Biodiversity of soil bacteria exposed to sub-lethal concentrations of phosphonium-based ionic liquids: Effects of toxicity and biodegradation

Little is known about the effect of ionic liquids (ILs) on the structure of soil microbial communities and resulting biodiversity. Therefore, we studied the influence of six trihexyl(tetradecyl)phosphonium ILs (with either bromide or various organic anions) at sublethal concentrations on the structure of microbial community present in an urban park soil in 100-day microcosm experiments. The biodiversity decreased in all samples (Shannon's index decreased from 1.75 down to 0.74 and OTU's number decreased from 1399 down to 965) with the largest decrease observed in the microcosms spiked with ILs where biodegradation extent was higher than 80% (i.e. [P66614][Br] and [P66614][2,4,4]). Despite this general decrease in biodiversity, which can be explained by ecotoxic effect of the ILs, the microbial community in the microcosms was enriched with Gram-negative hydrocarbon-degrading genera e.g. Sphingomonas. It is hypothesized that, in addition to toxicity, the observed decrease in biodiversity and change in the microbial community structure may be explained by the primary biodegradation of the ILs or their metabolites by the mentioned genera, which outcompeted other microorganisms unable to degrade ILs or their metabolites. Thus, the introduction of phosphonium-based ILs into soils at sub-lethal concentrations may result not only in a decrease in biodiversity due to toxic effects, but also in enrichment with ILs-degrading bacteria.
To enable quantifying environmental performance of products and technologies in relation to Planetary Boundaries, there is a need for life-cycle impact assessment (LCIA) methods which allow for expressing indicators of environmental impact in metrics corresponding to those of the control variables in the Planetary Boundaries framework. In this study, we present such a methodology, referred to as PB-LCIA. Characterization factors for direct use in the LCIA phase of a life cycle...
assessment, or other life-cycle based assessment, were developed for a total of 85 elementary flows recognized as
dominant contributors to transgressing specific Planetary Boundaries. Exception was made for “biosphere
integrity” and “introduction of novel entities” where a Planetary Boundary is yet to be defined for the latter and
characterization models are considered immature for the former. The PB-LCIA can be used to quantify the share of the
“safe operating space” that human activities occupy, as was illustrated by calculating indicator scores for about
10,600 products, technologies and services exemplifying several sectors, including materials, energy, transport, and
processing. The PB-LCIA can be used by companies interested in gauging their activities against the Planetary
Boundaries to support decisions that help to reduce the risk of human activities moving the Earth System out of the
Holocene state.

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Evaluating climate change mitigation potential of hydrochars: compounding insights from three different indicators

We employed life cycle assessment to evaluate the use of hydrochars, prospective soil conditioners produced from biowaste using hydrothermal carbonization, as an approach to improving agriculture while reusing carbon present in the biowaste. We considered six different crops (barley, wheat, sugar beet, fava bean, onion and lucerne) and two different countries (Spain and Germany), and used three different indicators of climate change: global warming potential (GWP), global temperature change potential (GTP), and climate tipping potential (CTP). We found that although climate change benefits (GWP) from just sequestration and temporary storage of carbon are sufficient to outweigh impacts stemming from hydrochar production and transportation to the field, even greater benefits stem from replacing climate-inefficient biowaste management treatment options, like composting in Spain. By contrast, hydrochar addition to soil is not a good approach to improving agriculture in countries where incineration with energy recovery is the dominant treatment option for biowaste, like in Germany. Relatively small, but statistically significant differences in impact scores were found between crops. Although these conclusions remained the same in our study, potential benefits from replacing composting were smaller in the GTP approach, which due to its long-term perspective gives less weight to short-lived GHGs like methane. Using CTP as indicator we also found that there is a risk of contributing to crossing of a short-term climatic target, the tipping point corresponding to an atmospheric GHG concentration of 450 ppm CO2 equivalents, unless hydrochar stability in the soil is optimized. Our results highlight the need for considering complementary perspectives that different climate change indicators offer, and overall provide a foundation for assessing climate change mitigation potential of hydrochars used in agriculture.

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Web of Science (2016): Impact factor 4.655
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Scopus rating (2015): CiteScore 5.14 SJR 1.962 SNIP 1.593
Goal Definition

The goal definition is the first phase of an LCA and determines the purpose of a study in detail. This chapter teaches how to perform the six aspects of a goal definition: (1) Intended applications of the results, (2) Limitations due to methodological choices, (3) Decision context and reasons for carrying out the study, (4) Target audience, (5) Comparative studies to be disclosed to the public and (6) Commissioner of the study and other influential actors. The instructions address both the conduct and reporting of a goal definition and are largely based on the ILCD guidance document (EC-JRC in European Commission—Joint Research Centre—Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook—General Guide for Life Cycle Assessment—Detailed Guidance. Publications Office of the European Union, Luxembourg 2010).
How to bring absolute sustainability into decision-making: An industry case study using a Planetary Boundary-based methodology

