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翻译

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ODYM—动态物质流分析的开源软件架构：基本原则、具体实现和数据结构

作者: [Stefan Pauliuk](#), [Niko Heeren](#)

关键字: 动态建模、物质流分析 (MFA)、开放科学、Python、软件、元素流分析 (SFA)

摘要:

物质流分析是指（在一定时空范围内）关于特定系统的物质流动和存量的系统性分析。物质流分析已广泛运用于对各类社会经济系统物质代谢的研究中，并吸收融合其他领域的研究手段或方法。随着物质流分析研究的兴起，物质流分析所涉及的数据处理和模型也愈加复杂。为了促进物质流分析领域的知识共享，本文作者提出一套针对物质流分析的开源软件架构，该架构是基于 Python 开发环境，遵循四个基本原则：一、进行物质流量与存量分析时，每个流量或存量都包含产品、部件、合金、化学元素等层级；二、进行流量驱动或存量驱动时，提供标准化的运算方法；三、数据的管理与调用是基于通用和开放获取的数据结构，促进物质流数据的分享与再使用；四、对动态物质流分析的各个组件进行模块化处理，保障分析的一致性并降低代码的重复性。本文对数据结构和模型实现进行了详细的阐述和例证，并在文末对未来研究进行了展望。

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ODYM—An open software framework for studying dynamic material systems: Principles, implementation, and data structures

[Stefan Pauliuk](#), [Niko Heeren](#)

Keywords: dynamic modeling, material flow analysis (MFA), open science, Python, software, substance flow analysis (SFA)

Summary:

Material flow analysis (MFA) studies the stocks and flows of goods and substances in systems. The methods and algorithms of MFA have improved over the last few years, but a flexible platform that integrates recent modeling advances such as simultaneous consideration of the product, component, material and chemical element levels, lifetime models, and uncertainty treatment is not available. There is also no versatile data format for exchanging data between projects. This lack of research infrastructure is detrimental to scientific progress. To fill that gap, we propose a novel industrial ecology community model for MFA. The Open Dynamic Material Systems Model (ODYM) is an open source framework for material systems modeling programmed in Python. The description of systems, processes, stocks, flows, and parameters is object-based, which facilitates the development of modular software and testing routines for individual model blocks. ODYM MFA models can handle any depth of flow and stock specification: products, components, sub-components, materials, alloys, waste, and chemical elements can be traced simultaneously. ODYM features a new data structure for material flow analysis; all input and output data are stored in a standardized file format and can thus be exchanged across projects. It also comes with an extended library for dynamic stock modeling. We present the features, design principles, software, and data structure of ODYM, describe its main methods and functions, and give an outlook on current and future applications.

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一种新的城市系统物质流量实物核算模型及其在斯德哥尔摩皇家海港区的应用

作者: Asterios Papageorgiou, Rajib Sinha, Björn Frostell, Cecilia Sundberg

关键字: 自下而上, 产业生态学, 物质流分析, 实物投入产出表, 斯德哥尔摩皇家海港, 城市代谢

摘要:

可持续的城市化要求精简城市系统中的资源管理, 进而需要了解城市代谢。尽管已有文献中已有多种方法对城市代谢进行分析, 但迄今为止, 还没有用于全面评估城市系统中物质流的标准化方法, 且很少采用自下而上的方法对物质流进行核算, 即使该方法可以对城市代谢进行全面分析。本文介绍了城市核算模型(UAM), 旨在基于自下而上的方法对城市物质流进行全面核算。该模型包括两个相互关联的子模型: 一是通过将新的城市系统实物投入产出表(PIOT)框架集成到三维结构中, 二是包括一组实物账户, 用于系统计算系统中每个经济部门的物质流量, 以支持实物投入产出表的编制。本文通过将城市核算模型应用于斯德哥尔摩皇家海港区的两个城市社区, 进而探索该城市核算模型的功能。该模型不仅可以描述城市系统与环境或其他社会经济系统之间的物理相互作用、捕获系统内的部门间的物质流动, 其账户提供的信息还可以深入分析特定部门的代谢。总体而言, 城市核算模型可作为城市代谢分析的有用工具, 不仅体现在将数据收集系统化的, 还可同时描绘出城市系统的物理现实。

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A new physical accounting model for material flows in urban systems with application to the Stockholm Royal Seaport District

Asterios Papageorgiou, Rajib Sinha, Björn Frostell, Cecilia Sundberg

Keywords: bottom-up, industrial ecology, material flow analysis, physical input output table, Stockholm Royal Seaport, urban metabolism

Summary:

Sustainable urbanization requires streamlining of resource management in urban systems which in turn requires understanding of urban metabolism (UM). Even though various methods have been applied for UM analysis, to date there is no standardized method for comprehensive accounting of material flows in urban systems. Moreover, the accounting of material flows is rarely implemented with a bottom-up approach that can provide a thorough analysis of UM. This article presents the Urban Accounting Model (UAM) which aims to allow comprehensive accounting of urban material flows based on a bottom-up approach. The model comprises two interlinked sub-models. The first was developed by integrating a new physical input output table (PIOT) framework for urban systems into a three-dimensional structure. The second comprises a set of physical accounts for systematic accounting of material flows of each economic sector in the system in order to support the compilation of the PIOTs. The functions of the UAM were explored through its application to two urban neighborhoods in the Stockholm Royal Seaport district. The application highlighted that the UAM can describe the physical interactions between the urban system and the environment or other socioeconomic systems, and capture the intersectoral flows within the system. Moreover, its accounts provide information that allow an in-depth analysis of the metabolism of specific sectors. Overall, the UAM can function as a useful tool for UM analysis as it systematizes data collection and at the same time depicts the physical reality of the urban system.

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在建筑和社区分辨率上刻画从人类排泄物中回收营养元素的空间热点

作者: [Rosanne Wielemaker](#), [John Stuiver](#), [Grietje Zeeman](#), [Jan Weijma](#)

关键字: 地理信息系统, 养分循环, 磷, 废水, 资源回收利用, 城市代谢, 产业生态学

摘要:

从人类排泄物及污水中回收营养物正逐渐引起人们的关注, 以寻求补充或替代化肥生产的途径。在用污水集中处理厂的营养物回收技术外, 很多去中心化的、源分离的卫生系统(也可被称为新式卫生系统)也被建立起来用于促进营养物回收。计划与建立新式卫生系统的决策将会得益于在空间上直观分布于城市中的大量营养物热点。为了可视化展示这种营养物载量, 作者团队建立了一种结合了时空建模与地理信息系统分析的方法, 并且将这种方法运用于阿姆斯特丹的案例中。本方法在整个营养物地图绘制领域中, 尤其是在建筑这个最小的地理尺度级别上较为新颖。本研究将氮、磷、钾各自的载量以及分布热点分别在建筑尺度与社区尺度上绘制成图, 从而引起决策者对于在决策过程中的多尺度分析需求的关注。在本文最后作者团队讨论了进一步发展文中提及方法的潜力, 以在今后的研究中包含更多详细且经过验证的数据, 以识别出适宜作为新式卫生系统选址的营养物热点。

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Identifying Amsterdam's nutrient hotspots: A new method to map human excreta at building and neighborhood scale

