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中文摘要

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翻译

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Chinese Abstracts

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生产者责任延伸制三问

作者： Atalay Atasu

关键字： 集体生产者责任延伸制，产品的环境设计，生产者责任延伸制，产业生态学，运营管理，废弃电子电气设备

摘要：

我们重新审视了源于学术界、政策或实践的生产者责任延伸（EPR）的三个重要假设：（1）EPR 的核心目标应该是促进产品的环境设计 （2）实施集体 EPR 制使其对环境设计的激励失效； （3）更严格的 EPR 政策将产生更好的环境收益。我们从运营角度讨论这些假设的潜在缺点及其对学术和政策研究的影响。

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Operational perspectives on extended producer responsibility

Atalay Atasu

Keywords: collective extended producer responsibility, design for environment (DfE), extended producer responsibility (EPR), industrial ecology, operations management, waste electrical and electronic equipment (WEEE)

Summary:

We revisit three important assumptions about extended producer responsibility (EPR) that originate from academia, policy, or practice: (1) A central objective of EPR should be to induce product designs for the environment; (2) collective EPR implementations mute incentives to design for the environment; and (3) more stringent EPR policy parameters will generate better environmental outcomes. We discuss the potential shortcomings of these assumptions from an operations perspective and their implications for academic and policy research.

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关键性评估的未来

作 者： Dimitra Ioannidou, Niko Heeren, Guido Sonnemann, Guillaume Habert

关键字： 关键性、产业生态学、物质流分析、金属、风险评估、系统动力学

摘要：

资源（尤其是原材料）关键性的研究内容迅速扩展到原材料供应的方方面面，随着研究的推进，针对原材料关键性的评估体系也逐渐完善。然而，大多数现有方法止步于静态断面和固定空间尺度分析，仅提供了原材料供需平衡及原材料关键性的时间截面结果，缺乏对时空维度的动态考量。因此，目前原材料关键性评估方法具有一定局限性，无法应用于保障原材料供应安全的长期政策制定中。本文从以下三个方向指出关键性评估体系的改进思路：一、考虑社会、技术和经济三个要素的动态变化；二、考虑原材料供应的局地性；三、考虑原材料供应管理框架等边界条件的变化。论文阐释了在针对关键性进行研究之外，其他领域是如何解决这些问题，并基于对属于资源供求这一一般性领域的研究综述，确定影响资源供求的动态参数。根据对已有文献的分析，将影响原材料供需的动态参数归纳为七类：开采、社会、经济、技术、政策、市场和环境。基于此，本文探讨了在关键性评估研究中如何考虑这些参数的动态性，并提出具体方法和实例加以阐释。本文还依据与原材料未来供需相关的研究工作，凝练未来关键性情景分析的研究思路和参考标准。本综述研究的论述与结论为关键性评估框架的进一步改进奠定了基础。

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The future in and of criticality assessments

Dimitra Ioannidou, Niko Heeren, Guido Sonnemann, Guillaume Habert

Keywords: criticality, industrial ecology, material flow analysis (MFA), metals, risk assessment, system dynamics

Summary:

In recent literature, the concept of criticality aspires to provide a multifaceted risk assessment of resource supply shortage. However, most existing methodologies for the criticality assessment of raw materials are restricted to a fixed temporal and spatial reference system. They provide a snapshot in time of the equilibrium between supply and demand/economic importance and do not account for temporal changes of their indicators. The static character of criticality assessments limits the use of criticality methodologies to short-term policy making of raw materials. In the current paper, we argue for an enhancement of the criticality framework to account for three key dynamic characteristics, namely changes of social, technical, and economic features; consideration of the spatial dimension in site-specific assessments; and impact of changing governance frameworks. We illustrate how these issues were addressed in studies outside of the field of criticality and identify the dynamic parameters that influence resource supply and demand based on a review of studies that belong to the general field of resource supply and demand. The parameters are grouped in seven categories: extraction, social, economic, technical, policy, market dynamics, and environmental. We explore how these parameters were considered in the reviewed studies and propose ways and specific examples of addressing the dynamic effects in the criticality indicators. Furthermore, we discuss the current work on future scenarios to provide reference points for indicator benchmarks. The insights and guidelines derived from the review and our recommendations for future research set the foundations for an enhanced dynamic and site-specific criticality assessment framework.

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迈向生产型城市：城市屋顶嵌体对促进食物-能量-水耦合的作用评价

作者： Susana Toboso-Chavero, Ana Nadal, Anna Petit-Boix, Oriol Pons, Gara Villalba, Xavier Gabarrell, Alejandro Josa, Joan Rieradevall

关键字： 产业生态学，生命周期评价，雨水收集，资源自给，太阳能，都市农业

摘要：

城市正在快速增长，需要寻找优化资源消耗的方法。大都市的三个主要系统特别脆弱，通常被称为 FEW（即食物、能源和水）耦合。在这种情况下，城市屋顶作为未充分利用的区域，可能用于生产这些资源。

本文提出了“屋顶嵌体”法(Roof Mosaic approach)，将生命周期评估与两条屋顶建设指南相结合，通过不同空间尺度（参考建筑和社区）的不同 FEW 生产方式组合（雨水收集、食物生产、能源生产）的情景分析，分析生产食物、能源及收集雨水的技术可行性和环境影响。本研究将屋顶嵌体法应用于地中海城市人口稠密的社区，参考建筑层面的结果表明，雨水收集和食物生产组合将减少在使用阶段较少的二氧化碳当量排放（13.9-18.6 千克二氧化碳当量/居民/年），但其建设对环境的影响较小。相比之下，能源系统（光伏或太阳能加热系统）与雨水收集相结合的应用有可能避免更高的二氧化碳当量排放量（177-196 千克二氧化碳当量/居民/年），但在施工阶段会产生更高的环境负。

社区层面，该方法可以满足 FEW 需求的 7%至 50%，并避免高达 157 吨 CO2 当量/年的 CO2 排放。这种方法对于优化 FEW 耦合具有指导意义，为在社区层面开发屋顶提供了多种选择，不仅可以帮助提高城市自给率、优化资源，还可以减少 CO2 当量排放。

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Towards productive cities: Environmental assessment of the food-energy-water nexus of the urban Roof Mosaic

Susana Toboso-Chavero, Ana Nadal, Anna Petit-Boix, Oriol Pons, Gara Villalba, Xavier Gabarrell, Alejandro Josa, Joan Rieradevall

Keywords: industrial ecology, life cycle assessment (LCA), rainwater harvesting, resource self-sufficiency, solar energy, urban agriculture

Summary:

Cities are rapidly growing and need to look for ways to optimize resource consumption. Metropolises are especially vulnerable in three main systems, often referred to as the FEW (i.e., food, energy, and water) nexus. In this context, urban rooftops are underutilized areas that might be used for the production of these resources.