The Planetary Boundaries concept has emerged as a framework for articulating environmental limits, gaining traction as a basis for considering sustainability in business settings, government policy and international guidelines. There is emerging interest in using the Planetary Boundaries concept as part of life cycle assessment (LCA) for gauging absolute environmental sustainability. We tested the applicability of a novel Planetary Boundaries-based life cycle impact assessment methodology on a hypothetical laundry washing case study at the EU level. We express the impacts corresponding to the control variables of the individual Planetary Boundaries together with a measure of their respective uncertainties. We tested four sharing principles for assigning a share of the safe operating space (SoSOS) to laundry washing and assessed if the impacts were within the assigned SoSOS. The choice of sharing principle had the greatest influence on the outcome. We therefore highlight the need for more research on the development and choice of sharing principles. Although further work is required to operationalize Planetary Boundaries in LCA, this study shows the potential to relate impacts of human activities to environmental boundaries using LCA, offering company and policy decision-makers information needed to promote environmental sustainability.

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Web of Science (2015): Impact factor 3.976
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Improving environmental performance of post-harvest supply chains of fruits and vegetables in Europe: Potential contribution from ultrasonic humidification

Post-harvest losses of fruits and vegetables during refrigerated storage, transportation and retail are an important contributor to total environmental impacts of food supply chains in Europe. Ultrasonic humidification can reduce these post-harvest losses, but it is currently unknown whether implementing the technology in practice improves the environmental performance of the supply chains. Here, using life cycle assessment we showed that ultrasonic humidification has the potential to reduce environmental impacts, including climate change impacts, of selected fruits and vegetables in Europe by up to 23% compared to conventional supply chains. The greatest potential is obtained when humidifiers are applied to fruits and vegetables chains with total inherent losses higher than 24% and when humidifiers allow reducing post-harvest losses in each post-harvest stage by 20% or more. Our results suggest that humidification may be an attractive technology for making supply chain management more sustainable.

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Influence of spatial differentiation in impact assessment for LCA-based decision support: Implementation of biochar technology in Indonesia

Spatial differentiation in evaluation of environmental impacts in life cycle assessment (LCA) may give more accurate and realistic results, especially in cases where impacts occur at a local or regional scale and where sensitivity of receiving ecosystems differs from generic conditions. However, from a decision maker's perspective it is of interest to investigate whether the use of spatially differentiated impact assessment methods in addition leads to better decisions. Biochar production and agricultural utilization in Indonesia is an example of a micro-level decision-support case where spatial differentiation could be relevant.

To study the influence of spatial differentiation on management recommendations for implementation of biochar as a waste management strategy and the choice of best performing biochar production techniques, agricultural utilization systems and geographic locations, comparisons were made between four communities living on different Indonesian islands, three biochar production techniques and two types of fertilizer.

Results showed that the differences in impact scores between generic and spatially differentiated impact scores were an order of magnitude different for some of the considered impact categories. These differences influenced the identification of which system performed best when considering total damage to human health, which was mainly due to differences in accounting for impacts arising from water use. By contrast, trade-offs between impact categories combined with relatively small contribution of some spatially differentiated impacts rendered spatial differentiation less relevant with regard to total damage to ecosystems. Total impact scores were influenced to a greater extent by variations in inventories determining environmental burden and benefits, than by differences between generic and spatially differentiated characterization factors. Hence, irrespective of the scenario and type of damage considered, both generic and spatially differentiated assessments showed that implementing biochar technology in Indonesia is expected to bring environmental benefits.

It was shown that spatial differentiation in impact assessment did not necessarily lead to better decisions in this case study. This may suggest that depending on the goal of the LCA, practitioners should consider potential benefits of implementing spatially differentiated life cycle impact assessment methods as opposed to potential benefits from collecting site-specific inventories.

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LCA Applications
The chapter gives examples of applications of LCA by the central societal actors in government, industry and citizens, and discusses major motivations and challenges for the use of LCA to support science-based decision-making from their respective perspectives. We highlight applications of LCA in policy formulation, implementation and evaluation, present different purposes of LCA application in industry at both product and corporate levels, and discuss challenges for LCA applications in small- and medium-sized enterprises. Our synthesis demonstrates the importance of LCA as a tool to quantify environmental impacts of products and systems and support decisions around production and consumption and highlights factors that prevent its even more widespread application.

LCA History
The idea of LCA was conceived in the 1960s when environmental degradation and in particular the limited access to resources started becoming a concern. This chapter gives a brief summary of the history of LCA since then with a focus on the fields of methodological development, application, international harmonisation and standardisation, and dissemination. LCA had its early roots in packaging studies and focused mainly on energy use and a few emissions, spurring a largely un-coordinated method development in the US and Northern Europe. Studies were primarily done for companies, who used them internally and made little communication to stakeholders. After a silent period in the 1970s, the 1980s and 1990s saw an increase in methodological development and international collaboration and coordination in the scientific community and method development increasingly took place in universities. With the consolidation of the methodological basis, application of LCA widened to encompass a rapidly increasing range of products and systems with studies commissioned or performed by both industry and governments, and results were increasingly communicated through academic papers and industry and government reports. To this day, methodological development has continued, and increasing attention has been given to international scientific consensus building on central parts of the LCA methodology, and standardisation of LCA and related approaches.
**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.