[Rosanne Wielemaker](#), [John Stuiver](#), [Grietje Zeeman](#), [Jan Weijma](#)

Keywords: geographic information system (GIS), nutrient recycling, phosphorus, resource recovery, urban metabolism, wastewater

Summary:

Recovering nutrients from human excreta and wastewater has been receiving increasing attention as a means to supplement or replace synthetic fertilizer production. Apart from technologies for nutrient recovery at centralized wastewater treatment plants, numerous decentralized, source-separated sanitation systems, also known as new sanitation systems, have been developed to facilitate recovery. Decision-making for the planning and implementation of new sanitation systems would benefit from a spatially explicit inventory of nutrient hotspots in urban areas. To provide visual representations of nutrient loads, we developed a methodology that combines spatial-temporal modeling with geographic information system analysis, and used it for the city of Amsterdam. The methodology is new in the field of nutrient mapping, especially at the smallest geographical scale: building. Nitrogen, phosphorus, and potassium loads and hotspots are mapped at both building and neighborhood scale, drawing attention to the need for multiple scale analyses in decision-making. This study concludes with a discussion on the potential to further develop the method proposed to include more detailed and verified data and to identify nutrient hotspots that are promising as nutrient recovery sites with new sanitation systems.

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岩土工程系统生命周期评价的影响类别和环境指标综述

作者: Alena J. Raymond, James R. Tipton, Alissa Kendall, Jason T. DeJong

关键字: 环境指标, 岩土工程, 影响类别, 产业生态学, 生命周期评价(LCA), 土壤质量

摘要:

生命周期评价(LCA)虽然在路面、道路等土木工程系统中得到了广泛的应用,但在岩土工程学科中的应用有限。对以往岩土工程生命周期评价的回顾表明,大多数研究只跟踪了一小部分影响类别,如能源和全球变暖潜力。因此,目前报告的环境指标可能无法有效或充分地反映与岩土工程系统有关的重要环境影响,包括与土地和土壤资源有关的影响和权衡。本研究回顾了以往土地利用和土壤相关影响评估的研究、方法和模型,以了解其对岩土工程生命周期评价的适用性。结果表明,在目前的知识与实践仍然存在着严重的差距。特别是,环境指标、影响类别和因果路径需要进一步发展或完善,因为它们与岩土工程应用有关,特别是与土壤质量、土壤功能和土壤提供的生态系统服务相关的应用。此外,许多现有的方法都是从与其他学科(如农业)有关的土地利用和土地利用变化的研究中产生的。为了适用于岩土工程项目,许多方法和结果指标的分辨率需要从景观/宏观尺度缩小到项目规模。近期内,岩土工程生命周期评价的从业人员应开始跟踪土壤性质的变化,并定性地报告对土地和土壤资源的影响。

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Review of impact categories and environmental indicators for life cycle assessment of geotechnical systems

Alena J. Raymond, James R. Tipton, Alissa Kendall, Jason T. DeJong

Keywords: environmental indicator, geotechnical engineering, impact categories, industrial ecology, life cycle assessment (LCA), soil quality

Summary:

Life cycle assessment (LCA) has only had limited application in the geotechnical engineering discipline, though it has been widely applied to civil engineering systems such as pavements and roadways. A review of previous geotechnical LCAs showed that most studies have tracked a small set of impact categories, such as energy and global warming potential. Accordingly, currently reported environmental indicators may not effectively or fully capture important environmental impacts and tradeoffs associated with geotechnical systems, including those associated with land and soil resources. This research reviewed previous studies, methods, and models for assessment of land use and soil-related impacts to understand their applicability to geotechnical LCA. The results of this review show that critical gaps remain in current knowledge and practice. In particular, further development or refinement of environmental indicators, impact categories, and cause-effect pathways is needed as they pertain to geotechnical applications—specifically those related to soil quality, soil functions, and the ecosystem services soils provide. In addition, many existing methods emerge from research on land use and land use change related to other disciplines (e.g., agriculture). For applicability to geotechnical projects, the resolution of many of these methods and resulting indicators need to be downscaled from the landscape/macro scale to the project scale. In the near term, practitioners of geotechnical LCA should begin tracking changes to soil properties and report impacts to land and soil resources qualitatively.

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零排放社区的生命周期评价模型

作者: Carine Laussetlet, Linda Ager-Wick Ellingsen, Anders Hammer Strømman, Helge Brattebø

关键字: 建筑、建成环境、功能单元、生命周期评价 (LCA)、城市代谢、零排放

摘要:

建筑是低碳未来的重要组成部分, 其使用寿命长, 因而迫切需要采用最先进的性能标准, 以避免在长期技术解决方案选择上的重大锁定风险。建筑、交通和能源系统紧密相连, 以零排放社区 (ZEN) 为目标来评估它们之间的联系, 可以为减缓气候变化提供了独特的机会。我们对挪威的零排放社区进行了生命周期评估, 并设计了四种情景来测试房屋大小、家庭规模、建筑能源使用和生产情况以及出行方式的影响。在具有 60 年时间跨度的情景分析中, 我们使用了不同脱碳水平的电力结构。我们的结果显示了社区建设时期建筑物和交通系统的运营使用对排放的重要贡献, 以及随着电力结构的脱碳化其影响逐步下降。在临近使用寿命结束、电力结构脱碳完成时, 隐含碳排放将成为排放的主要部分。功能单元的选择对于评价有决定性影响, 我们主张使用“每个社区”为首选功能单元, “每个人”为次选功能单元。使用“每平方米”作为功能单元具有误导性, 因为它忽略了对建筑面积的预防性使用。为了最好地缓解气候变化, 应将气候积极行为与反映隐含能耗的能效标准相结合, 并将绝对阈值与行为变化相结合。

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A life-cycle assessment model for zero emission neighborhoods

Carine Laussetlet, Linda Ager-Wick Ellingsen, Anders Hammer Strømman, Helge Brattebø

Keywords: buildings, built environment, functional unit, life cycle assessment (LCA), urban metabolism, zero emissions

Summary:

Buildings represent a critical piece of a low-carbon future, and their long lifetime necessitates urgent adoption of state-of-the-art performance standards to avoid significant lock-in risk regarding long-lasting technology solution choices. Buildings, mobility, and energy systems are closely linked, and assessing their nexus by aiming for Zero Emission Neighborhoods (ZENS) provides a unique chance to contribute to climate change mitigation. We conducted a life-cycle assessment of a Norwegian ZEN and designed four scenarios to test the influence of the house size, household size, and energy used and produced in the buildings as well as mobility patterns. We ran our scenarios with different levels of decarbonization of the electricity mix over a period of 60 years. Our results show the importance of the operational phases of both the buildings and mobility in the neighborhood's construction, and its decline over time induced by the decarbonization of the electricity mix. At the neighborhood end-of-life, embodied emissions then become responsible for the majority of the emissions when the electricity mix is decarbonized. The choice of functional unit is decisive, and we thus argue for the use of a primary functional unit "per neighborhood," and a second "per person." The use of a "per m²" functional unit is misleading as it does not give credits to the precautionary use of floor area. To best mitigate climate change, climate-positive behaviors should be combined with energy efficiency standards that incorporate embodied energy, and absolute threshold should be combined with behavioral changes.