We developed the Roof Mosaic approach, which combines life cycle assessment with two rooftop guidelines, to analyze the technical feasibility and environmental implications of producing food and energy, and harvesting rainwater on rooftops through different combinations at different scales. To illustrate, we apply the Roof Mosaic approach to a densely populated neighborhood in a Mediterranean city. The building-scale results show that integrating rainwater harvesting and food production would avoid relatively insignificant emissions (13.9–18.6 kg CO2 eq/inhabitant/year) in the use stage, but their construction would have low environmental impacts. In contrast, the application of energy systems (photovoltaic or solar thermal systems) combined with rainwater harvesting could potentially avoid higher CO2 eq emissions (177–196 kg CO2 eq/inhabitant/year) but generate higher environmental burdens in the construction phase.

When applied at the neighborhood scale, the approach can be optimized to meet between 7% and 50% of FEW demands and avoid up to 157 tons CO2 eq/year. This approach is a useful guide to optimize the FEW nexus providing a range of options for the exploitation of rooftops at the local scale, which can aid cities in becoming self-sufficient, optimizing resources, and reducing CO2 eq emissions.

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将城市投入产出表和城市能源足迹关联：框架建立及应用

作者： Heran Zheng, Jing Meng, Zhifu Mi, Malin Song, Yuli Shan, Jiamin Ou, Dabo Guan

关键字： 自底向上方法，中国，城市尺度，产业生态学，京津冀，城市集群，多区域投入产出表汇编

摘要：

多区域投入产出模型（MRIO）在经济和环境分析中的作用日益重要。然而，大多数 MRIO 模型无法分辨分区域之间的异质性，尤其是以城市划分区域。缺乏城市级 MRIO 表不仅妨碍了市级的研究，而且也妨碍了对城市增长与消费之间的联系以及与其他地区的联系。在本文中，我们提出了一个部分基于调查的多层框架，用于编制以城市划分区域单位的中国一个省的 MRIO 表。该框架可以有效地处理大量数据，并保持各层之间的一致性。使用此框架，首先我们需要编制一个嵌套的中国河北省城市级的 MRIO 表，然后应用于华北城市群的城市级能源足迹核算。我们的研究结果显示了河北省的城市在 2012 年的能源供应中所起到的关键作用，并量化了国内贸易商品中能源使用情况。不管是处于欠发达地区还是发达地区，唐山、石家庄和邯郸都是能源供应链中的特色城市。这个多层框架是一种开发次区域级 MRIO 模型的可行方法，并且为用有限数据以次区域层面对全球贸易进行分析提供了可能。本文分析的数据和结果可从中国碳核算数据库（CEADs）下载。

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Linking city-level input-output table to urban energy footprint: Construction framework and application

Heran Zheng, Jing Meng, Zhifu Mi, Malin Song, Yuli Shan, Jiamin Ou, Dabo Guan

Keywords: bottom-up approach, China, city level, industrial ecology, Jing-Jin-Ji urban agglomeration, MRIO table compilation

Summary:

Multiregion input–output (MRIO) models have become increasingly important in economic and environmental analysis. However, the current resolution of most MRIO models fails to capture the heterogeneity between subregions, especially in cities. The lack of city-level MRIO tables has impeded the accomplishment of city-level studies and hampered the understanding of the relationship between urban growth and consumption, and teleconnections to other regions. In this paper, we propose a partial survey-based multiple-layer framework for MRIO table compilation of a Chinese province that distinguishes city-based regions. This framework can effectively address a large number of data processes and retain consistency between layers. Using the framework, we first compile a nested Hebei-China city-level MRIO table and then apply city-level energy footprint accounting of the North China urban agglomeration. Our results present the critical role of Hebei cities in energy supply in 2012 and quantify energy use embodied in goods for the domestic trade. Tangshan, Shijiazhuang, and Handan are distinctive cities in the energy supply chain of other regions, for both less developed and developed regions. This multiple-layer framework represents a feasible approach for developing subregional-level MRIO models and offers the possibility to analyze global trade at the subregional level with limited data. The data and results from the analysis in this article are available for download from China Emission Accounts and Datasets.

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住宅建筑材料成分指标的可转移性：基于德日比较的概念方法

作者：Georg Schiller, Alessio Miatto, Karin Gruhler, Regine Ortlepp, Clemens Deilmann, Hiroki Tanikawa

关键字： 跨环境转移，产业生态学，物料组成指标，物质流分析（MFA），物料强度，住宅建筑

摘要：
大多数人为材料的存量和流量与建筑部门有关。最近的几项研究开发了物料组成指标（MCI），适用于以一种自下而上的方法来计算建筑部门的物料存量和流量，这在提供信息以支持资源效率政策方面具有巨大的潜力。而一个主要的局限性在于目前缺乏特定国家的物料组成指标。这项研究旨在通过提出定义 MCI 的要求，并讨论可转移性的选择和局限性，提出一种在不同环境下更好地转移 MCI 的概念。本文作者以德国和日本现有的居民住宅 MCI 为案例研究，并通过应用协调方法使其具有可比性。在此基础上，系统地考虑了它们的社会经济、文化、技术和环境因素，对它们的异同进行了识别和讨论。研究结果表明，独立式住宅 MCI 的可转让性受到很大限制，而大型公寓楼尽管环境不同，但均质性更高。这表明，虽然可以假设外国 MCI 适用于大型建筑，但仍需要为较小的单户住宅估算局部系数。

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Transferability of material composition indicators for residential buildings: A conceptual approach based on a German–Japanese comparison

Georg Schiller, Alessio Miatto, Karin Gruhler, Regine Ortlepp, Clemens Deilmann, Hiroki Tanikawa

Keywords: cross-context transfer, industrial ecology, material composition, indicator, material flow analysis (MFA), material intensity, residential buildings

Summary:
Most anthropogenic material stocks and flows are associated with the building sector. Several recent studies have developed material composition indicators (MCIs) suitable for calculating material stocks and flows of the building sector using bottom-up approaches, which hold great potential to provide information to support resource efficiency policies. A major limitation is the lack of country-specific MCIs. This study aims to introduce a concept for a better transferability of MCI across different contexts by proposing requirements for defining MCIs and to discuss options and limits of the transferability. We take existing MCIs for residential buildings in Germany and Japan as case studies and make them comparable by applying harmonization methods. Based on that, similarities and differences are systematically identified and discussed, considering their socioeconomic, cultural, technical, and environmental factors. Our results indicate significant limitations to the transferability of MCIs for detached houses, while bigger apartment complexes show greater homogeneity despite the very different environments in which they are constructed. This indicates that while it is possible to assume foreign MCIs as plausible for large constructions, local coefficients need to be estimated for smaller single-family homes.