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**Life cycle assessment in corporate sustainability reporting: Global, regional, sectoral, and company-level trends**

Large companies now commonly release corporate sustainability (CS) reports in which they describe their approach to handle sustainability challenges. To guide environmental sustainability efforts in the industry, the life cycle assessment (LCA) methodology has been recognized as an important tool by researchers and policy makers. But to what extent has the LCA methodology been present in companies’ narratives through their CS reports up to now? To answer this question, we map references to the LCA methodology in CS reports over the past two decades at geographical, sectoral, and company levels through keyword searching within an extensive database (~45,000 CS reports), analyze trends, and highlight challenges, opportunities, and recommendations to strengthen the presence of LCA in CS reports. The results show that LCA generally remains weakly present in CS reporting, with some geographical and sectoral variations. Recommendations to strengthen LCA presence in CS reports are derived for method developers, policy makers, and companies.

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Life Cycle Inventory Analysis

The inventory analysis is the third and often most time-consuming part of an LCA. The analysis is guided by the goal and scope definition, and its core activity is the collection and compilation of data on elementary flows from all processes in the studied product system(s) drawing on a combination of different sources. The output is a compiled inventory of elementary flows that is used as basis of the subsequent life cycle impact assessment phase. This chapter teaches how to carry out
this task through six steps: (1) identifying processes for the LCI model of the product system; (2) planning and collecting data; (3) constructing and quality checking unit processes; (4) constructing LCI model and calculating LCI results; (5) preparing the basis for uncertainty management and sensitivity analysis; and (6) reporting.

Main Characteristics of LCA
Life cycle assessment (LCA) has a number of defining characteristics that enables it to address questions that no other assessment tools can address. This chapter begins by demonstrating how the use of LCA in the late 2000s led to a drastic shift in the dominant perception that biofuels were “green”, “sustainable” or “carbon neutral”, which led to a change in biofuel policies. This is followed by a grouping of the LCA characteristics into four headlines and an explanation of these: (1) takes a life cycle perspective, (2) covers a broad range of environmental issues, (3) is quantitative, (4) is based on science. From the insights of the LCA characteristics we then consider the strengths and limitations of LCA and end the chapter by listing 10 questions that LCA can answer and 3 that it cannot.

Report Template
To ensure consistent reporting of life cycle assessment (LCA), we provide a report template. The report includes elements of an LCA study as recommended but the ILCD Handbook. Illustrative case study reported according to this template is presented in Chap. 39.
Scope Definition
The scope definition is the second phase of an LCA. It determines what product systems are to be assessed and how this assessment should take place. This chapter teaches how to perform a scope definition. First, important terminology and key concepts of LCA are introduced. Then, the nine items making up a scope definition are elaborately explained: (1) Deliverables, (2) Object of assessment, (3) LCI modelling framework and handling of multifunctional processes, (4) System boundaries and completeness requirements, (5) Representativeness of LCI data, (6) Preparing the basis for the impact assessment, (7) Special requirements for system comparisons, (8) Critical review needs and (9) Planning reporting of results. The instructions relate both to the performance and reporting of a scope definition and are largely based on ILCD.

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Toward Harmonizing Ecotoxicity Characterization in Life Cycle Impact Assessment
Ecosystem quality is an important area of protection in life cycle impact assessment (LCIA). Chemical pollution has adverse impacts on ecosystems at the global scale. To improve methods for assessing ecosystem impacts, the Life Cycle Initiative hosted at the United Nations Environment Programme established a task force to evaluate the state-of-the-science in modelling chemical exposure of organisms and resulting ecotoxicological effects for use in LCIA. Outcome of the task force work will be global guidance and harmonization by recommending changes to the existing practice in exposure and effect modelling in ecotoxicity characterization. These changes reflect the current science and ensure stability of recommended practice. Recommendations must work within the needs of LCIA in terms of (a) operating on information from any inventory reporting chemical emissions with limited spatiotemporal information, (b) applying best estimates rather than conservative assumptions to ensure unbiased comparison with results for other impact categories, and (c) yielding results that are additive across substances and life cycle stages and allow a quantitative expression of damage to the exposed ecosystem. Here, we report the current framework as well as discuss research questions identified in a roadmap. Primary research questions relate to the approach for ecotoxicological effect assessment, the need to clarify the method's scope and interpretation of its results, the need to consider additional environmental compartments and impact pathways, and the relevance of effect metrics other than the currently applied geometric mean of toxicity effect data across species. Because they often dominate ecotoxicity results in LCIA, metals pose a specific focus, which includes consideration of their possible essentiality and changes in environmental bioavailability. We conclude with a summary of key questions along with preliminary recommendations to address them as well as open questions that require additional research efforts. This article is protected by copyright. All rights reserved.

