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翻译

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LCA 艺术：通过科学记录与视觉艺术的结合来传播产业生态学研究

作者：Matthew J. Eckelman, Michelle M. Laboy

关键字： 循环经济、消费、排放、环境教育、环境影响、总材料需求

摘要：
本文描述了一个工程与建筑领域的交叉协作课题，其目的是使用定量准确的、人类比例的逼真图像来可视化产业生态学中一些最具影响力的成果。我们的目标是运用艺术和建筑中的可视化理论和实践来解决我们领域中的主要传播问题：产业生态学研究尽管从概念上具有启发性，但在实践中仍然难以被许多人理解：模型庞大而复杂，度量深奥，结果报告的规模通常远离人的直观感受。本文将隐含流和隐含排放置于可见之处，以生活中常见的、可以与个人直观感受对应起来的图像来显示消费对环境的影响。我们还将其与世界各地的有关“消费艺术”的其他作品进行比较和讨论，以提供一定的历史背景。产业生态学预想了这样一个世界：在这个世界里，生产系统可以实时纳入社会和环境影响，人类通过我们对权衡取舍和不平等的最佳理解来制定政策，公众能够鉴别哪些行动有意义，而所有这些都以在维护环境和人类健康的同时改善所有人的生活质量为目标。有效地交流和传播研究成果对于达成针对这一愿景的政策和行动共识至关重要，我们领域在交流和传播中对艺术的同情力还未有足够的重视。

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LCAart: Communicating industrial ecology at a human scale

Matthew J. Eckelman, Michelle M. Laboy

Keywords: circular economy, consumption, emissions, environmental education, environmental impact, total material requirement (TMR)

Summary:
This Forum piece describes a collaborative project between engineering and architecture to visualize some of the most influential results from industrial ecology using human-scale, photorealistic images that are quantitatively accurate. Our goal was to apply visualization theories and practices from art and architecture to address a major communication problem in our field: though inspirational in concept, in practice much industrial ecology research is difficult to comprehend for the average person. Models are large and complex, metrics are esoteric, and results are often reported on a scale that is devoid of personal meaning. Our strategy was to place hidden flows and embodied emissions in plain sight, creating images that show the environmental implications of consumption as absurd insertions into scenes of daily life, at a scale that is relatable and personally meaningful. We also compare with and discuss other artistic efforts around the world in the oeuvre of “Consumption Art,” providing historical context. Industrial ecology envisions a world where production systems can incorporate social and environmental implications in real-time, where policy is informed by our best understanding of trade-offs and inequities, and where the public has an appreciation for what actions are meaningful, all with the goals of improving quality of life for all while safeguarding the environment and human health. Effective communication of our research is vital to build consensus for policy and action toward this vision, and one under-appreciated aspect of communication in our field is the sympathetic power of Art.

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美国钢铁行业的材料循环和自给潜力

作者：Daniel R. Cooper, Nicole A. Ryan, Kyle Syndergaard, Yongxian Zhu

关键字： 循环经济，铜污染，动态物质流分析，产业生态学，回收利用，关税

摘要：
实现美国循环经济将减少对环境的影响并增强原材料的自给自足。本文计算了一个自给自足的钢铁行业的最大回收成分（RC）和回收率（RR），并估计了用可回收废料替代当前进口的潜力，这些可回收废料目前或被填埋，或成为不被启用的库存，或用于出口（LHSE）。本文进行了美国动态物料流分析（1880–2100），以估算年度钢铁消耗量和废钢产生量。该结果与一个线性优化模型相结合，该模型在满足新消耗量的体积和成分需求的同时，将主要钢材需求降至最低。成分分析仅检查最受回收者关心的铜含量问题。

即便是最乐观的估计，也发现自给自足的回收率可能达到的最大值已经受到铜污染的约束。在没有干预的情况下，该最大回收率将在整个世纪内逐渐下降。年度消耗量与废品存量比（C2SR）将从目前的 1.4 左右下降。同时，最大回收成分升高，但随着回收率降低，稳定在 75% 以下。这凸显了循环经济条件中的冲突：消耗量与废品存量比趋于统一是回收成分高的必要条件，但导致废料污染稀释的机会减少，从而降低了回收率。要达到更高的回收成分，需要利于回收的产品设计改进，并利用废料精炼技术。2017 年，填埋、库存和出口的美国废钢总量超过了直接进口钢的数量。仅国内废钢出口的回收利用就可以取代直接钢进口的 36%，使美国的贸易赤字减少 55 亿美元。