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混合生命周期评估中重复计算的校正

作者: Maxime Agez, Guillaume Majeau-Bettez, Manuele Margni, Anders H. Strømman, Réjean Samson

关键字: 数据质量, 环境投入产出分析, 混合生命周期评估, 产业生态学, 生命周期评估, 生命周期清单

摘要:

生命周期评估 (LCA) 和环境扩展的投入产出分析 (EEIOA) 是两种用于评估一项活动/产品环境影响的通用方法。它们的优缺点是互补的, 因此有规律地将它们组合在一起的方法为混合 LCA。混合 LCA 中存在许多方法, 它们会产生不同的结果。用于确保 LCA 和 EEIOA 数据不重叠 (即重复计算校正) 的方法的不同是产生这些差异的原因之一, 其在混合评估中经常被忽略, 并且尚未有研究对此进行全面分析。本文旨在列出、比较和分析重复计算校正的现有方法。在引入简化的方法之前, 我们首先统一现有校正方法的定义, 并使用通用符号表示这些方法。然后比较它们各自的假设和局限性。我们讨论了所研究活动/产品中特定信息的丢失, 以及由某些校正方法导致的货币表示连贯性的丢失。本研究阐明了从混合单个 LCA 流程到集成完整数据库过程中不同方法的最适用情景。最后, 我们为未来的混合分析提供了建议。

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Lifting the veil on the correction of double counting incidents in hybrid life cycle assessment

Maxime Agez, Guillaume Majeau-Bettez, Manuele Margni, Anders H. Strømman, Réjean Samson

Keywords: data quality, environmental input–output analysis, hybrid life-cycle assessment, industrial ecology, life cycle assessment (LCA), life cycle inventory (LCI)

Summary:

Life cycle assessment (LCA) and environmentally extended input–output analyses (EEIOA) are two techniques commonly used to assess environmental impacts of an activity/product. Their strengths and weaknesses are complementary, and they are thus regularly combined to obtain hybrid LCAs. A number of approaches in hybrid LCA exist, which leads to different results. One of the differences is the method used to ensure that mixed LCA and EEIOA data do not overlap, which is referred to as correction for double counting. This aspect of hybrid LCA is often ignored in reports of hybrid assessments and no comprehensive study has been carried out on it. This article strives to list, compare, and analyze the different existing methods for the correction of double counting. We first harmonize the definitions of the existing correction methods and express them in a common notation, before introducing a streamlined variant. We then compare their respective assumptions and limitations. We discuss the loss of specific information regarding the studied activity/product and the loss of coherent financial representation caused by some of the correction methods. This analysis clarifies which techniques are most applicable to different tasks, from hybridizing individual LCA processes to integrating complete databases. We finally conclude by giving recommendations for future hybrid analyses.

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哥斯达黎加地区热带森林的选择性伐木的生命周期碳排放

作者: Federico E. Alice-Guier, Frits Mohren, Pieter A. Zuidema

关键字: 碳中和, 气候变化, 木质林产品, 产业生态学, 生命周期评估, 选择性伐木

摘要:

关于森林采伐是否会影响大气中的碳浓度问题一直以来存在争议, 特别对于热带地区而言, 这两者的关系更加复杂, 因为森林采伐与森林退化有关。因此, 本文利用生命周期核算方法估算了哥斯达黎加天然热带森林采伐对碳平衡的影响。系统边界包括了一个周期(15年)内区域尺度的所有与采伐相关的主要生命周期过程。整个分析过程的生物碳利用物质流分析获得。分析数据来源于哥斯达黎加西北地区的所有采伐作业过程(107家采伐厂)、将木材制成最终产品的加工行业(20个锯木厂)以及相关报告。分析结果表明, 一个周期(15年)内, 系统中存储的碳为 -3.06 Mg C/ha 。若考虑不确定性和参数的可变性时, 一个周期(15年)内, 系统中存储的碳减少至 -2.19 Mg C/ha , 数据的置信水平为95%, 置信区间为 -5.26 Mg C/ha 至 1.86 Mg C/ha 。与森林系统作为碳储存库相比, 尽管采伐带来的碳储存较小, 但该置信区间揭示了由于采伐而导致大气中碳净增加的概率。该结果也表明, 从天然林获得的生物材料有利于碳中和。同时, 研究结果也表明, 人工的碳储存库在延迟碳排放中起决定性作用, 这也许可以解释为什么已有的关于热带森林管理的碳平衡研究会存在差异。因此, 减缓气候变化并不应该只局限于森林管理, 而是应从木材转化、使用和处置的整个生命周期过程考虑。

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The life cycle carbon balance of selective logging in tropical forests of Costa Rica

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Keywords: carbon neutrality, climate change mitigation, harvested wood products, industrial ecology, life cycle assessment, tropical selective logging

Summary:

The effect of logging on atmospheric carbon concentrations remains highly contested, especially in the tropics where it is associated to forest degradation. To contribute to this discussion, we estimated the carbon balance from logging natural tropical forests in Costa Rica through a life cycle accounting approach. Our system included all major life cycle processes at a regional level during one rotation period (15 years). We used mass flow analysis to trace biogenic carbon. Data were gathered from all logging operations in the Costa Rican NW region (107 management plants), a sample of industries transforming wood into final products (20 sawmills), and national reports. We estimated a surplus of $-3.06 \text{ Mg C ha}^{-1} 15 \text{ year}^{-1}$ stored within the system. When accounting for uncertainty and variability in a Monte Carlo analysis, the average balance shifted to $-2.19 \text{ Mg C ha}^{-1} 15 \text{ year}^{-1}$ with a 95% CI of -5.26 to 1.86 . This confidence interval reveals probabilities of a net increase in atmospheric carbon due to harvesting although these are smaller than those from a system that acts as a reservoir. Our results provide evidence for the carbon neutrality of bio-materials obtained from natural forests. We found that anthropogenic reservoirs play a determinant role in delaying carbon emissions and that these may explain differences with previous carbon balance studies on tropical forest management. Therefore, the climate mitigation potential of forest-derived products is not exclusive to forest management, but measures should be considered throughout the processes of wood transformation, use, and disposal.