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揭示产业共生的环境优势：基于木材的生物经济的生命周期评价

作者：Jakob Hildebrandt, Sinéad O'Keeffe, Alberto Bezama, Daniela Thrän

关键字： 产业生态学、产业共生、集成工业生产网络、生命周期评、木质纤维素生物炼厂、木材生物经济

摘要：
德国政府近期启动了区域基于木材的生物经济战略的激励资助计划，鼓励区域内的木材和化学工业共同行动，即共享试验工厂设施，在可行的情况下偶联工艺，并在整个工艺网络中实现木材原料的梯级利用。然而，在这些区域发展生物经济的规划阶段，需要对不同选择进行评估，以便生产生物基聚合物和工程木材产品的各个行业之间过程和能源的整合实现可持续性。本文旨在确定产业共生的环境可持续性，以在德国中部的木材生物经济区生产高附加值的生物基产品。本研究对生物经济网络中三种可能的情景进行了分析，这三种情景分别体现了不同的产业共生程度。研究者采用生命周期评价（Life Cycle Assessment, LCA）考虑了 11 种环境影响类别，将这三种情景与传统的基于化石原料的生产系统进行比较。结果表明，在大多数情况下，生物经济网络的表现优于基于化石原料的生产系统，环境影响能够减轻 25％至 130％。

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Revealing the environmental advantages of industrial symbiosis in wood-based bioeconomy networks: An assessment from a life cycle perspective

Jakob Hildebrandt, Sinéad O'Keeffe, Alberto Bezama, Daniela Thrän

Keywords: industrial ecology, industrial symbiosis, integrated industrial production networks, life cycle assessment, lignocellulosic biorefineries, wood-based bioeconomy

Summary:
The German government has recently initiated funding schemes that incentivize strategies for wood-based bioeconomy regions. Regional wood and chemical industries have been encouraged to act symbiotically, that is, share pilot plant facilities, couple processes where feasible, and cascade woody feedstock throughout their process networks. However, during the planning stages of these bioeconomy regions, options need to be assessed for sustainably integrating processes and energy integration between the various industries that produce bio-based polymers and engineered wood products. The aim of this paper is to identify the environmental sustainability of industrial symbiosis for producing high-value-added, bio-based products in the wood-based bioeconomy region of Central Germany. An analysis was conducted of three possible future scenarios with varying degrees of symbiosis in the bioeconomy network. A life cycle assessment (LCA) approach was used to compare these three scenarios to a traditional fossil-based production system. Eleven environmental impact categories were considered. The results show that, in most cases, the bioeconomy network outperformed the fossil-based production system, mitigating environmental impacts by 25% to 130%.

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基于物质流和空间数据分析研究我国东北石油消耗和与石油相关的碳排放

作者：Guangxin Liu , Ming Wu, Fengrui Jia, Qiang Yue, Heming Wang

关键字： 二氧化碳排放，能源消费，物质流分析，中国东北，石油流量，空间数据分析

摘要：
本研究利用物质流分析方法（MFA）和空间数据分析（SDA），研究了中国东北地区的石油消耗和与石油相关的 CO2 排放（PCOEs）。论文绘制了 2014 年的石油流量图，然后分别计算了石油消耗和 PCOEs 的空间格局、平均中心（WMCs）和空间自相关情况。研究发现，中国东北地区是一个石油开采-加工-出口地区；石油流入总量由两部分组成：开采量（约 60%）和进口量（约 40%）。约 1/3 的成品油供应流入其他省份。在消费过程中，成品油主要由两个部门组成：工业部门（45.5%）和运输部门（31%）。在废物排放过程中，PCOEs 的排放率为 3669 万吨。同时石油消耗和 PCOEs 的平均中心位于中国东北的南部。石油管道的位置是决定石油消耗和 PCOEs 空间格局的因素，热点均沿石油管道线分布，特别是在环渤海地区。这些区域的经济发展显示了对石油消耗的积极依赖，也产生了更多的 PCOEs。研究结果可为我国东北地区低碳发展提供重要的决策参考。

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Material flow and spatial data analysis of the petroleum use to carbon dioxide (CO2) emissions in Northeast China

Guangxin Liu , Ming Wu, Fengrui Jia, Qiang Yue, Heming Wang

Keywords: CO2 emissions, energy consumption, material flow analysis (MFA), Northeast China, petroleum flows, spatial data analysis

Summary:
This study investigated the petroleum consumption and petroleum-related CO2 emissions (PCOEs) in Northeast China at city level using material flow analysis (MFA) and spatial data analysis (SDA). The petroleum flows for the year 2014 were plotted, and then the spatial patterns, weighted mean centers (WMCs), and spatial autocorrelations of petroleum consumption and PCOEs were calculated, respectively. It was found that Northeast China is a petroleum exploitation-processing-export region in China; the total input of petroleum flows comprised two parts—exploitation (about 60%) and import (about 40%). About one third of the total product oil supply flowed into other provinces. In the consumption process, the product oil was dominated by two sectors: the industry sector (45.5%) and the transportation sector (31%). The rate of PCOEs was 36.69 million tonnes in the waste discharge process. Meanwhile, the WMCs of the petroleum consumption and the PCOEs were located in the south of Northeast China. The location of the petroleum pipelines was the factor shown to determine the spatial patterns of petroleum consumption and PCOEs and the hotspots were distributed along the petroleum pipeline, especially in the Circum-Bohai Sea regions. Economic development in these regions shows a positive dependence on petroleum consumption and generates larger PCOEs. The findings obtained in this study could provide important decision-making support to low-carbon development in Northeast China.