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The potential for material circularity and independence in the U.S. steel sector

Daniel R. Cooper, Nicole A. Ryan, Kyle Syndergaard, Yongxian Zhu

Keywords: circular economy, copper contamination, dynamic material flow analysis, industrial ecology, recycling, tariffs

Summary:
Achieving a U.S. circular economy would reduce environmental impacts and increase material independence. This article calculates maximum recycled contents (RCs) and recycling rates (RRs) in an independent U.S. steel sector, and estimates the potential to displace current imports with recycled scrap that is currently destined for landfill, hibernating stocks, or export (LHSE). A U.S. dynamic material flow analysis (1880–2100) is conducted to estimate annual steel consumption and scrap generation. The results are coupled with a linear optimization model that minimizes primary steel demand while satisfying the volumetric and compositional demands of new consumption. The compositional analysis examines only copper content because it is of greatest concern to recyclers.

The best estimate is that the maximum independent RR is already constrained by copper contamination. Without interventions, this maximum RR will gradually decline throughout the century. The annual consumption to scrap availability ratio (C2SR) will decrease from around 1.4 today. Concurrently, the maximum RC rises but then plateaus below 75% as the RR falls. This highlights a conflict in the conditions for a circular economy: a C2SR approaching unity is a necessary condition for a high RC but leads to fewer opportunities for scrap contaminant dilution, which decreases the RR. Improved product design for recycling and deployment of scrap refining technologies will be needed to reach higher RCs. In 2017, the mass of U.S. scrap destined for LHSE exceeded direct steel imports. Domestic recycling of scrap exports alone could have displaced 36% of direct steel imports, reducing the U.S. deficit by $5.5 billion.

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恢复与再生：循环经济中的概念探索

作者：Piero Morseletto

关键字： 生物与技术循环、循环经济、循环经济指导原则、产业生态学、恢复和再生理念

摘要：
循环经济最公认的定义是它是一种恢复和再生型经济。尽管“恢复”和“再生”概念被广泛使用且具有重要性，但在循环经济文献中很少对其进行定义或解释。在这种情况下，本研究对这两个术语进行了批判性检视，同时为它们的未来应用和发展提供了指导。具体而言，该研究调查了概念的起源，在预期与循环经济概念有关的框架中的采用以及在循环经济文献中的含义。该审查用以支持对清晰明确的定义以及精确使用的需求。文献综述显示尽管恢复需要对循环经济的生物学/生态方面进行概念上的强化，但恢复是比再生定义的更好的概念。这项研究建议着眼于恢复生态学的方向，这是生态学研究的一个成熟分支。相反，再生是一种象征性/唤起情感的术语，除了某些农业实践以外，在循环系统中几乎没有实际应用。在新概念发展介入之前，再生似乎不适用于整个经济，因此，循环经济的指导原则可能会放弃再生。与再生不同，恢复可以被视为一项核心原则，因为它具有广泛的应用范围，可以作为循环应用的参考点。这并不排除可能需要其他概念来增强恢复的可能性.

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Restorative and regenerative: Exploring the concepts in the circular economy

Piero Morseletto

Keywords: biological and technical cycles, circular economy, circular economy guiding principles, industrial ecology, restorative and regenerative concepts

Summary:
The most recognized definition of the circular economy is that it is a restorative and regenerative economy. Despite the wide use and importance attributed to the concepts of “restoration” and “regeneration,” they are rarely defined or explained in the circular economy literature. In this context, this study critically examines the two terms, while providing guidance on their future utilization and development. Specifically, the study investigates the origin of the concepts, their adoption in frameworks that anticipated the idea of the circular economy, and their connotations in the circular economy literature. The examination supports the need for clear and distinct definitions, combined with precision in usage. From a review of the literature, restoration is a better-defined concept than regeneration, although it needs conceptual re-enforcement relative to the biological/ecological aspects of the circular economy. This study suggests looking in the direction of restoration ecology, a well-established branch of ecological research. Conversely, regeneration is a symbolic/evocative term with little practical application in the context of circular systems except in the case of certain agricultural practices. Until new conceptual developments intervene, regeneration does not seem to be applicable to the economy as a whole and because of this, might be abandoned as a guiding principle of the circular economy. Unlike regeneration, restoration can be considered a core principle because it has widespread application and can be a point of reference for circular applications. This does not preclude the possibility that other concepts may be needed to augment restoration.