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投入产出分析环境扩展表的两类设计对能源足迹核算的影响

作者: Hanspeter Wieland, Stefan Giljum, Nina Eisenmenger, Dominik Wiedenhofer, Martin Bruckner, Anke Schaffartzik, Anne Owen

关键字: 能源消耗, 能源效率, 能量流, 能源足迹, 环境扩展投入产出分析, 产业生态学

摘要:

投入产出分析法是产业生态学核心分析方法之一。然而讨论环境扩展表的不同结构(例如物质流的范围及其在货币型投入产出表中所归属的部门)的文献仍是碎片化的。本文以能源核算为例,研究了两种常用但不同的环境扩展表设计的概念和实证内涵,其中一个为能源供应,另一种指经济中的能源消费。我们从官方能源供应和使用数据库中提取这两个扩展表,并将其应用于奥地利的单一投入产出(SRIO)模型中,以便研究来自扩展设计决策的影响。我们也将研究结果与基于全球多区域投入产出数据库 EXIOBASE 核算的能源足迹进行了交叉比对。结果显示最终需求类别(例如,家庭和出口)的足迹的排名受扩展表设计的影响较大,产品层面的结果可能会有几个数量级的差异。基于全球多区域投入产出模型的对比进一步揭示了,对一些国家来说,基于供应扩展表计算的足迹可能是基于消费扩展表的两倍(例如澳大利亚和挪威)。我们提出一个图方法以提供一个通用框架来展示环境扩展表的设计。通过将类推应用到混合生命周期评估中,我们讨论了两种扩展表设计的概念差异。我们的发现有助于监测能源效率、减排目标和公司足迹账户。

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Supply versus use designs of environmental extensions in input–output analysis: Conceptual and empirical implications for the case of energy

Hanspeter Wieland, Stefan Giljum, Nina Eisenmenger, Dominik Wiedenhofer, Martin Bruckner, Anke Schaffartzik, Anne Owen

Keywords: energy consumption, energy efficiency, energy flow analysis, energy footprint, environmental input–output analysis, industrial ecology

Summary:

Input–output analysis is one of the central methodological pillars of industrial ecology. However, the literature that discusses different structures of environmental extensions (EEs), that is, the scope of physical flows and their attribution to sectors in the monetary input–output table (MIOT), remains fragmented. This article investigates the conceptual and empirical implications of applying two different but frequently used designs of EEs, using the case of energy accounting, where one represents energy supply while the other energy use in the economy. We derive both extensions from an official energy supply–use dataset and apply them to the same single-region input–output (SRIO) model of Austria, thereby isolating the effect that stems from the decision for the extension design. We also crosscheck the SRIO results with energy footprints from the global multi-regional input–output (GMRIO) dataset EXIOBASE. Our results show that the ranking of footprints of final demand categories (e.g., household and export) is sensitive to the extension design and that product-level results can vary by several orders of magnitude. The GMRIO-based comparison further reveals that for a few countries the supply-extension result can be twice the size of the use-extension footprint (e.g., Australia and Norway). We propose a graph approach to provide a generalized framework to disclosing the design of EEs. We discuss the conceptual differences between the two extension designs by applying analogies to hybrid life-cycle assessment and conclude that our findings are relevant for monitoring of energy efficiency and emission reduction targets and corporate footprint accounting.

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中国环境税政策的成本效益分析: 基于前沿分析环境扩展投入产出优化方法的研究

作者: Ke Wang, Jiayu Wang, Klaus Hubacek, Zhifu Mi, Yi-Ming Wei

关键字: 大气污染, 数据包络分析 (DEA), 环境税, 环境扩展的投入产出表, 前沿分析, 优化模型

摘要:

中国经济的高速发展和对自然资源的过度消耗造成了严重的环境污染。环境税被视为有助于减轻空气污染的有效经济手段。为评估不同情景下环境税政策的效果, 本文提出了一个基于生产前沿面的环境扩展投入产出优化模型, 并在其中新增了减排部门, 以反映减排的投入和效益。前沿分析确保可以在相同的技术效率基准下评估政策情景, 而投入产出分析则描述了一个经济体各部门之间广泛的经济交易。本文考虑了四种情景: 单独提高 SO₂、NO_x、烟尘中的一种污染物的税率以及同时提高三种污染物的税率。估算结果表明: 同时提高 SO₂、NO_x 和烟尘的税率, 减排效果最好, 其中 SO₂ 的税率对减排的贡献最大。提高烟尘税率是最环境友好的策略, 通过避免健康成本, 提升了减排效益。本研究将前沿分析和投入产出分析相结合, 为政策制定者提供了一种综合性、分部门的方法来评估环境税的成本和收益。

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A cost-benefit analysis of the environmental taxation policy in China: A frontier analysis-based environmentally extended input-output optimization method

Ke Wang, Jiayu Wang, Klaus Hubacek, Zhifu Mi, Yi-Ming Wei

Keywords: air pollution, data envelopment analysis (DEA), environmental tax, environmentally extended input-output table, frontier analysis, optimization model

Summary:

China's high-speed economic development and reliance on overconsumption of natural resources have led to serious environmental pollution. Environmental taxation is seen as an effective economic tool to help mitigate air pollution. In order to assess the effects of different scenarios of environmental taxation policies, we propose a frontier-based environmentally extended input-output optimization model with explicit emission abatement sectors to reflect the inputs and benefits of abatement. Frontier analysis ensures policy scenarios are assessed under the same technical efficiency benchmark, while input-output analysis depicts the wide range of economic transactions among sectors of an economy. Four scenarios are considered in this study, which are increasing specific tax rates of SO₂, NO_x, and soot and dust separately and increasing all three tax rates simultaneously. Our estimation results show that: raising tax rates of SO₂, NO_x, and soot and dust simultaneously would have the highest emission reduction effects, with the SO₂ tax rate making the greatest contribution to emission reduction. Raising the soot and dust tax rate is the most environmentally friendly strategy due to its highest abatement to welfare through avoided health costs. The combination of frontier analysis and input-output analysis provides policy makers a comprehensive and sectoral approach to assess costs and benefits of environmental taxation.

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西班牙温室气体排放的关键部门——一种替代的投入产出分析

作者: [Vicent Alcántara](#), [Emilio Padilla](#)

关键字: 温室气体排放、产业生态学、投入产出、关键部门、生产结构、西班牙

摘要:

我们开发了一种替代的投入产出方法, 并将其应用于识别排放中的关键部门。这一方法使我们能够根据不同的生产部门的温室气体排放量和它们在生产结构中的作用, 以及它们的产出在生产总量中的参与来评估和分类。与以往的方法相比, 我们不关注最终需求的责任, 而是关注每个部门的总产量的责任。本文将该方法应用于世界投入产出数据库 (2016) 提供的 2014 年西班牙投入产出表。结果表明, 排放更多的部门是食品制造、批发和零售贸易以及建筑业。那些拉动排放的部门与它们本身的最终需求是一致的, 最重要的部门是电力和天然气供应、农业和交通。所获得的分类可为不同部门的温室气体减排政策提供方向。

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Key sectors in greenhouse gas emissions in Spain: An alternative input–output analysis

[Vicent Alcántara](#), [Emilio Padilla](#)

Keywords: greenhouse gas emissions, industrial ecology, input–output, key sectors, production structure, Spain

Summary:

We develop an alternative input–output approach and apply it to the determination of key sectors in emissions. This methodology allows us to assess and classify the different productive sectors according to their greenhouse gas emissions and the role that they play in the productive structure, as well as the participation of their output in the total volume of production. In contrast with previous approaches, we do not focus on the responsibility of final demand, but on the responsibility of the total production of each sector. We apply our methodology to the 2014 input–output table for Spain provided by the World Input–Output Database (2016). The results show that the sectors that induce more emissions from other sectors are manufacture of food products, wholesale and retail trade, and construction. Those that are pulled to emit coincide with those that are relevant for their own final demand, being the most important electricity and gas provision, agriculture, and transportation. The classification obtained allows to orient the design of greenhouse gas emission mitigation policies for the different sectors.