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绝对环境可持续性评估方法的开发和交流框架

作者：Anders Bjørn, Katherine Richardson, Michael Zwicky Hauschild

关键字： 承载力，基于环境的可持续性，氮排放，磷排放，行星边界，基于科学的目标

摘要：

绝对环境可持续性评估（AESA）解决了生产或消费活动是否可以在绝对意义上视为环境可持续。这涉及将其环境压力与其分配的环境承载能力进行比较。AESA 方法已经在多个学术领域得到发展，每个领域都使用自己的概念和术语集，而跨领域的交流很少。近来，使用 AESA 方法提供决策支持日益引发人们的兴趣，这要求人们对 AESA 方法的组成以及如何与科学同仁和潜在用户进行交流有更好的共识。

为此，我们开发了 AESA 方法的框架，该框架由四个评估步骤组成，涉及方法开发者或用户必须做出的六种方法选择。然后，我们使用该框架来分析和比较五种选定的 AESA 方法，评估向环境释放的磷和氮。通过这种方式，我们表明该框架能够系统地区分最初看起来相似的 AESA 方法。框架的目标用户包括：（1）向学术同行或潜在方法用户传达新的 AESA 方法的开发人员；（2）比较现有 AESA 方法并将其差异传达给同行和寻求方法选择指导的潜在用户的研究人员。

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A framework for development and communication of absolute environmental sustainability assessment methods

Anders Bjørn, Katherine Richardson, and Michael Zwicky Hauschild

Keywords: carrying capacity, context-based sustainability, nitrogen emission, phosphorus emission, planetary boundaries, science-based targets

Summary:

An absolute environmental sustainability assessment (AESA) addresses whether a production or consumption activity can be considered environmentally sustainable in an absolute sense. This involves a comparison of its environmental pressure to its allocated environmental carrying capacity. AESA methods have been developed in multiple academic fields, each using their own set of concepts and terms with little communication across the fields. A recent growing interest in using AESA methods for decision support calls for a better common understanding of the constituents of an AESA method and how it can be communicated to scientific peers and to potential users.

With this aim, we develop a framework for AESA methods, composed of a succession of four assessment steps and involving six methodological choices that must be made by the method developer or the user. We then use the framework to analyze and compare five selected AESA methods that focus on the release of phosphorus and nitrogen to the environment. In this manner, we show that the framework is able to systematically differentiate AESA methods that initially appear to be similar. Intended users of the framework include (1) method developers communicating new AESA methods to academic peers or potential method users and (2) researchers comparing a group of existing AESA methods and communicating their differences to their peers and to potential users looking for guidance on method selection.

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企业积极的环境披露是在漂绿，还是的确带来环境表现改善？

作者：Manpreet Hora, Ravi Subramanian

关键字： 粗化精确匹配，环境披露，环境绩效，漂绿，产业生态学，新闻发布，有毒物质排放清单

摘要：

公司对环保行为进行积极的自主信息披露，以示对经营活动环境影响的关注。一方面，企业的披露可能促使公众从产生负面环境影响的经营活动中转移注意力（例如，具有“隐蔽的权衡之罪”的漂绿行为）；另一方面，进行披露的公司也可以合理地改善其整体环境绩效。我们的研究从实证角度解决了以下问题：相比其他公司，进行积极的自主环境披露的公司是否改善了整体环境绩效？具体而言，由于新闻发布已成为积极自主披露的一种流行媒介，我们考察了企业超出合规的环境披露公告与适当加权汇总的企业级排放的污染物（来自美国环境保护局的有毒物质排放清单，TRI）之间的关系。我们采用匹配方法（粗化精确匹配和倾向得分匹配）来说明内生性的潜在来源，包括公司先前的环境绩效与其披露环境信息的倾向之间的关系。研究结果是令人欣慰的：隐性权衡的漂绿行为似乎并不普遍。此外，我们的事后分析基于披露内容和行业来探索原因，这可能有助于解释作出环境披露的公司之间环境绩效的差异。

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Relationship between positive environmental disclosures and environmental performance: An empirical investigation of the greenwashing sin of the hidden tradeoff

Manpreet Hora, Ravi Subramanian

Keywords: coarsened exact matching, environmental disclosures, environmental performance, greenwashing, industrial ecology, press announcements, Toxics Release Inventory

Summary:

Firms make positive discretionary disclosures about their environmental efforts in order to signify attention to the environmental impacts of their operations. On the one hand, firms may choose to make these disclosures to deflect attention away from other activities that may contribute negatively to their environmental performance (i.e., greenwashing in the form of the “sin of the hidden trade-off”). On the other hand, firms making these disclosures may legitimately improve their overall environmental performance. Our study empirically addresses the following question: Do firms that make positive discretionary environmental disclosures improve their overall environmental performance more than the firms that do not make such disclosures? Specifically, because press announcements have been shown to be a popular medium for positive discretionary disclosures, we examine the relationship between announcements in the press of firms’ environmental efforts beyond compliance, and suitably weighted-aggregated firm-level releases of the range of pollutants reported to the U.S. Environmental Protection Agency's Toxics Release Inventory (TRI). We employ matching methods (coarsened exact matching and propensity score matching) that account for potential sources of endogeneity, including the relationship between firms’ prior environmental performance and their propensity to disclose environmental information. Our findings from the matching methods provide encouraging evidence that greenwashing in the form of the sin of the hidden trade-off does not appear to be prevalent. Additionally, our post hoc analysis explores factors based on the content of disclosures and industry, that may help explain differences in environmental performance among the firms making the disclosures.