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Evaluating Climate Change Mitigation Potential of Carbonaceous Materials: Do Different Indicators Point to the Same Conclusion?

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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.

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Humidification of fresh produce: evaluating potential for reducing postharvest losses and environmental impacts of food supply chains

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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

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Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Radboud University Nijmegen
Contributors: Owsianiak, M., Huijbregts, M., Hauschild, M. Z.
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 EC50 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.
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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Contributors: Laurent, A., Owsiianka, M.
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BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 4.86 SJR 2.406 SNIP 1.729
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 3.98 SJR 1.792 SNIP 1.353
Web of Science (2014): Impact factor 3.491
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 3.72 SJR 1.637 SNIP 1.337
Web of Science (2013): Impact factor 2.758
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 3.43 SJR 1.64 SNIP 1.276
Web of Science (2012): Impact factor 3.168
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.53 SJR 1.186 SNIP 1.39
Web of Science (2011): Impact factor 2.438
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.261 SNIP 0.86
Web of Science (2010): Impact factor 2.1
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**Toward meaningful evaluation of climate change impacts in sustainability assessment of bioplastics**

General information
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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Contributors: Fabbri, S., Owsianiak, M.
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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
Contributors: Owsianiak, M., Ryberg, M., Hauschild, M. Z.
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URLs:
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Bibliographical note
Sustain Abstract R-2
Research output: Research - peer-review › Conference abstract for conference – Annual report year: 2016

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.
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

State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Polytechnic University of Valencia
Contributors: Owsianiak, M., Ryberg, M., Renz, M., Hitzl, M., Hauschild, M. Z.
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 6.45 SJR 1.657 SNIP 1.369
Web of Science (2017): Impact factor 6.14
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 5.92 SJR 1.572 SNIP 1.434
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.

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Department of Environmental Engineering, Water Technologies, Poznan University of Technology, Poznan University Of Life Sciences, Polish Academy of Sciences
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Web of Science (2017): Impact factor 3.733
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.67 SJR 1.08 SNIP 1.262
Web of Science (2016): Impact factor 3.813
Structural and functional robustness of an environmental bacterial community degrading diesel fuel

General information
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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Source: PublicationPreSubmission
Source-ID: 127875758
Advances in assessing terrestrial toxicity of metal emissions for improved sustainability characterization of technologies

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment
Contributors: Owsianiak, M., Hauschild, M. Z.
Number of pages: 1
Publication date: 2015

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Electronic versions:
A13_DTU_Sustain_2015.pdf

Bibliographical note
Poster presentation
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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.

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Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, University of Copenhagen
Contributors: Owsianiak, M., Holm, P. E., Fantke, P., Christiansen, K. S., Borggaard, O. K., Hauschild, M. Z.
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Scopus rating (2017): CiteScore 5 SJR 1.615 SNIP 1.46
Web of Science (2017): Impact factor 4.358
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.27 SJR 1.827 SNIP 1.74
Web of Science (2016): Impact factor 5.099
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4.72 SJR 2.003 SNIP 1.75
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Opportunities and challenges for including Planetary Boundaries in Life-Cycle Assessment

General information
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.
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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BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 30.87 SJR 14.59 SNIP 4.819
Web of Science (2017): Impact factor 30.067
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 26.39 SJR 12.283 SNIP 4.325
Web of Science (2016): Impact factor 29.518
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 19.28 SJR 7.769 SNIP 4.001
Web of Science (2014): Impact factor 20.523
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 14.81 SJR 6.019 SNIP 2.996
Web of Science (2013): Impact factor 15.49
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 11.84 SJR 5.868 SNIP 2.599
Web of Science (2012): Impact factor 11.653
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 9.96 SJR 3.737 SNIP 2.505
Web of Science (2011): Impact factor 9.61
ISI indexed (2011): ISI indexed no
Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 3.87 SNIP 2.42
Strengthening the Link between Life Cycle Assessment and Indicators for Absolute Sustainability To Support Development within Planetary Boundaries

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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 6.58 SJR 2.535 SNIP 1.941
Web of Science (2017): Impact factor 6.653
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.559 SNIP 1.902
Web of Science (2016): Impact factor 6.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.61 SJR 2.546 SNIP 1.838
Web of Science (2015): Impact factor 5.393
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 5.5 SJR 2.777 SNIP 2.003
Web of Science (2014): Impact factor 5.33
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 5.52 SJR 2.952 SNIP 2.102
Web of Science (2013): Impact factor 5.481
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 5.17 SJR 3.115 SNIP 2.043
Web of Science (2012): Impact factor 5.257
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
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.