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资本对美国碳、能源和物质足迹的影响

作者: Peter Berrill, T. Reed Miller, Yasushi Kondo, Edgar G. Hertwich

关键字: 碳排放, 环境压力, 基础设施, 投入产出生命周期评价, 私营资本流动, 国民经济核算体系

摘要:

固定资本存量在满足人类基本需求和促进工业生产方面发挥着至关重要的作用。它们的积累需要大量的能源和材料, 并产生温室气体排放和其他污染。资本存量通过其建造和随后几十年的使用来源影响经济生产和环境污染。我们对美国 2007 年和 2012 年的总消费、资本投资和资本消费进行了环境足迹分析。2012 年, 资本消费分别占碳、能源和物质足迹总量的 13%、19%和 40%。住房、联邦国防、州和地方政府教育和其他服务(包括家庭道路消费)、个人交通燃料和医院是资本足迹最大的消费部门。这些部门提供住房、交通、教育和保健等基本需求, 这体现了资本服务的重要性。内生资本使环境乘数低的部门的足迹增加的比例最大。这项工作建立在美国现有的生产和消费投入产出模型的基础上, 提供了 2007 年和 2012 年碳、能源、物质足迹和乘数的资本包容性数据库。本文满足了 JIE 数据开放徽章的要求。

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Capital in the American carbon, energy, and material footprint

Peter Berrill, T. Reed Miller, Yasushi Kondo, Edgar G. Hertwich

Keywords: carbon emissions, environmental intensity, infrastructure, input-output life cycle assessment (IO-LCA), private capital flows, system of national accounts (SNA)

Summary:

Stocks of fixed capital play a vital role in fulfilling basic human needs and facilitating industrial production. Their build-up requires great quantities of energy and materials, and generates greenhouse gas emissions and other pollution. Capital stocks influence economic production and environmental pollution through their construction and over subsequent decades through their use. We perform an environmental footprint analysis of total consumption, capital investment, and capital consumption in the United States for 2007 and 2012. In 2012, capital consumption accounted for 13%, 19%, and 40% of total carbon, energy, and material footprints, respectively. Housing, federal defense, state and local government education and other services (including household consumption of roads), personal transport fuels, and hospitals are the consumption sectors with largest capital footprints. These sectors provide fundamental needs of shelter, transport, education, and health, underlying the importance of capital services. Endogenizing capital causes the biggest proportional increase to footprints of sectors with low environmental multipliers. This work builds upon existing input-output models of production and consumption in the United States, and provides a capital-inclusive database of carbon, energy, and material footprints and multipliers for 2007 and 2012. This article met the requirements for a gold – gold JIE data openness badge described at <http://jie.click/badges>.

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2016 年欧盟 28 国肉类和乳制品供应链的材料、能源和温室气体流量分析

作者: [Stephen Ivan aan den Toorn](#), [Ernst Worrell](#), [Machteld A. van den Broek](#)

关键字: 气候变化、产业生态学、家畜、肉类和乳制品、社会经济代谢、供应和利用表

摘要:

为了使欧盟脱碳, 蛋白质消耗必须转换到肉类和奶制品含量较低的饮食, 这将彻底改变目前肉类和奶制品供应链中的物质和能量流动。为了解对当前流动的影响, 需要一个基线。尽管最近的研究已经扩大了所报告的温室气体 (GHG) 排放量的范围, 但还没有包括中间产品和最终产品流在内的定量综述。为弥补这些研究空白, 我们将肉类和奶制品供应链构建为一组相互连接的转换节点和分配节点。前者是将输入转换为输出的过程, 而后者是输出分配给其他过程, 将它们作为输入。目前, 牲畜通过食用 271 兆吨饲料作物、108 兆吨谷物、85 兆吨牧草生物质、49 兆吨油料粉和 16 兆吨饲料副产品, 在农业和其他行业发挥着核心作用。这些饲料被转化为 64 兆吨的奶制品和 35 兆吨的肉类, 保证了欧盟 28 国是肉类和乳制品的净出口国, 同时提供了 25 兆吨的副产品。这种生产还导致 435 兆吨二氧化碳当量, 其中肉牛 (35%)、奶牛 (32%) 和猪 (20%) 为主要贡献源。因此, 与肉类相比, 奶制品的温室气体强度较低并不意味着对总排放量的贡献较低。通过绘制材料、能源和温室气体排放的流量图, 我们创建了一个适用于识别蛋白质转化可能导致的供应链变化及其相关温室气体增加或减少的基线。

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Meat, dairy, and more: Analysis of material, energy, and greenhouse gas flows of the meat and dairy supply chains in the EU28 for 2016

[Stephen Ivan aan den Toorn](#), [Ernst Worrell](#), [Machteld A. van den Broek](#)

Keywords: climate change, industrial ecology, livestock, meat and dairy, socioeconomic metabolism, supply and use tables

Summary:

To decarbonize the European Union, protein consumption must transition to diets low in meat and dairy which will drastically change the material and energy flows in current meat and dairy supply chains. To understand the impacts on current flows, a baseline is required. Although recent studies have improved the scope of reported greenhouse gas (GHG) emissions, no quantitative overview exists including intermediate and final product flows. To address this knowledge gap, we structured the meat and dairy supply chains into a connected set of transformation nodes and distribution nodes. The former are processes transforming inputs into outputs, whereas the latter distribute the outputs to other processes using them as inputs. Currently, livestock play a central role in agriculture and other industries through the consumption of 271 Mt fodder crops, 108 Mt grain, 85 Mt grazed biomass, 49 Mt oil meal, and 16 Mt feed by-products. This feed is transformed into 64 Mt dairy and 35 Mt meat which ensures that the EU28 is a net exporter of meat and dairy while providing 25 Mt of by-products. This production also leads to 435 Mt CO₂-eq. with the main contribution from beef cattle (35%), dairy cattle (32%), and swine (20%). Thus, the lower GHG intensities of dairy products compared to meat do not imply a low contribution to the total emissions. By mapping the material, energy, and GHG emission flows, we have created a baseline suitable for identifying potential supply chain changes and their related GHG increase or decrease resulting from the protein transition.

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企业层面的循环经济创新、增长和就业：德国的经验证据

作者: Jens Horbach, Christian Rammer

关键字: 循环经济, 社区创新调查, 生态创新, 增长, 产业生态学, 分位数回归

摘要:

循环经济 (CE) 描述了一种旨在通过在产品的整个生命周期 (包括生产和维修以及再利用和再循环) 中减少对材料和能源的使用来节约资源的概念。CE 创新通过聚焦可持续性的环境、经济和社会层面来帮助实现可持续发展目标。本文通过调查具有 CE 创新的企业在销售增长和就业方面的表现来研究可持续发展的经济和社会方面。我们的计量经济学分析使用了来自两次社区创新调查的德国部分的数据。分位数回归表明, CE 创新与营业额和就业增长呈正相关。尽管 CE 创新对劳动生产率没有统计学上的显著影响, 但具有 CE 创新的企业显著表现出更优的财务状况。

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Circular economy innovations, growth and employment at the firm level: Empirical evidence from Germany

Jens Horbach, Christian Rammer

Keywords: circular economy, community innovation survey, eco-innovation, growth, industrial ecology, quantile regression

Summary:

Circular economy (CE) describes a concept that aims at saving resources by minimizing the use of material and energy over the entire life-cycle of products, including production and repair, as well as reuse and recycling. CE innovations help to realize the goals of sustainable development by targeting environmental, economic, and social dimensions of sustainability. This paper looks at the economic and social dimensions by investigating whether firms with CE innovations perform better or worse in terms of sales growth and employment. Our econometric analysis uses data from two waves of the German part of the Community Innovation Survey. Quantile regressions show that CE innovations are positively linked to turnover and employment growth. While there is no statistically significant impact on labor productivity, at the same time, firms with CE innovations show a significantly better financial standing.