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中国高铁的碳足迹：以京沪线为例

作者：Jianyi Lin, Huimei Li, Wei Huang, Wangtu Xu, Shihui Cheng

关键字： 碳足迹，中国，高速铁路，混合环境投入产出生命周期评价，产业生态学，交通

摘要：
评估中国高速铁路（HSRs）的碳足迹（CF）有助于指导世界上最长的高铁网络的进一步发展。本研究采用混合经济投入产出和生命周期评估（EIO-LCA）方法对京沪高铁线路的 CF 进行估算，分析了生产线的不同子系统、不同生产阶段和三个计算范围的特定 CF。结果显示，京沪高铁的年度 CF 正在增加，而每位乘客的 CF 在 2011 年至 2014 年间不断下降。范围 1 排放平均占年度 CF 总量的 4%，范围 2 贡献 71%，范围 3 占 25%。在不同阶段中，运营贡献最大（71%），其次是建设（20%）和维护（9%）。在施工阶段，桥梁有最大的 CF，其次是火车，然后是铁轨。在由桥梁建设导致的碳排放增加与受地形平整变化影响的运营排放减少之间存在权衡。与其他八条高铁线路相比，京沪高铁的人均 CF 相对较高，这主要是由于中国以煤为基础的碳密集型电力生产能源结构、高桥梁比例、高运行速度以及更重的车身。未来，更清洁的电力供应选择、更有效的原材料生产以及列车的改进是降低中国高铁 CF 的关键。

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A carbon footprint of high-speed railways in China: A case study of the Beijing–Shanghai line

Jianyi Lin, Huimei Li, Wei Huang, Wangtu Xu, Shihui Cheng

Keywords: carbon footprint, China, high-speed railway (HSR), hybrid, environmental input-output life cycle assessment (EIO-LCA), industrial ecology, transportation

Summary:
A carbon footprint (CF) assessment of Chinese high-speed railways (HSRs) can help guide further development of the world's longest HSR network. In this research, a hybrid economic input-output and life cycle assessment (EIO-LCA) method was applied to estimate the CF of the Beijing-Shanghai HSR line. Specific CFs were analyzed of different subsystems of the line, different stages of production, and three calculation scopes. Results showed that the annual CF of the Beijing-Shanghai HSR is increasing, whereas the per-passenger CF constantly declined between 2011 and 2014. Scope 1 emissions account for an average of 4% of the total annual CF, Scope 2 contribute 71%, and Scope 3 comprise 25%. Among the different stages, operation contributes the largest (71%), followed by construction (20%) and maintenance (9%). In the construction stage, the bridges have the largest CF, followed by trains, and then rails. A trade-off exists between the increase in carbon emissions due to construction of bridges and the reduction in operation emissions affected by leveling changes in terrain. The Beijing-Shanghai HSR line has a relatively higher per-passenger CF than eight other HSR lines, which is largely due to China's coal-based carbon-intensive energy mix of electricity generation, high proportion of bridges, higher operating speed, and heavier train body. In the future, cleaner electricity supply options, more efficient raw material production, and improvement of trains are keys to reducing the CF of Chinese HSRs.

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通过投入产出分析评估组织的环境足迹：建筑部门的案例研究

作者：Sara Martinez, Maria del Mar Delgado, Ruben Martinez Marin, Sergio Alvarez

关键字： 企业环境管理，环境扩展的多区域投入产出，绿色公共采购，产业生态学，供应链，可持续性

摘要：
近年来，实施全球可持续发展已引发普遍关注。组织的环境足迹涵盖 14 个影响类别，是从生命周期的角度对组织所提供的商品和服务的环境绩效进行的多标准衡量。本文重点量化西班牙一家建筑公司的组织环境足迹。通过应用环境扩展的投入产出方法，计算了其连续两年来的总足迹和对整个供应链的影响。结果表明，第二年的环境影响显著高于第一年。其中，气候变化这一影响类别在这两年间增幅最大（增长了 31%）。这项工作概述了所评估公司的 14 种环境影响类别，以及在公司和公共采购中实施该指标的建议。本方法可以为制定组织的行动计划和应对欧洲所面临的环境挑战铺平道路。

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Organization Environmental Footprint through input-output analysis: A case study in the construction sector

Sara Martinez, Maria del Mar Delgado, Ruben Martinez Marin, Sergio Alvarez

Keywords: corporate environmental management, environmentally extended multiregional input-output, green public procurement, industrial ecology, supply chain, sustainability

Summary:
The implementation of global sustainability has gained worldwide attention in recent years. The Organization Environmental Footprint, which encompasses 14 impact categories, is a multicriteria measure of the environmental performance of goods and services provided by an organization from a life cycle perspective. In this article, the focus is on quantifying the Organization Environmental Footprint of a construction company in Spain. By applying an environmentally extended input-output approach, its total footprint and impacts along the supply chain from two consecutive years were calculated. The results show that the environmental impacts from the second year of implementation were significantly higher than those from the first year. The impact category climate change was found to have experienced the greatest increase from one year to the other, with a 31% increase. This work provides an overview of 14 environmental impact categories of the company assessed, as well as recommendations for the implementation of this indicator in companies and public procurement. This approach could pave the way to shape organizations' action plans and meet the European environmental challenges.

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利用实物供应和使用表计算经济系统物质流指标

作者：Jan Kovanda

关键字： 捷克， 经济系统物质流分析（EW-MFA）， 环境扩展的投入产出模型（EE-IO）， 实物供给使用表（PSUTs）， 原材料当量（RME），环境经济核算系统（SEEA）

摘要：
本文基于最近发布的环境经济核算系统（SEEA）的方法学标准，首次提出实物供应和使用表（PSUT）。该表格针对 2014 年捷克共和国编制。论文详细介绍了编制程序，以便为其他研究人员和统计人员提供启发和基准。PSUT 的主要缺点是，所需数据并非全部能以物理单位轻松获得，并且不需要基于替代指标的估计。因此，表格的某些部分承受了一定程度的不确定性。为了解决通常在货币供应和使用表（MSUT）中常见的商品产出、进口和出口的部门价格的不均匀性，本研究进一步将 PSUT 和 MSUT 用于计算进出口的原材料当量、原材料投入（RMI）和原材料消耗（RMC）指标。结果比较表明，总指标相差不大：出口原材料当量的最大差异为5%，而RMC则保持几乎相同。但是，我们仍然主张使用PSUTs计算原材料当量，因为指标总量的变化伴随着其材料结构的变化。由于环境影响因材料而异，因此这可能会对评估与材料消耗有关的环境影响。

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Use of physical supply and use tables for calculation of economy-wide material flow indicators

Jan Kovanda

Keywords: Czech Republic, economy-wide material flow analysis (EW-MFA), environmentally extended input-output (EE-IO) model, physical supply and use tables (PSUTs), raw material equivalents (RME), System of Environmental-Economic Accounting (SEEA)

Summary:
The study described in this article presents the first-ever physical supply and use tables (PSUTs) based on the recently published methodological standard for the System of Environmental-Economic Accounting (SEEA). The tables were compiled for the Czech Republic for 2014. The compilation procedure followed was described in detail so that it can serve as a source of inspiration and a benchmark for other researchers and/or statisticians. The major shortcoming of the PSUTs is that not all needed data were readily available in physical units and required estimations based on proxies. Some parts of the tables are therefore burdened with a degree of uncertainty. In order to address the price inhomogeneity of sectoral prices for commodity outputs, imports, and exports, which tends to be typical for monetary supply and use tables (MSUTs), the PSUTs and MSUTs were further used for the calculation of raw material equivalents of import, exports, and raw material input (RMI) and raw material consumption (RMC) indicators. A comparison of results showed that the total indicators do not differ that much: the largest difference of 5% was recorded for raw material equivalents of exports, while RMC, for instance, remained nearly the same. However, we still argue for the use of PSUTs for the calculation of raw material equivalents, as changes in total volume of the indicators were accompanied with changes in their material structure. This can have significant consequences for the assessment of environmental impacts related to material consumption, as environmental impacts are very material specific.