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整合 PLCA 与 MRIO 数据库以提供完善的产品系统覆盖范围

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

关键字： 数据库，环境扩展投入产出分析，混合生命周期评估，基于过程的生命周期评估，软件，截断误差

摘要：
基于过程的生命周期评价（PLCA）依赖于对扩展的价值链及其与环境的交互关系的详细描述，但是主要数据的缺失限制了系统描述的完整性，并导致清单存在截断误差进而低估了影响。混合生命周期评估（HLCA）旨在结合 PLCA 与环境扩展投入产出分析（EEIO）的优势，以获得更具体、完整的系统描述。但是，当前大多数 HLCA 都是修正了针对特定案例的过程的截断误差（前景过程），然后将这些过程与非混合 PLCA 数据库中的（被截断的）通用背景过程链接。因此，需要一个混合的 PLCA-EEIO 数据库来完全解决 PLCA 的截断问题，从而获得全面的产品系统覆盖范围。本文介绍了使用 pyLCAIO 构建的此类数据库。pyLCAIO 是一种新颖的框架和开源软件，可实现整个 PLCA 和 EEIO 数据库的简化混合。我们将此框架应用于 PLCA 数据库 Ecoinvent3.5 和多区域 EEIO 数据库 EXIOBASE3。由于对这个新的混合数据库中的截断误差进行了修正，其生命周期全球变暖潜能（GWP）的中值和平均值增长了 7%和 14%。这些修正仅反映了可以以半自动化方式轻松识别和估计的截断；我们期望进一步的数据库集成可在将来带来更高级别的修正。

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Hybridization of complete PLCA and MRIO databases for a comprehensive product system coverage

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

Keywords: database, environmentally extended input output (EEIO) analysis, hybrid life-cycle assessment, process-based life cycle assessments (PLCA), software, truncation error

Summary:
Process-based Life Cycle Assessments (PLCA) rely on detailed descriptions of extensive value chains and their associated exchanges with the environment, but major data gaps limit the completeness of these system descriptions and lead to truncations in inventories and underestimations of impacts. Hybrid Life Cycle Assessments (HLCA) aim to combine the strength of PLCA and Environmentally Extended Input Output (EEIO) analysis to obtain more specific and complete system descriptions. Currently, however, most HLCAs only remediate truncation of processes that are specific to each case study (foreground processes), and these processes are then linked to (truncated) generic background processes from a non-hybridized PLCA database. A hybrid PLCA-EEIO database is therefore required to completely solve the truncation problems of PLCA and thus obtain a comprehensive product system coverage. This paper describes the construction of such a database using pyLCAIO, a novel framework and open-source software enabling the streamlined hybridization of entire PLCA and EEIO databases. We applied this framework to the PLCA database Ecoinvent3.5 and the multiregional EEIO database EXIOBASE 3. Thanks to the correction for truncation in this new hybrid database, the median and average life cycle global warming potential (GWP) of its processes increased by 7% and 14%, respectively. These corrections only reflect the truncations that could be readily identified and estimated in a semi-automated manner; and we anticipate that further database integration should lead to higher levels of correction in the future.

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南极研究站运行的环境影响

作者：Enda Crossin, Karli Verghese, Simon Lockrey, Hieu Ha , Gordon Young

关键字： 南极洲，凯西站，产业生态学，生命周期评估(LCA)，物质和能量流分析，战略

摘要：
本文对南极洲 Casey 站（凯西站）的运行进行了生命周期评估(LCA)。LCA 包括量化材料和能量流动、基本流量建模以及带来的环境影响。环境影响以与货运业务和热电联产相关的排放为主。研究采用了参与式设计方法来确定减少环境影响的备选方案，其中包括提高货运效率、降低生活区的温度设定值和安装替代能源系统。文章使用 LCA 对这些方案进行评估，根据环境指标的不同，这些方案可能减少 2%至 19.1%的环境影响。

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The environmental impacts of operating an Antarctic research station

Enda Crossin, Karli Verghese, Simon Lockrey, Hieu Ha , Gordon Young

Keywords: Antarctica, Casey Station, industrial ecology, life cycle assessment (LCA), material and energy flow analysis, strategy

Summary:
We present a life cycle assessment (LCA) of the operation of Casey Station in Antarctica. The LCA included quantifying material and energy flows, modeling of elementary flows, and subsequent environmental impacts. Environmental impacts were dominated by emissions associated with freight operations and electricity cogeneration. A participatory design approach was used to identify options to reduce environmental impacts, which included improving freight efficiency, reducing the temperature setpoint of the living quarters, and installing alternative energy systems. These options were then assessed using LCA, and have the potential to reduce environmental impacts by between 2% and 19.1%, depending on the environmental indicator.