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通过产业共生生产土壤和面层副产品的环境表现评估

作者: Michael Martin

关键字: 副产品协同、生态工业园、环境评价、环境绩效、产业共生、生命周期评价

摘要:

产业共生 (IS) 是指不同的实体在能源、公用设施、材料或服务方面进行合作, 被认为是提高工业资源效率和循环性的一种方法。本文评估了 IS 网络与废物管理、土壤、面层、纸张、木材和能源相关公司的环境绩效。其目的是突出 IS 网络的环境绩效, 特别关注 IS 系统网络中产品性能的提高。生命周期评估用于将当前 IS 网络与参考场景和潜在的未来发展进行比较。结果表明, IS 网络具有显著的收益。温室气体排放量和非生物资源消耗大幅减少。此外, 局部影响即富营养化和酸化影响大幅减少。结果显示, 网络中的所有公司都从所涉及的协同效应中获益, 其中很大一部分得益于与废物管理公司的便利交流。用网络内的生物基物质替代传统产品和能源流具有重要意义。最后, 研究结果指出了促进副产品协同效应的重要性, 以及这种协同效应在该地区创造的巨大价值和改善企业及其产品的环境绩效的巨大潜力。

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Evaluating the environmental performance of producing soil and surfaces through industrial symbiosis

Michael Martin

Keywords: by-product synergy, eco-industrial park (EIP), environmental assessment, environmental performance, industrial symbiosis (IS), life cycle assessment (LCA)

Summary:

Industrial symbiosis (IS), where different entities collaborate in the management of energy, utilities, materials, or services, has been identified as an approach to improve resource efficiency and circularity in industry. This article assesses the environmental performance of an IS network with firms involved in waste management, soil, surfaces, paper, lumber, and energy. The aim is to highlight the environmental performance of an IS network and pay particular attention to the improved performance for products in the IS network. Life cycle assessment is used to compare the current IS network with a reference scenario and a potential future development. The results suggest that there are significant benefits from the IS network. Large reductions in greenhouse gas (GHG) emissions and abiotic resource depletion were identified. Furthermore, large reductions in local impacts, namely eutrophication and acidification impacts are illustrated. It was shown that all firms in the network benefit from the synergies involved, with a large share of the benefits stemming from the facilitated exchanges with the waste management company. The replacement of conventional products and energy streams with bio-based counterparts from within the network is of significant importance. Finally, the results point to the importance of the facilitation of by-product synergies, and the significant value this creates in the region, with large potential to improve the environmental performance of firms and their products.

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基于机器学习的家庭建模: 使用自下而上的区域化方法研究消费引起的环境影响

作者: [Andreas Froemelt](#), [René Buffat](#), [Stefanie Hellweg](#)

关键字: 数据挖掘, 家庭消费, 产业生态学, 大规模自下而上模型, 机器学习, 空间分析

摘要:

作为经济的主要驱动力, 家庭在全球对环境产生了很大的影响。需要量化当地消费方式的可变性以及相关的环境影响, 以此作为制定针对性措施以减少家庭环境足迹的重要起点。本文旨在开发和评估一个综合的区域性自下而上模型, 该模型可以评估特定区域中每个家庭的实际环境概况。为此, 研究在新的基于概率的分类框架内, 将基于物理的建筑能耗模型、基于主体的运输模拟结果和数据驱动的家庭消费模型相互关联, 并将其应用于瑞士。所得模型通过考虑每个瑞士家庭的特殊情况, 预测了其在大约 400 个不同消费区域中的需求, 得出了家庭环境足迹变化的真实画面。市一级的模型分析结果表明, 人均收入、人口密度、建筑物年龄和家庭结构是城市碳足迹的可能驱动力。排放量较高的市位于郊区, 且通常有较高比例的老式建筑, 而排放量较低的市的家庭比例较高, 并且通常在人口稠密的地区。但是, 在分析中观察到的各种变量的相反影响证实了能够刻画区域差异的模型的重要性。模型总体构成了一个全面的信息库, 可帮助政策制定者了解其所在地区的消费模式并制定针对特定人群的环境战略。

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Machine learning based modeling of households: A regionalized bottom-up approach to investigate consumption-induced environmental impacts

[Andreas Froemelt](#), [René Buffat](#), [Stefanie Hellweg](#)

Keywords: data mining, household consumption, industrial ecology, large-scale bottom-up model, machine learning, spatial analysis

Summary:

As major drivers of economy, households induce a large share of worldwide environmental impacts. The variability of local consumption patterns and associated environmental impacts needs to be quantified as an important starting point to devise targeted measures aimed at reducing household environmental footprints. The goal of this article is the development and appraisal of a comprehensive regionalized bottom-up model that assesses realistic environmental profiles for individual households in a specific region. For this purpose, a physically based building energy model, the results of an agent-based transport simulation, and a data-driven household consumption model were interlinked within a new probability-based classification framework and applied to the case of Switzerland. The resulting model predicts the demands in about 400 different consumption areas for each Swiss household by considering its particular circumstances and produces a realistic picture of variability in household environmental footprints. An analysis of the model results on a municipal level reveals per-capita income, population density, buildings' age, and household structure as possible drivers of municipal carbon footprints. While higher-emission municipalities are located in rural areas and tend to show higher shares of older buildings, lower-emission communities have larger proportions of families and can be found in highly populated regions by trend. However, the opposing effects of various variables observed in this analysis confirm the importance of a model that is able to capture regional distinctions. The overall model constitutes a comprehensive information base supporting policymakers in understanding consumption patterns in their region and deriving environmental strategies tailored to their specific population.

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奥地利产品消费背后生产链的温室气体排放: 产品和技术特异性方法的发展和应用

作者: Bernhard Windsperger, Andreas Windsperger, David Neil Bird, Hannes Schwaiger, Gerfried Jungmeier, Carsten Nathani, Rolf Frischknecht

关键字: 消费, 能源系统, 温室气体排放, 生命周期分析, 产品消费, 生产链

摘要:

全球化是影响我们整体经济的主要驱动力之一。因此, 除了根据《联合国气候变化框架公约》(UNFCCC) 制定的侧重区域性排放量的国家排放清单之外, 与进出口有关的温室气体排放量 (GHG) 也应得到关注。为了能够正确计算进出口, 并找出排放最密集的产品及其来源, 本研究选取了迄今尚未得到应用的产品和技术特异性方法。本研究解决了这一研究方法在应用和发展上的空白, 计算了奥地利产品消费背后的温室气体排放。该方法以物质流量为基础, 结合基于生命周期的排放因子及来自部门和国家特定能源组合的排放强度, 计算奥地利消费产品生产链 (从资源到最终产品) 背后的所有排放量。结果表明, 奥地利的产品消费导致的排放量比国家清单的排放量多出约 60%, 多出的排放量主要来自产品的供应。排放最密集的产品来自化工和金属工业, 特别是进口产品, 是这些排放的主要驱动力, 而且比奥地利本地生产的产品排放更为密集。因此, 不仅在奥地利, 而且在国外, 有必要对生产链上的实际减排措施开展研究。