General information
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 for low ranking coals or lignite where the ash content is above ≈25 % and the carboncontent is less than ≈50 %. Overall, it can be concluded that demineralization of coal is not advised for 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 membranebound 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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Peer-reviewed: Yes

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BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.62 SJR 1.435 SNIP 1.448
Web of Science (2017): Impact factor 4.427
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.39 SJR 1.447 SNIP 1.625
Web of Science (2016): Impact factor 4.208
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4.04 SJR 1.497 SNIP 1.567
Web of Science (2015): Impact factor 3.698
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 3.76 SJR 1.59 SNIP 1.639
Web of Science (2014): Impact factor 3.34
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 3.92 SJR 1.721 SNIP 1.751
Web of Science (2013): Impact factor 3.499
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.5 SJR 1.794 SNIP 1.618
Web of Science (2012): Impact factor 3.137
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 3.61 SJR 1.962 SNIP 1.508
Web of Science (2011): Impact factor 3.206
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.879 SNIP 1.424
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Scopus rating (2009): SJR 1.842 SNIP 1.572
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.658 SNIP 1.58
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.5 SNIP 1.605
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Scopus rating (2006): SJR 1.418 SNIP 1.673
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.479 SNIP 1.558
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Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.321 SNIP 1.323
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.902 SNIP 1.06
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.924 SNIP 0.978
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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

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment
Contributors: Owssianiak, M., Laurent, A., Bjørn, A., Hauschild, M. Z.
Publication date: 2014

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.

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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Web of Science (2016): Impact factor 3.173
Web of Science (2016): Indexed yes
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Scopus rating (2015): CiteScore 3.49 SJR 1.53 SNIP 1.579
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
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BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 3.35 SJR 1.672 SNIP 1.978
Web of Science (2013): Impact factor 3.089
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 2.89 SJR 1.529 SNIP 1.707
Web of Science (2012): Impact factor 2.773
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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 $1.4 \times 10^3$ (1.7 x 102 to 2.0 x 104) and $1.7 \times 10^3$ (2.1 x 102 to 1.1 x 104) m3/kg·day, respectively. The geographic variability of 3 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 $1.4 \times 10^3$ (1.7 x 102 to 2.0 x 104) and $1.7 \times 10^3$ (2.1 x 102 to 1.1 x 104) m3/kg·day, respectively. The geographic variability of 3 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.

**General information**

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Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Radboud University Nijmegen
Pages: 3241-3250
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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Contributors: Sørensen, S. N., Owsianiak, M., Engelbrekt, C., Baun, A.
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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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BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.559 SNIP 1.902
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Web of Science (2015): Impact factor 5.393
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Scopus rating (2014): CiteScore 5.5 SJR 2.777 SNIP 2.003
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Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 5.52 SJR 2.952 SNIP 2.102
Web of Science (2013): Impact factor 5.481
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BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 5.17 SJR 3.115 SNIP 2.043
Web of Science (2012): Impact factor 5.257
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 5.16 SJR 3.18 SNIP 1.945
Web of Science (2011): Impact factor 5.228
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.979 SNIP 1.726
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 mediumsized 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.

General information
Defining and mapping LCA networks: Initial results

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Organisations: Quantitative Sustainability Assessment, Department of Management Engineering
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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 krigging 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.
Mapping and characterization of LCA networks

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Research output: Research - peer-review › Conference abstract in proceedings – Annual report year: 2012

The misuse of LCA-based methods to claim environmental sustainability of remediation technologies

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Organisations: Department of Environmental Engineering, Water Resources Engineering, Department of Management Engineering, Quantitative Sustainability Assessment
Contributors: Lemming, G., Owsianiak, M.
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programme_abstracts_book_31102012_v2.pdf
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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) which 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 ecot 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 comparing to that of the BF. Site-generic CFs can be employed to calculate EFs for metals for which TBLMs are not available. From 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. This method highlights the importance of taking into account variability of soil properties in deriving operational characterization factors for terrestrial ecotoxicity of metals.

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Organisations: Quantitative Sustainability Assessment, Department of Management Engineering
Contributors: Owsianiak, M., Rosenbaum, R. K., Hauschild, M. Z.
Are Free Ion Activity Models Sufficient Alternatives to Biotic Ligand Models in Evaluating Metal Toxic Impacts in Terrestrial Environments?