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澳大利亚的南极基础设施减少环境影响的策略制定

作者：Simon Lockrey, Karli Verghes, Enda Crossin, Gordon Young

关键字： 南极洲，协同设计，环境管理，人类影响，产业生态学，生命周期评估

摘要：
在本文中，我们首先描述环境影响减少策略的各个方面，这些策略是与为支持澳大利亚最大的南极研究站凯西站所必需的运营而进行的生命周期评估相结合而开发的。然后，本文确定了负责澳大利亚在南极洲存在的澳大利亚南极分部的未来研究和运营改进机会。这些观点与构成澳大利亚南极司如何在南极大陆上工作的现有知识、条约、计划和政策相呼应，确保战略中的业务规划具有相关性和可操作性。文章的结尾为未来的环境管理实施提出了建议，包括提升数据收集的质量，采取战略方法，利用新的破冰方式，通过员工的参与和支持促进行为改变。

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Development of an environmental impact reduction strategy for Australia's Antarctic infrastructure

Simon Lockrey, Karli Verghese, Enda Crossin, Gordon Young

Keywords: Antarctica, codesign, environmental management, human impacts, industrial ecology, life cycle assessment

Summary:
In this article, we first describe aspects of the environmental impact reduction strategy that was developed in conjunction with a life cycle assessment undertaken for the operations necessary to support Australia's largest Antarctic research station, Casey Station. The article then identifies future research and operational improvement opportunities for the Australian Antarctic Division, who is responsible for Australia's presence in Antarctica. These insights are mapped against knowledge, treaties, plans, and policies framing how the Australian Antarctic Division operates on the southern continent, making operational planning from the strategy relevant and actionable. The article concludes by posing recommendations, for future environmental management practice, that cover making improvements to data quality collection, undertaking a strategic approach, utilizing a new ice breaker, and facilitating behavior change via engagement and active support of staff.

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如何将 LCA 与因果推断相结合：生命周期评价中刻画行动的环境后果的方法综述

作者：Joseph Palazzo, Roland Geyer, Sangwon Suh

关键字： 环境评估，环境政策，生命周期评价（LCA），方法，建模，系统扩展

摘要：
在产业生态学领域，尤其是在生命周期评价（LCA）领域，理解行动的环境后果越来越重要。然而，如何将这一想法付诸实施，尚未有共识。目前已有各种方法被提出并应用于案例研究，涵盖了归果型生命周期评估（CLCA）的多个方面。以往对该主题的综述多集中在 CLCA 的广泛议程以及不同的建模框架如何适应其目标等问题上，缺乏对方法范围及其在 CLCA 各方面应用的明确检视。本文将详细介绍已用于分析行动的环境后果的 CLCA 模型方法。我们介绍了四类结构建模方法：（a）经济均衡模型，（b）系统动力学模型，（c）技术选择模型，（d）基于主体的模型。我们详细综述了 CLCA 领域中每类模型的特定应用，讨论了每种方法的优缺点，阐明了其与 CLCA 的关系。由此，我们能够将这些模型对应到 CLCA 的既定方面。我们了解到，仅使用结构模型不足以量化 CLCA 中潜在参数的不确定性分布，来完成结果的稳健性分析的重要组成部分。为解决这一问题，我们简要介绍了在 CLCA 文献中开始出现的基于反事实因果推断的方法，用于参数识别和不确定性分析。我们建议未来的研究方向可以探讨在经验估计和结构模型间建立反馈回路。

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A review of methods for characterizing the environmental consequences of actions in life cycle assessment

Joseph Palazzo, Roland Geyer, Sangwon Suh

Keywords: environmental assessment, environmental policy, life cycle assessment (LCA), methods, modeling, system expansion