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基于绝对可持续性的生命周期评估（ASLCA）：在 2° C 全球碳预算范围内操作农产品系统的基准方法

作者： Chanjief Chandrakumar, Sarah J. McLaren, Nihal P. Jayamaha, and Thiagarajah Ramilan

关键字： 绝对的环境可持续性，农业食品，碳预算，气候变化，产业生态学，生命周期评估

摘要：

鉴于全球农业食品系统对环境的影响越来越大，在所谓的绝对环境边界内运行和开发这些系统变得至关重要，因此绝对环境可持续性概念尤为重要。这项研究引入了一种称为基于绝对可持续性的生命周期评估（ASLCA）的方法，该方法可以绝对地告知农业食品系统（在任何经济水平上）的气候影响。首先，计算出的全球碳预算足以将全球变暖限制在 2° C 以下。接下来，估算了可用于全球农业食品部门的碳预算的份额，然后使用四种替代方法在多个经济水平的农业食品系统之间共享碳预算。第三，使用生命周期评估方法计算了这些系统的气候影响，并以这些碳预算份额为基准。该方法用于评估许多新西兰农业食品系统（农业食品部门、园艺行业和产品），以调查这些系统相对于碳预算份额的运作方式。结果表明，2013 年，新西兰农业食品系统在四种方法之一的碳预算份额内，并说明了农业食品系统在其碳预算份额内执行所需的变化规模。可以将这种方法扩展为考虑具有全球边界的其他环境影响；但是，有必要进一步发展 ASLCA，以解决其他环境影响，这些影响的界限只有在区域或地方级别定义时才有意义。

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Absolute sustainability-based life cycle assessment: A benchmarking approach to operate agri-food systems within the 2°C global carbon budget

Chanjief Chandrakumar, Sarah J. McLaren, Nihal P. Jayamaha, Thiagarajah Ramilan

Keywords: absolute environmental sustainability, agri-food, carbon budget, climate change, industrial ecology, life cycle assessment

Summary:

Given the increasing environmental impacts associated with global agri-food systems, operating and developing these systems within the so-called absolute environmental boundaries has become crucial, and hence the absolute environmental sustainability concept is particularly relevant. This study introduces an approach called absolute sustainability-based life cycle assessment (ASLCA) that informs the climate impacts of an agri-food system (on any economic level) in absolute terms. First, a global carbon budget was calculated that is sufficient to limit global warming to below 2°C. Next, a share of the carbon budget available to the global agri-food sector was estimated, and then it was shared between agri-food systems on multiple economic levels using four alternative methods. Third, the climate impacts of those systems were calculated using life cycle assessment methodology and were benchmarked against those carbon budget shares. This approach was used to assess a number of New Zealand agri-food systems (agri-food sector, horticulture industries and products) to investigate how these systems operated relative to their carbon budget shares. The results showed that, in 2013, the New Zealand agri-food systems were within their carbon budget shares for one of the four methods, and illustrated the scale of change required for agri-food systems to perform within their carbon budget shares. This method can potentially be extended to consider other environmental impacts with global boundaries; however, further development of the ASLCA is necessary to account for other environmental impacts whose boundaries are only meaningful when defined at a regional or local level.

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重视提升经济系统的物质生产力 弥合气候变化减缓的缺口

作者： Kate Scott, Jannik Giesekam, John Barrett, Anne Owen

关键字： 气候变化减缓，需求缩减，减排和气候政策，产业生态学，物质生产力

摘要：
对英国温室气体排放的预测显示：现有和计划的气候政策在实现其应对气候变化目标方面存在差距，即英国在气候变化减缓上的努力与目标存在缺口（mitigation gap）。物质投入和产品需求正在推动工业温室气体排放的速度超过经济中碳强度的改善。有证据表明，可以用更少的碳密集的生产要素来生产产品，并且对新产品的需求也可以降低。物质生产力（material productivity）和生活方式改变对整个英国气候变化减缓“缺口”的影响尚未得到充分研究。我们将投入产出框架、计量经济学分析和案例研究证据相结合，以分析物质生产力的潜力，帮助英国弥合其预期的减排缺口，实现与 2° C 和 1.5° C 温升目标一致的变革所需的额外努力。我们估计，物质生产力提升举措所能带来的减排量与政府的气候政策一揽子计划相当。这些额外措施可能会使英国的预期排放赤字降低 73%。结果表明，气候政策需要更加重视物质生产力提升的作用。

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Bridging the climate mitigation gap with economy-wide material productivity

Kate Scott, Jannik Giesekam, John Barrett, Anne Owen

Keywords: climate mitigation, demand reduction, emissions savings and climate policy, industrial ecology, material productivity

Summary:
Projections of UK greenhouse gas emissions estimate a shortfall in existing and planned climate policies meeting UK climate targets: the UK's mitigation gap. Material and product demand is driving industrial greenhouse gas emissions at a rate greater than carbon intensity improvements in the economy. Evidence shows that products can be produced with fewer carbon intensive inputs and demand for new products can be reduced. The economy-wide contribution of material productivity and lifestyle changes to bridging the UK's mitigation gap is understudied. We integrate an input-output framework with econometric analysis and case study evidence to analyse the potential of material productivity to help the UK bridge its anticipated emissions deficits, and the additional effort required to achieve transformative change aligned with 2 and 1.5°C temperature targets. We estimate that the emissions savings from material productivity measures are comparable to those from the Government's planned climate policy package. These additional measures could reduce the UK's anticipated emissions deficit up to 73%. The results demonstrate that material productivity deserves greater consideration in climate policy.