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Greenhouse gas emissions of the production chain behind consumption of products in Austria: Development and application of a product- and technology-specific approach

Bernhard Windsperger, Andreas Windsperger, David Neil Bird, Hannes Schwaiger, Gerfried Jungmeier, Carsten Nathani, Rolf Frischknecht

Keywords: consumption, energy systems, greenhouse gas emissions, life cycle analysis, product consumption, production chain

Summary:

Globalization has been one main driver affecting our whole economy. Thus, greenhouse gas emissions (GHGs) associated with imports and exports should get addressed in addition to the national emission inventory according to the United Nations Framework Convention on Climate Change (UNFCCC), which is focused on territorial emissions only. To enable a correct calculation for imports and exports and to find the most emission-intensive products and their origin, a product- and technology-specific approach would be favorable which has not been applied up to now. This article addresses this research gap in developing and applying such an approach to calculate the GHGs behind consumption of products in Austria. It is based on physical flows combined with life-cycle-based emission factors and emission intensities derived from sector- and country-specific energy mix, for calculating all emissions behind the production chain (resources to final products) of products consumed in Austria. The results have shown that consumption of products in Austria leads to about 60% more emissions than those of the national inventory and that the main part of these emissions comes from the provision of products. The most emission-intensive products are coming from the chemical and the metal industry. In particular, imports are the main driver of these emissions and are more emission intensive than those produced in Austria. As a result, it is necessary to look at practical measures to reduce emissions along the production chain not only in Austria, but especially abroad as well.

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沼气生产对荷兰乳业系统中氮元素流的影响: 沼气生产链中氮指标的多级评估

作者: Dieu Linh Hoang, Chris Davis, Henri C.Moll, Sanderine Nonhebel

关键字: 共消化, 乳制品沼气, 多级评估, 氮排放, 氮气回收, 元素流分析

摘要:

在奶牛场生产沼气是一项应对气候变化的举措, 因为此举能捕获粪便排放的温室气体甲烷, 并产生可再生能源。厌氧分解产生的沼渣沼液是沼气生产的副产品, 通常以与传统肥料类似的方式循环利用。尽管肥料和消化物具有相似的功能, 但在氮循环和氮排放方面有不同表现, 这是肥料在农业和环境方面的重要问题。本文提供了关于沼气生产对当前奶牛养殖实践中氮排放和氮再循环问题的影响的见解。我们使用元素流分析(SFA)方法在三个层面上分析了变化: 粪便处理、奶牛场和整个链条。研究考虑了荷兰奶牛场中四种与原料类型和来源有关的沼气生产方案。与目前没有沼气生产的奶牛养殖场相比, 我们对这些生产沼气奶牛场的沼气产量, 氮肥替代率(%)和相应的氮排放量(kgN/年; kgN/m³ 沼气)进行了量化。我们得出的结论是, 带有其他原料的沼气生产方案将对奶牛场的氮循环利用和连锁水平的氮排放产生深刻的影响。此外, 结果表明, 确定最佳的沼气生产方案可能具有挑战性, 因为评估高度依赖于所用的氮指标和所包含的分析水平。我们的发现表明, SFA 和多层次的视角使人们对环境影响的取舍有更广泛的了解。

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Impacts of biogas production on nitrogen flows on Dutch dairy system: Multiple level assessment of nitrogen indicators within the biogas production chain

Dieu Linh Hoang, Chris Davis, Henri C.Moll, Sanderine Nonhebel

Keywords: codigestion, dairy biogas, multiple level assessment, nitrogen emissions, nitrogen recycling, substance flow analysis (SFA)

Summary:

Biogas production on dairy farms is promoted as a climate change measure since it captures methane, a greenhouse gas emitted by manure, and produces renewable energy. Digestate is a by-product of biogas production and is often used for nutrient recycling in a similar way as traditional manure. Despite having similar functions, manure and digestate have different behaviors related to nitrogen recycling and nitrogen emissions which are significant agricultural and environmental concerns of manure. This paper provides an insight into the impact of biogas production on nitrogen emissions and nitrogen recycling issues of the current dairy farming practice. Using the Substance Flow Analysis (SFA) approach, we analyzed the changes on three levels: manure handling, dairy farm, and the whole chain. Four biogas production options on a Dutch dairy farm related to types and sources of feedstocks were considered. We quantified biogas output, nitrogen fertilizer replacement percentage (%) and consequential nitrogen emissions (kgN/year; kgN/m³ biogas produced) of these productions in comparison with the baseline of current dairy farming without biogas. We conclude that biogas production options with additional feedstocks will cause profound changes in the nitrogen recycling on dairy farms and the nitrogen emissions at the chain level. Besides, the results show that determining the optimal biogas production option can be challenging as the evaluation is highly dependent on the used nitrogen indicator and the included level of analysis. Our findings show how SFA and a multilevel perspective can give a broader understanding of environmental trade-offs.

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粉末床熔合技术生产的骨科器械的环境可持续性

作者: [Grazia Maria Cappucci](#), [Martina Pini](#), [Paolo Neri](#), [Marta Marassi](#), [Elena Bassoli](#), [Anna Maria Ferrari](#)

关键字: 增材制造, 产业生态学, 生命周期 (LCA), 骨科器械, 产品寿命, 传统制造

摘要:

增材制造包括将金属粉末熔化以从 3D 数据中逐层生产物体。它的工业应用范围包括汽车、生物医学 (例如牙科和骨科的假体植入物)、航空航天等。这项研究使用生命周期评估来评价基于激光的粉末床熔合增材制造系统在假体生产中的可能改善的环境性能。本文评估了设计解决方案的制造、使用和废弃对环境的影响。此外, 研究比较了两种粉末生产技术, 即气体雾化 (GA) 和等离子体雾化 (PA), 以确定可持续表现更优的技术。论文进一步比较了传统减法技术生产的产品和增材制造的产品。与传统技术相比, 发现 3D 建造在环境方面具有明显优势。增材制造过程对环境影响比较大的是粉末制造过程, 但是, 如果使用 GA 粉末, 可以减轻其影响。

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Environmental sustainability of orthopedic devices produced with powder bed fusion

[Grazia Maria Cappucci](#), [Martina Pini](#), [Paolo Neri](#), [Marta Marassi](#), [Elena Bassoli](#), [Anna Maria Ferrari](#)

Keywords: additive manufacturing industrial ecology life cycle assessment (LCA) orthopedic device product lifetime traditional manufacturing

Summary:

Additive manufacturing consists in melting metallic powders to produce objects from 3D data, layer upon layer. Its industrial applications range from automotive, biomedical (e.g., prosthetic implants for dentistry and orthopedics), aeronautics and others. This study uses life cycle assessment to evaluate the possible improvement in environmental performance of laser-based powder bed fusion additive manufacturing systems on prosthetic device production. Environmental impacts due to manufacturing, use, and end of life of the designed solution were assessed. In addition, two powder production technologies, gas atomization (GA) and plasma atomization (PA), were compared in order to establish the most sustainable one. Production via traditional subtractive technologies and the additive manufacturing production were also compared. 3D building was found to have a significant environmental advantage compared to the traditional technology. The powder production process considerably influences on a damage point of view the additive manufacturing process; however, its impact can be mitigated if GA powders are employed.