Summary:
Understanding the environmental consequences of actions is becoming increasingly important in the field of industrial ecology in general, and in life cycle assessment (LCA) more specifically. However, a consensus on how to operationalize this idea has not been reached. A variety of methods have been proposed and applied to case studies that cover various aspects of consequential life cycle assessment (CLCA). Previous reviews of the topic have focused on the broad agenda of CLCA and how different modeling frameworks fit into its goals. However, explicit examination of the spectrum of methods and their application to the different facets of CLCA are lacking. Here, we provide a detailed review of methods that have been used to construct models of the environmental consequences of actions in CLCA. First, we cover the following structural modeling approaches: (a) economic equilibrium models, (b) system dynamics models, (c) technology choice models, and (d) agent-based models. We provide a detailed review of particular applications of each model in the CLCA domain. The advantages and disadvantages of each are discussed, and their relationships with CLCA are clarified. From this, we are able to map these models onto the established aspects of CLCA. We learn that structural models alone are not sufficient to quantify the uncertainty distributions of underlying parameters in CLCA, which are essential components of a robust analysis of consequences. To address this, we provide a brief introduction to a counterfactual-based causal inference approach to parameter identification and uncertainty analysis that is emerging in the CLCA literature. We recommend that one potential research path forward is the establishment of feedback loops between empirical estimates and structural models.

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全球粮食系统中的能源使用

作者：Arkaitz Usubiaga-Liaño, Paul Behrens, Vassilis Daioglou

关键字： 能源足迹，能源使用，食品系统，产业生态学，投入产出分析

摘要：
全球粮食系统是主要的能源使用系统，也是引起气候变化的重要原因。迄今为止，有关粮食系统能源状况的文献仅针对单个国家和/或粮食产品，因此仍缺乏跨地区的可比评估。本文使用了一个全球性的多区域环境扩展投入产出数据库，并结合了新建立的净能源使用账户，提供基于生产和消费的不同世界区域 2000–2015 年期间粮食系统能源使用的库存量。总体而言，粮食系统能源消耗与整体经济之间的比率正在缓慢下降。同样，粮食生产与能源使用、世界各地能源类型、使用者和消费方式相关差异的绝对值相对脱钩。利用(效率低的)传统生物质烹饪大减少了高收入国家和低收入国家人均能源使用之间的预期差距。能源多样性和与地区总体经济相比暴露程度更高的能源安全问题表明该系统的干预措施应考虑地理环境。减少能源使用和食品供应链的脱碳需要结合技术措施和消费模式的改变。改变粮食系统的生产和消费方式会产生社会和环境方面的积极效应，因此干预措施应考虑对能源使用的直接影响以外的影响。

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Energy use in the global food system

Arkaitz Usubiaga-Liaño, Paul Behrens, Vassilis Daioglou

Keywords: energy footprint, energy use, food system, industrial ecology, input–output analysis

Summary:
The global food system is a major energy user and a relevant contributor to climate change. To date, the literature on the energy profile of food systems addresses individual countries and/or food products, and therefore a comparable assessment across regions is still missing. This paper uses a global multi-regional environmentally extended input–output database in combination with newly constructed net energy-use accounts to provide a production and consumption-based stock-take of energy use in the food system across different world regions for the period 2000–2015. Overall, the ratio between energy use in the food system and the economy is slowly decreasing. Likewise, the absolute values point toward a relative decoupling between energy use and food production, as well as to relevant differences in energy types, users, and consumption patterns across world regions. The use of (inefficient) traditional biomass for cooking substantially reduces the expected gap between per capita figures in high- and low-income countries. The variety of energy profiles and the higher exposure to energy security issues compared to the total economy in some regions suggests that interventions in the system should consider the geographical context. Reducing energy use and decarbonizing the supply chains of food products will require a combination of technological measures and behavioral changes in consumption patterns. Interventions should consider the effects beyond the direct effects on energy use, because changing production and consumption patterns in the food system can lead to positive spillovers in the social and environmental dimensions outlined in the Sustainable Development Goals.

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从多环境影响角度比较美国和印度城市食品系统的特征和行动：迈向简化方法

