd Student: Owsianiak, Mikolaj (Intern)  
Supervisor: Rosenbaum, Ralph K. (Intern)  
Main Supervisor: Hauschild, Michael Zwicky (Intern)  
Examiner: Olsen, Stig Irving (Intern)  
Diamond, Miriam Leah (Ekstern)  
Lützhøft, Hans-Christian Holten (Intern)
Financing sources
Source: Internal funding (public)
Name of research programme: Anden EU-finansiering
Project: PhD

LC-IMPACT: Development and application of environmental Life Cycle Impact assessment Methods for imProved sustAinability Characterisation of Technologies

Department of Management Engineering
Quantitative Sustainability Assessment
Radboud Universiteit
Swiss Federal Institute of Technology
Swedish Institute for Food and Biotechnology
PRé Consultants B.V.
International Institute for Applied Systems Analysis
Unilever
University of Stuttgart
Quantis
Leiden University
European Commission - Joint Research Center
Institute of Agri-food Research and Technology
University of Bayreuth
Period: 01/12/2009 → 31/05/2013
Number of participants: 6
LCA
Acronym: LC-IMPACT
Project participant:
Hauschild, Michael Zwicky (Intern)
Rosenbaum, Ralph K. (Intern)
Larsen, Henrik Fred (Intern)
Fantke, Peter (Intern)
Owsianiak, Mikolaj (Intern)
Cosme, Nuno Miguel Dias (Intern)

Relations
Parent project:
Development and application of environmental Life Cycle Impact assessment Methods for improved sustAinability Characterisation of Technologies

Activities:

Climate change mitigation potential of hydrochars
Period: 31 May 2017
Mikolaj Owsianiak (Speaker)
Department of Management Engineering
Quantitative Sustainability Assessment

Related event
Climate change mitigation potential of hydrochars
31/05/2017 → 31/05/2017
Valencia, Spain  
Activity: Talks and presentations › Conference presentations

**SETAC Europe: 27th Annual Meeting – Environmental Quality Through Transdisciplinary Collaboration**  
Period: 8 May 2017  
Mikolaj Owsianiak (Participant)  
Department of Management Engineering  
Quantitative Sustainability Assessment  

**Description**  
Position of existing footprints in the environmental sustainability landscape  
Degree of recognition: International  

**Related event**  
**SETAC Europe: 27th Annual Meeting – Environmental Quality Through Transdisciplinary Collaboration**  
07/05/2017 → 13/07/2017  
Brussels, Belgium  
Activity: Attending an event › Participating in or organising a conference

**Are free ion activity models (FIAM) sufficient alternatives to biotic ligand models (BLM) for metal toxic impact assessment in terrestrial ecosystems?: Student day in Danish Society of Soil Sciences (DFJ)**  
Period: 9 Sep 2011  
Mikolaj Owsianiak (Speaker)  
Department of Management Engineering  
Quantitative Sustainability Assessment  

**Description**  
Place: KU-LIFE, University of Copenhagen  

**Related external organisation**  
Unknown external organisation  
Activity: Talks and presentations › Conference presentations

**LC-IMPACT Workshop on Spatial Differentiation in LCA: Terrestrial ecotoxicity with a specific focus on metals**  
Period: 25 Jan 2011  
Mikolaj Owsianiak (Speaker)  
Department of Management Engineering  
Quantitative Sustainability Assessment  

**Description**  
Place: Copenhagen  

**Related external organisation**  
Unknown external organisation  
Activity: Talks and presentations › Conference presentations