Metal partitioning between solid and aqueous phases and speciation in soil pore water control the bioavailability of toxic forms of metals, while protons and base cations can mitigate metal ecotoxicity by competitive interactions with biotic ligands. The employment of BLMs to evaluate toxicity potential of metals in soils results in site-specific toxicity scores due to large variability of soil properties and differences in ionic composition. Unfortunately, terrestrial BMLs are available only for few metals and few organisms, thus their applicability to hazard ranking or toxic impact assessment is low and alternatives must be found. In this study, we compared published terrestrial BLMs and their potential alternatives such as free ion activity models (FIAM), for applicability in addressing metal toxic impacts in terrestrial environments. A set of 1300 soils representative for the whole world is employed to calculate EC50 and thereafter hazardous concentration HC50 (geometric mean of all EC50) for these terrestrial organisms, for which both TBLMs and FIAMs are available. Results showed that median HC50 for all soils predicted with BLMs range 2 and 3 orders of magnitude for copper and nickel, respectively. In all cases, predictions of FIAMs fall within the range of values predicted with BLMs, and toxicity ratio of copper to nickel is accurately predicted with both models. As both models are able to distinguish between the two metals in terms of their average toxicity. Given that the calculated toxicity scores show large variability even for soils located in close proximity to each other, selection of FIAMs is also justified in deriving soil quality criteria. It remains to be investigated at what spatial scale the FIAMs are a good alternative to TBLMs in evaluating metal toxic impacts in terrestrial environments.

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

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

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Organisations: Poznan University of Technology, Poznan University Of Life Sciences
Contributors: Lawniczak, L., Czaczyk, K., Owsianiak, M., Chrzanowski, L.
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Scopus rating (2014): CiteScore 0.28 SJR 0.135 SNIP 0.169
Web of Science (2014): Impact factor 0.286
Scopus rating (2013): CiteScore 0.28 SJR 0.129 SNIP 0.228
Web of Science (2013): Impact factor 0.271
ISI indexed (2013): ISI indexed yes
Scopus rating (2012): CiteScore 0.25 SJR 0.122 SNIP 0.152
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.

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Contributors: Dechesne, A., Owsianiak, M., Bazire, A., Grundmann, G. L., Binning, P. J., Smets, B. F.
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BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.559 SNIP 1.902
Web of Science (2016): Impact factor 6.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.61 SJR 2.546 SNIP 1.838
Web of Science (2015): Impact factor 5.393
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 5.5 SJR 2.777 SNIP 2.003
Web of Science (2014): Impact factor 5.33
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 5.52 SJR 2.952 SNIP 2.102
Web of Science (2013): Impact factor 5.481
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 5.17 SJR 3.115 SNIP 2.043
Web of Science (2012): Impact factor 5.257
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 5.16 SJR 3.18 SNIP 1.945
Web of Science (2011): Impact factor 5.228
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.979 SNIP 1.726
Web of Science (2010): Impact factor 4.827
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.86 SNIP 1.809
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.96 SNIP 1.935
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.774 SNIP 1.914
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.55 SNIP 1.893
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.608 SNIP 1.999
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.86 SNIP 2.046
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.54 SNIP 2.065
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 2.392 SNIP 1.949
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 2.387 SNIP 1.968
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 3.03 SNIP 2.315
Web of Science (2000): Indexed yes
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
Contributors: Owsianiak, M., Dechesne, A., Binning, P. J., Chambon, J. C. C., Sørensen, S. R., Smets, B. F.
Pages: 7622-7627
Publication date: 2010
Peer-reviewed: Yes

Publication information
Journal: Environmental Science & Technology (Washington)
Volume: 44
Issue number: 19
ISSN (Print): 0013-936X
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 6.58 SJR 2.535 SNIP 1.941
Web of Science (2017): Impact factor 6.653
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.559 SNIP 1.902
Web of Science (2016): Impact factor 6.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.61 SJR 2.546 SNIP 1.838
Web of Science (2015): Impact factor 5.393
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 5.5 SJR 2.777 SNIP 2.003
Web of Science (2014): Impact factor 5.33
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 5.52 SJR 2.952 SNIP 2.102
Web of Science (2013): Impact factor 5.481
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.

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.
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 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, Poznan University Of Life Sciences, Helmholtz Centre for Environmental Research
Pages: 545–553
Publication date: 2009
Peer-reviewed: Yes

Publication information
Journal: Applied Microbiology and Biotechnology
Volume: 84
ISSN (Print): 0175-7598
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 3.64 SJR 1.182 SNIP 1.161
Web of Science (2017): Impact factor 3.34
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.57 SJR 1.2 SNIP 1.182
Web of Science (2016): Impact factor 3.42
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.43 SJR 1.256 SNIP 1.221
Web of Science (2015): Impact factor 3.376
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 3.71 SJR 1.332 SNIP 1.448
Web of Science (2014): Impact factor 3.337
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.3 SJR 1.54 SNIP 1.43
Web of Science (2013): Impact factor 3.811
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 4 SJR 1.488 SNIP 1.29
Web of Science (2012): Impact factor 3.689
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 3.72 SJR 1.437 SNIP 1.229
Web of Science (2011): Impact factor 3.425
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
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.
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
Contributors: Chrzanowski, L., Stasiewicz, M., Owsianiak, M., Szulc, A., Piotrowska-Cyplik, A., Olejnik-Schmidt, A., Wyrwas, B.
Pages: 661-671
Publication date: 2009
Peer-reviewed: Yes