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使用经济数据估算排放系数和质量平衡：一种随机前沿方法

作者： Benjamin Hampf

关键字： 减排过程，空气污染，质量平衡，随机前沿分析

摘要：

在本文中，我们提出了对质量平衡的随机表述，该表述对生产技术施加了物理约束。该模型的估计涉及一个组合的误差项结构，该结构通常用于生产效率随机前沿分析的文献中。此外，我们讨论了如何使用普通的最小二乘法和最大似然法来基于所提出的模型估算排放系数，并将结果与基于投入产出分析的线性规划技术的估算值进行比较。与以前的方法相比，我们的模型允许人们在存在统计噪声的情况下估计生产可能性的物理局限性，并且对数据要求的依赖性更弱。我们使用美国化石燃料发电厂的样本来估算二氧化硫和二氧化碳的排放系数。

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Estimating emission coefficients and mass balances using economic data: A stochastic frontier approach

Benjamin Hampf

Keywords: abatement processes, air pollution, mass balances, stochastic frontier analysis

Summary:

In this article, we propose a stochastic formulation of mass balances that impose physical constraints on production technologies. The estimation of the model involves a composed error term structure that is commonly applied in the literature on stochastic frontier analysis of productive efficiency. Moreover, we discuss how ordinary least squares and maximum likelihood methods can be used to estimate emission coefficients based on the proposed model and compare the results to estimates based on linear programming techniques from input–output analysis. In contrast to previous approaches, our model allows one to estimate the physical limitations to production possibilities in the presence of statistical noise and depends on substantially weaker data requirements. We apply our approach to estimate emission coefficients for sulfur dioxide and carbon dioxide using a sample of fossil-fueled power plants in the United States.

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MRIO 模型之间的数据偏差对材料足迹的影响：EXIOBASE、Eora 和 ICIO 投入产出数据库的比较

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关键字： 材料足迹，多区域投入产出数据库，原材料当量，资源政策，结构分解分析，结构生产层分解

摘要：
在诸如联合国可持续发展目标之类的各种国际政策进程中，过去几年迫切需求基于消费的物质流或物质足迹（MF）指标。但是，用不同的全球多区域投入产出数据库计算得出的物质足迹存在差异，这对广泛采用这些指标构成了重大障碍。本文的目的是量化 GMRIO 数据库之间的数据偏差对所得 MF 的影响。我们使用两种方法（结构分解分析和结构生产层分解）对三个 GMRIO 数据库 EXIOBASE、Eora 和 OECD 国家间投入产出数据库（ICIO）进行成对评估，并使用相同的材料集扩展名。尽管三个 GMRIO 数据库的足迹结果方向相同，也就是说，一个国家的最终需求是依赖于从国外净进口原材料还是该国是净出口国，但它们有时在物质流的水平和构成上存在显著差异。通过分解 Leontief 矩阵（经济结构）的影响，我们发现在供应链的最初阶段，有几个部门，即原材料提取和基本加工，解释了 60％的来自技术矩阵的总偏差。我们得出的结论是，未来研究应该重点发展能使 GMRIO 的结果保持一致的方法，尤其对于材料密集型行业和供应链。这对于加强在资源政策中采用基于需求的物质流指标至关重要。

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The impacts of data deviations between MRIO models on material footprints: A comparison of EXIOBASE, Eora and ICIO

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Keywords: material footprint, multiregional input–output databases, raw material equivalents, resource policy, structural decomposition analysis, structural production layer decomposition

Summary:
In various international policy processes such as the UN Sustainable Development Goals, an urgent demand for robust consumption-based indicators of material flows, or material footprints (MFs), has emerged over the past years. Yet, MFs for national economies diverge when calculated with different Global Multiregional Input–Output (GMRIO) databases, constituting a significant barrier to a broad policy uptake of these indicators. The objective of this paper is to quantify the impact of data deviations between GMRIO databases on the resulting MF. We use two methods, structural decomposition analysis and structural production layer decomposition, and apply them for a pairwise assessment of three GMRIO databases, EXIOBASE, Eora, and the OECD Inter-Country Input–Output (ICIO) database, using an identical set of material extensions. Although all three GMRIO databases accord for the directionality of footprint results, that is, whether a countries' final demand depends on net imports of raw materials from abroad or is a net exporter, they sometimes show significant differences in level and composition of material flows. Decomposing the effects from the Leontief matrices (economic structures), we observe that a few sectors at the very first stages of the supply chain, that is, raw material extraction and basic processing, explain 60% of the total deviations stemming from the technology matrices. We conclude that further development of methods to align results from GMRIOs, in particular for material-intensive sectors and supply chains, should be an important research priority. This will be vital to strengthen the uptake of demand-based material flow indicators in the resource policy context.

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中国水泥相关的二氧化碳峰值排放量以及驱动因素的变化

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关键字： 水泥产业、中国、碳排放、驱动力、指数分解分析、产业生态学

摘要：

为了应对气候变化，中国对超排放行业制定了一系列减排政策。水泥行业是与过程有关的排放的主要来源，应更加关注该行业。本研究计算了中国水泥行业与过程有关的排放、直接与化石燃料有关的排放以及与电力有关的间接排放。该研究发现，中国水泥相关的排放量在 2014 年达到顶峰。根据不同的新建筑类型使用的水泥，排放量首次被分为七个部分。省级排放分析发现，发达省份将水泥产能外包给欠发达地区。随后，本研究采用指数分解分析来探索中国水泥相关排放变化的驱动力。结果表明，经济增长是排放增长的主要驱动力，而排放强度和效率是两个抵消因素。自 2014 年以来，建筑行业结构的变化和效率的提高是导致排放量减少的两个主要驱动因素。

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Peak cement-related CO2 emissions and the changes in drivers in China

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Keywords: cement industry, China, CO2 emissions, driving forces, index decomposition analysis, industrial ecology

Summary:

In order to fight against the climate change, China has set a series of emission reduction policies for super-emitting sectors. The cement industry is the major source of process-related emissions, and more attention should be paid to this industry. This study calculates the process-related, direct fossil fuel–related, and indirect electricity-related emissions from China's cement industry. The study finds that China's cement-related emissions peaked in 2014. The emissions are, for the first time, divided into seven parts based on the cement used in different new building types. The provincial emission analysis finds that developed provinces outsourced their cement capacities to less developed regions. This study then employs index decomposition analysis to explore the drivers of changes in China's cement-related emissions. The results show that economic growth was the primary driver of emission growth, while emission intensity and efficiency were two offsetting factors. The changes in the construction industry's structure and improvement in efficiency were the two major drivers that contributed to the decreased emissions since 2014.