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硅酸盐水泥熟料的低碳替代品生产的生态效率评估

作者: José-Luis Gálvez-Martos, Antonio Valente, Mathías Martínez-Fernández, Javier Dufour

关键字: 硫铝酸钙, 二氧化碳, 水泥, 熟料, 生态效率, 温室气体

摘要:

硫铝酸钙基水泥 (CSA) 被视作一种低碳足迹的水泥替代品。CSA 的性质使制造过程需要的温度更低, 燃料和方解石更少, 但它需要来自铝土矿和铝土矿衍生废物的氧化铝和硫酸钙或硫单质中的硫。本文按照 ISO 14045 的生态效率原则, 以传统硅酸盐水泥为基准, 对 240 个 CSA 熟料生产方案进行了 CSA 水泥生态效率评估。生态效率指标将环境指标与产品系统价值指标相关联, 并针对每个研究的参数进行计算, 包括铝土矿的地理来源, 用于熟料的燃料, 硫的来源以及熟料的成分。生态效率结果表明, 其对铝土矿的来源有很大的依赖性, 而其他参数, 如所用燃料、硫含量或其他原材料的供应, 则不那么重要。最生态高效的解决方案是那些减小与铝土矿资源关联的解决方案。为了实现全球解决方案, 即独立于原材料来源的 CSA 水泥生产, 需要将铝土矿的数量降至最低, 并限制 CSA 的成分。

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Eco-efficiency assessment of calcium sulfoaluminate clinker production

José-Luis Gálvez-Martos, Antonio Valente, Mathías Martínez-Fernández, Javier Dufour

Keywords: calcium sulfoaluminate, carbon dioxide, cement, clinker, eco-efficiency, greenhouse gases

Summary:

Calcium sulfoaluminate-based cements (CSA) are proposed as a cement alternative with a low carbon footprint. The nature of CSA makes the manufacturing process to require lower temperature, less fuel, and less calcite. However, it requires aluminum oxide, Al₂O₃, which would be originated from bauxite and bauxite-derived wastes, and sulfur, coming from calcium sulfate or elemental sulfur. An eco-efficiency assessment of CSA cements, benchmarked against the conventional Portland cement, has been performed following the principles of ISO 14045 on eco-efficiency for a total of 240 CSA clinker production scenarios. The eco-efficiency indicator relates an environmental indicator with a product system value indicator, and it is calculated for each of the studied parameters: bauxite geographical origin, the fuel used for clinkering, the source of sulfur, and the composition of the clinker. Eco-efficiency results show a strong dependence on the origin of bauxite, while other parameters, as the fuel used, its content in sulfur, or the supply of other raw materials, are of less importance. The most eco-efficient solutions are those with certain closeness to bauxite sources. To achieve global solutions, that is, cement-making based on CSA independently of the origin of the raw materials, the amount of bauxite needs to be minimized and CSA composition restricted.

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越南红河三角洲农产品加工工艺村的区域物质流分析及资源环境管理意义

作者: [Nguyet Thi Tran](#), [Dirk Weichgrebe](#)

关键字: 工艺村, 数据不确定性分析, 产业生态学, 物质流分析 (MFA), 红河三角洲, 转型经济

摘要:

1986 年的经济改革 “Đổi Mới” 使得越南手工艺村的数量迅速增加, 尤其是在红河三角洲地区 (RRD), 导致环境恶化。本文采用改进的物质流分析方法, 对红河三角洲农业-食品加工工艺村 (FPCVs) 的环境和资源问题进行了评估, 重点是对不确定性的一致量化, 尤其注意转型经济物质流分析中经常遇到的二手数据和经验数据。在一个被称为红河三角洲的模型中, 对包括八种生产方式在内的农业食品加工作物质流进行了研究, 并将其与私人家庭、水稻种植和养猪业的活动联系起来。被调查的物质为货物 (即全部物质)、有机碳 (org. C)、氮 (N) 和磷 (P)。结果发现, 物质循环几乎是完全开放的, 也就是说, 用于 FPCVs 的材料不会在该区域内循环使用。在用于农业食品加工的 ~1050 万吨/年的进口货物中, 最终产品和利用的材料仅占小部分 (以重量计算, 大约 5%)。相反, 大部分 (88%) 被直接排出。以库存形式累积的材料占货物的 1% (100,000 吨/年), org. C 的 21% (~34,000 吨/年), N 的 42% (~1300 吨/年), P 的 57% (~300 吨/年), 其物质浓度远远超过自然复原能力。虽然农业食品加工所占红河三角洲的物质份额微不足道, 但由于家庭生产的地理位置原因, FPCVs 在当地的污染严重。对于 FPCVs 的环境和资源管理, 建议在不同系统规模上采用几种选择来闭合物质回路。物质流分析结果提供了一个数据库, 可用作工艺村生产企业和相关机构在确定环境规划和资源管理优先事项时的决策支持工具。

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Regional material flow behaviors of agro-food processing craft villages in Red River Delta, Vietnam

Nguyet Thi Tran, Dirk Weichgrebe

Keywords: craft villages, data uncertainty analysis, industrial ecology, material flow analysis (MFA), Red River Delta, transition economies

Summary:

The economic reform “Đổi Mới” in 1986 has rapidly increased the number of craft villages in Vietnam, especially in the Red River Delta (RRD) leading to environmental degradation. This article presents an assessment of environmental and resource issues of agro-Food Processing Craft Villages (FPCVs) in RRD using a refined approach to material flow analysis focusing on consistent quantification of uncertainty with particular attention to secondary and empirical data that are often faced in material flow analyses in transition economies. Material flows of agro-Food Processing including eight types of production were examined and linked to activities of private Households, Rice Cultivation, and Pig Farming in a model called Red River Delta. Materials investigated were Goods (i.e., total materials), organic carbon (org.C), nitrogen (N), and phosphorus (P). The findings reveal material cycles are almost entirely open, that is, the materials used in FPCVs do not recycle within the region. From ~10.5 million tons/year of imported Goods used for agro-Food Processing, final products and utilized materials account for minor fractions (~5%, by weight). Conversely, the majority (88%) is directly discharged. Materials accumulated as stocks represent 1% of Goods (100,000 tons/year), 21% of org.C (~34,000 tons/year), 42% of N (~1,300 tons/year), and 57% of P (~300 tons/year), whose substance concentrations vastly exceed natural resilience capacities. Although agro-Food Processing accounts for negligible material shares in Red River Delta, FPCVs pollution is severe at local levels due to the location of home-based production. Several options for closing material loops at various system scales are recommended for environmental and resource management of FPCVs. The material flow analysis results provide a database that may be used as a decision support tool for production establishments in craft villages and relevant authorities in setting priorities on environmental planning and resource management. This article met the requirements for a gold – silver JIE data openness badge described at <http://jie.click/badges>.