Publication information
Journal: Biodegradation
Volume: 20
Issue number: 5
ISSN (Print): 0923-9820
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
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, Helmholtz Centre for Environmental Research
Contributors: Chrzanowski, Ł., Bielicka-Daszkiewicz, K., Owsianiak, M., Aurich, A., Kaczorek, E., Olszanowski, A.
Pages: 1943–1949
Publication date: 2008
Peer-reviewed: Yes

Publication information
Journal: World Journal of Microbiology and Biotechnology
Volume: 24
ISSN (Print): 0959-3993
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.14 SJR 0.604 SNIP 0.81
Web of Science (2017): Impact factor 2.1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.99 SJR 0.621 SNIP 0.88
Web of Science (2016): Impact factor 1.658
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.83 SJR 0.635 SNIP 0.941
Web of Science (2015): Impact factor 1.532
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.83 SJR 0.609 SNIP 1.06
Web of Science (2014): Impact factor 1.779
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.64 SJR 0.559 SNIP 0.898
Web of Science (2013): Impact factor 1.353
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.56 SJR 0.554 SNIP 1.024
Web of Science (2012): Impact factor 1.262
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 1.68 SJR 0.609 SNIP 1.046
Web of Science (2011): Impact factor 1.532
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.556 SNIP 0.767
Web of Science (2010): Impact factor 1.214
Scopus rating (2006): SJR 0.325 SNIP 0.554
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.377 SNIP 0.59
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.383 SNIP 0.617
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.293 SNIP 0.459
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.3 SNIP 0.494
Scopus rating (2000): SJR 0.383 SNIP 0.679
Scopus rating (1999): SJR 0.395 SNIP 0.649
Original language: English
Keywords: Biodegradation, Hydrophobicity, n-Alkanes, Phenol, Yeast
DOI:
10.1007/s11274-008-9704-8
Source: PublicationPreSubmission
Source-ID: 92779324
Research output: Research - peer-review › Journal article – Annual report year: 2008

Projects:

The objective of the GLAM project is to run a global process aiming at global guidance and consensus building on a limited number of environmental life cycle impact category indicators developed within a consistent framework, and to identify the related research agenda. The deliverable would be a global guidance publication with a supporting web system that includes the limited number of 6 to 10 life cycle assessment (LCA) based environmental impact category indicators and the characterization factors (for various regions). It may also include guidance on how to best establish a particular regional impact category indicator in case global consensus on characterization factors cannot be achieved or makes no sense.
Fantke, P., Project Participant, Quantitative Sustainability Assessment, Department of Management Engineering
Hauschild, M. Z., Project Participant, Quantitative Sustainability Assessment, Department of Management Engineering
Laurent, A., Project Participant, Quantitative Sustainability Assessment, Department of Management Engineering
Owsianiak, M., Project Participant, Quantitative Sustainability Assessment, Department of Management Engineering
Aurisano, N., Project Participant, Quantitative Sustainability Assessment, Department of Management Engineering
01/05/2013 → 31/07/2020
Keywords: UNEP, Life Cycle Impact Assessment
Collaborators: United Nations Environmental Programme
Project: Research

**Climate tipping indicators for improved environmental sustainability assessment of bioplastics**
Fabbri, S., PhD Student, Department of Management Engineering
Owsianiak, M., Main Supervisor, Department of Management Engineering
Hauschild, M. Z., Supervisor, Department of Management Engineering
Samfinansieret - Andet
01/09/2017 → 17/11/2020
Award relations: Climate tipping indicators for improved environmental sustainability assessment of bioplastics
Project: PhD

**ECOdesign of urban buildings by integration of organic photovoltaics microgrids (ECLIPS microgrids)**
Chatzisideris, M. D., PhD Student, Department of Energy Conversion and Storage
Laurent, A., Main Supervisor, Department of Management Engineering
Integration of boundaries for selected planetary threads into life cycle assessment
Ryberg, M., PhD Student, Department of Management Engineering
Hauschild, M. Z., Main Supervisor, Department of Management Engineering
Owsianiak, M., Supervisor, Department of Management Engineering
Olsen, S. I., Examiner, Department of Management Engineering
Cornell, S. E., Examiner
Sala, S., Examiner
Richardson, K., Supervisor
Cornell, S. E., Examiner
Sala, S., Examiner
Institut stipendie (DTU)
15/12/2014 → 30/09/2018
Award relations: Integration of boundaries for selected planetary threads into life cycle assessment
Project: PhD

Development of a methodology for inclusion of terrestrial ecotoxic impacts of metals in life cycle impact assessment
Owsianiak, M., PhD Student, Department of Environmental Engineering
Hauschild, M. Z., Main Supervisor, Department of Management Engineering
Rosenbaum, R. K., Supervisor, Department of Management Engineering
Olsen, S. I., Examiner, Department of Management Engineering
Diamond, M. L., Examiner
Lützhøft, H. H., Examiner, Department of Environmental Engineering
Anden EU-finansiering
01/04/2010 → 12/12/2013
Award relations: Development of a methodology for inclusion of terrestrial ecotoxic impacts of metals in life cycle impact assessment
Project: PhD