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产业共生的生命周期评估：对相关参照情景的评述

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关键字： 分配，环境评估，产业生态学，情景分析，敏感性分析，地域

摘要：
本文重点介绍了使用生命周期评估（LCA）方法定义和设计与产业共生（IS）情景进行比较的参照情景的方法和参数。为此，对 IS 领域使用 LCA 的 26 篇同行评审论文进行了评述。本研究分析着重于参照情景的定义和设计，通过五种交叉分析确定参照情景的型和数量与所研究的 IS 情景类型以及一些 LCA 特性之间的相关性，例如功能单元、数据类型、以及敏感性分析。结果表明，参照情景的定义主要取决于所考虑的 IS 情景的类型。对于当前工业规模的 IS 发展，合适的参照情景主要是假设的非共生方案。对于未来的 IS，合适的参照情景主要是当前存在的非共生方案。通过本评述，我们发现了参照情景的可变性问题。为了解决该问题，作者分析了不同的参照情景，或进行了敏感性分析。此外，在参照情景的设计中很少考虑地域因素。由于地域因素的影响，这显然是 IS 领域的 LCA 研 究空白。新的研究挑战包括考虑地域方面定义和设计最坏和最佳参照情景以评估 IS 的环境绩效。

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Life cycle assessment of industrial symbiosis: A critical review of relevant reference scenarios

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Keywords: allocation, environmental assessment, industrial ecology, scenario analysis, sensitivity analysis, territory

Summary:
This paper highlights the methods and parameters used to define and design a reference scenario to be compared with an industrial symbiosis (IS) scenario using the life cycle assessment (LCA) methodology. To this end, a critical review was conducted of 26 peer-reviewed papers using LCA in the field of IS. The analysis focuses on the definition and design of reference scenarios through five cross-analyses to determine correlations between the type and the number of reference scenarios and the type of IS scenarios studied and also some LCA characteristics such as the functional unit, the type of data used, and the use of sensitivity analysis. Results show that the definition of reference scenarios depends mainly on the type of IS scenario considered. For a current IS developed at an industrial scale, the suitable reference scenario is mainly a hypothetical nonsymbiotic reference scenario. For a prospective IS, the suitable reference scenario is mainly a current nonsymbiotic reference scenario. Due to this critical review, the problem of variability of reference scenarios emerges. To resolve it, the authors analyze different reference scenarios or use sensitivity analysis. What is more, territorial aspects are rarely taken into account in the design of reference scenarios. It is clearly a gap for LCA of IS because of the influence of territorial factors. The new research challenge is to include the consideration of territorial aspects to define and design the worst- and best-case reference scenarios to assess strict environmental performances of IS.

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从生命周期评估角度考察亚麻纤维增强聚合物复合材料作为汽车轻量化组件的优化设计

作者： Yelin Deng, Yansong Guo, Peng Wu, Giuseppe Ingarao

关键字： 汽车，复合材料，亚麻纤维，产业生态学，生命周期评估，混合定律模型

摘要：
本研究结合了通用的混合定律（Rule of mixtures, ROM）模型和 Ashby 材料选择方法，用于亚麻纤维增强聚合物（FRP）和玻璃纤维增强聚合物（GFRP）的生命周期评估（LCA）。ROM 模型可以根据亚麻 FRP 的特定参数（例如纤维规格、体积分数、制造技术和承重能力）进行生命周期环境影响预测。在这项研究中进行的比较是在两种常见的复合结构上进行的：垫板和具有相同刚度和强度作为设计标准的注模支撑。一方面，参数 LCA 预测，亚麻 FRP 的强度设计标准相同，会导致质量持续增加，从而与参考 GFRP 相比，对生命周期的环境影响更大；另一方面，在等刚度标准下，相对于玻璃毡-PP 复合材料，亚麻毡聚丙烯（亚麻毡-PP）薄膜有助于减少质量，从而使生命周期内的大部分环境影响类别降低了 20-50％。纤维体积分数对亚麻 FRP 的影响的后续评估显示了不同的模式。对于短亚麻纤维-PP 复合材料，随着纤维体积分数的增加，可以观察到生命周期 CO2 排放量的稳定下降。但是，对于亚麻毡-PP 复合材料，取决于亚麻纤维的拉伸模量，纤维的最佳体积分数从 28％v / v 变为 32％ v / v，从而可以实现最低的生命周期温室气体（GHG）排放。

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Optimal design of flax fibre reinforced polymer composite as a lightweight component for automobile from a life cycle assessment perspective

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Keywords: automotive, composite, flax fiber, industrial ecology, life cycle assessment, rule-of-mixture model

Summary:
The present study combines the generalized rule-of-mixture (ROM) model and the Ashby material selection method for the life cycle assessment (LCA) of flax fiber reinforced polymers (FRPs) and glass FRPs (GFRPs). The ROM model allows life cycle environmental impact predictions according to specific parameters of flax FRPs such as fiber format, volume fraction, manufacturing technique, and load-bearing capacity. The comparisons applied in this study are constructed on two common composite structures: mat panels and injection molded struts with equal stiffness and strength as the design criteria. On the one hand, the parametric LCA predicts that the equal strength design criterion for flax FRPs contributes to consistent mass increases, subsequently resulting in higher life cycle environmental impacts compared to the reference GFRPs; on the other hand, under the equal stiffness criterion the flax mat polypropylene (flax mat-PP) film helps with mass reduction in reference to the glass mat-PP composite, leading to the 20–50% life cycle environmental impact reductions for most impact categories. The subsequent evaluation of the influences of the fiber volume fraction on flax FRPs shows different patterns. For the short flax fiber-PP composite, a steady decrease of the life cycle CO2 emissions can be observed with the increasing fiber volume fraction. However, for the flax mat-PP composite, depending on the tensile modulus of the flax fiber, the optimal volume fractions of the fiber change from 28 to 32% v/v, whereby the lowest life cycle greenhouse gas (GHG) emissions can be achieved.