LC-IMPACT: LC-IMPACT: Development and application of environmental Life Cycle Impact assessment Methods for Improved sustainability Characterisation of Technologies
Hauschild, M. Z., Project Participant, Department of Management Engineering, Quantitative Sustainability Assessment
Rosenbaum, R. K., Project Participant
Larsen, H. F., Project Participant
Fantke, P., Project Participant, Department of Management Engineering, Quantitative Sustainability Assessment
Owsianiak, M., Project Participant, Department of Management Engineering, Quantitative Sustainability Assessment
Cosme, N. M. D., Project Participant, Department of Management Engineering, Quantitative Sustainability Assessment
FP7 Contract ID: 243827
01/12/2009 → 31/05/2013
Keywords: LCA
Collaborators: International Institute for Applied Systems Analysis, University of Stuttgart, Leiden University, European Commission - Joint Research Center, Swiss Federal Institute of Technology, Unilever, Radboud University Nijmegen, University of Bayreuth, Institute of Agri-food Research and Technology, Swedish Institute for Food and Biotechnology, Quantis, PRé Consultants B.V.
Project: Research

Activities:
Pellston(TM) workshop on “Global guidance on environmental life cycle impact assessment indicators, 2nd round”
Period: 24 Jun 2018 → 29 Jun 2018
Alexis Laurent (Participant)
Michael Zwicky Hauschild (Participant)
Peter Fantke (Participant)
Mikolaj Owsianiak (Participant)

Quantitative Sustainability Assessment
Department of Management Engineering

Description
UNEP/SETAC Pellston WorkshopTM to Support Development of “Global Guidance for Life Cycle Impact Assessment Indicators and Methods, Phase 2” (GLAM)
Degree of recognition: International

Related event
Pellston(TM) workshop on "Global guidance on environmental life cycle impact assessment indicators, 2nd round"
24/06/2018 → 29/06/2018
Valencia, Spain
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

25th CIRP Life Cycle Engineering (LCE) Conference
Period: 30 Apr 2018 → 2 May 2018
Christine Molin (Organizer)
Alexis Laurent (Organizer)
Alexandra Segolene Corinne Leclerc (Organizer)
Carlos Manuel Moraleda Melero (Organizer)
Malene Emilie Vinding (Organizer)
Mikolaj Owsianiak (Organizer)
Peter Fantke (Organizer)
Leo Alting (Chairman)
Michael Zwicky Hauschild (Chairman)
Quantitative Sustainability Assessment
Department of Management Engineering

Description
Degree of recognition: International

Related event
25th CIRP Life Cycle Engineering (LCE) Conference
30/04/2018 → 02/05/2018
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising a conference

Interactive Session on "How can the Life Cycle Engineering community contribute to meet the UN's Sustainable Development Goals?"
Period: 30 Apr 2018
Christine Molin (Organizer)
Mikolaj Owsianiak (Organizer)
Peter Fantke (Organizer)
Alexis Laurent (Organizer)
Sami Kara (Organizer)
Christoph Herrmann (Organizer)
Wim Dewulf (Organizer)
Michael Zwicky Hauschild (Organizer)
Quantitative Sustainability Assessment
Department of Management Engineering

Description
Interactive Session aimed at identifying solutions (tools, concrete actions, etc.) that the LCE community can offer in addressing the challenges in order to meet the UN Sustainable Development Goals and some of their underlying targets.
Degree of recognition: International

Related event
Interactive Session on "How can the Life Cycle Engineering community contribute to meet the UN's Sustainable Development Goals?"
30/04/2018 → 30/04/2018
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising a conference

Short Course on "Addressing the most critical issues in LCA: from theory to practice"
Period: 29 Apr 2018
Christine Molin (Organizer)
Mikolaj Owsianiak (Organizer)
Alexis Laurent (Organizer)

Quantitative Sustainability Assessment
Department of Management Engineering

Description
1-day course given back-to-back with the 25th CIRP Life Cycle Engineering Conference 2018, Copenhagen, DK. Approx. 30 participants.
Degree of recognition: International

Related event
Short Course on "Addressing the most critical issues in LCA: from theory to practice"
29/04/2018 → 29/04/2018
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Sustainability (Journal)
Period: 2018
Alexis Laurent (Editor)
Mikolaj Owsianiak (Editor)

Quantitative Sustainability Assessment
Department of Management Engineering

Description
Special Issue (Open Access) on "Heavy Metals in Agricultural Soils: Sources, Releases and Environmental Impacts". Available here: http://www.mdpi.com/journal/sustainability/special_issues/Environmental_Impacts.
Degree of recognition: International
Links:
http://www.mdpi.com/journal/sustainability/special_issues/Environmental_Impacts (Link to Special Issue (Open Access))

Related journal
Sustainability
2071-1050
Indexed in DOAJ
Central database
Activity: Research › Journal editor
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