作者：Dana Boyer, Anu Ramaswami

关键字： 环境足迹，食品行动计划，食物-能量-水联系，产业生态学，可持续城市系统，城市食品系统

摘要：
全球许多城市的食品行动计划都订立了多个目标，包括减少对环境和跨界环境的影响（水、土地、温室气体）。但是，几乎没有标准化的分析工具来比较城市和国家之间的粮食系统特征和行动，以评估多个目标（即健康、公平）与环境结果之间的权衡取舍。本文演示了一种简化的模型，该模型用于分析美国和印度四个具有不同特征的城市，以量化与多种食品系统行动相关的水、能源、温室气体和土地影响，解决健康、公平和环境问题。本文通过分析基本饮食发现，各国在肉食（德里 4 公斤/人/年；本地治里 16 公斤/人/年；美国 59 公斤/人/年）和平均饮食对环境的影响方面存在主要差异（占全社区温室气体排放量比重：纽约 21％；明尼阿波利斯 19％；德里<1％；本地治里<1％）。分析食品供应链发现城市的平均距离有所不同（德里 420；本地治里 200；美国平均 1640 千米/吨-食品）。印度粮食需求的温室气体排放对灌溉强度的空间变异性的敏感性高于美国城市。分析还发现，与美国相比，印度的消费前的食物浪费比消费后更大。尽管在食物系统特征上存在这些差异，但食物垃圾管理和饮食变化始终是关键策略。在饮食方案中，并不是所有的素食都对环境有益，美国政府建议的素食与其他针对性更强的饮食改变相比，带来的益处要小。

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Comparing urban food system characteristics and actions in US and Indian cities from a multi-environmental impact perspective: Toward a streamlined approach

Dana Boyer, Anu Ramaswami

Keywords: environmental footprinting, food action planning, food-energy-water nexus, industrial ecology, sustainable urban systems, urban food systems

Summary:
Food action plans in many global cities articulate interest in multiple objectives including reducing in- and trans-boundary environmental impacts (water, land, greenhouse gas (GHG)). However, there exist few standardized analytical tools to compare food system characteristics and actions across cities and countries to assess trade-offs between multiple objectives (i.e., health, equity) with environmental outcomes. This paper demonstrates a streamlined model applied for analysis of four cities with varying characteristics across the United States and India, to quantify system-wide water, energy/GHG, and land impacts associated with multiple food system actions to address health, equity, and environment. Baseline diet analysis finds key differences between countries in terms of meat consumption (Delhi 4; Pondicherry 16; United States 59, kg/capita/year), and environmental impact of processing of the average diet (21%, 19%, <1%, <1% of community-wide GHG-emissions for New York, Minneapolis, Delhi, and Pondicherry). Analysis of supply chains finds city average distance (food-miles) varies (Delhi 420; Pondicherry 200; United States average 1,640 km/t-food) and the sensitivity of GHG emissions of food demand to spatial variability of energy intensity of irrigation is greater in Indian than US cities. Analysis also finds greater pre-consumer waste in India versus larger post-consumer accumulations in the United States. Despite these differences in food system characteristics, food waste management and diet change consistently emerge as key strategies. Among diet scenarios, all vegetarian diets are not found equal in terms of environmental benefit, with the US Government's recommended vegetarian diet resulting in less benefit than other more focused targeted diet changes.

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空间视角强化关于纳米材料风险的建模

作者： Elizabeth A. Moore, Callie W. Babbitt, Brian Tomaszewski, Anna Christina Tyler

关键字： 新兴材料，地理空间建模，产业生态学，物质流，纳米材料，风险评估

摘要：
新型工程纳米材料（ENM）越来越多地被制造并集成到可再生能源发电和存储技术中。由于 ENM 生产的生命周期影响以及它们直接释放到生态系统中的潜力，过去的研究估计了这种需求增加对环境系统的潜在影响。但是，许多模型都将 ENM 的生产和使用视为默认位置，而没有考虑潜在排放物的特定地理位置。如果不考虑地理环境，可能会低估 ENM 的积累或影响。在这里，我们引入一个综合预测模型，该模型预测可能的 ENM 制造地点和潜在的环境排放，重点关注关键的环境领域和淡水生态系统。文章对四个在锂离子电池生产中有应用前景的 ENM 进行了空间显式浓度估算。结果表明，在高释放情景下，敏感生态系统缓冲区内制造地点的潜在 ENM 暴露量将累积到与测得的生态毒性风险相关的水平，从而强调了在生命周期毒性影响评估中增加时空视角的重要性。这种预测性集成建模方法对于纳米材料文献而言是新颖的，可以应用于其他地区和材料案例研究，以主动作出生命周期的权衡和决策。

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Spatial perspectives enhance modeling of nanomaterial risks

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Keywords: emerging materials, geospatial modeling, industrial ecology, material flows, nanomaterials, risk assessment

Summary:
Novel engineered nanomaterials (ENMs) are increasingly being manufactured and integrated into renewable energy generation and storage technologies. Past research estimated the potential impact of this increased demand on environmental systems, due to both the life cycle impact of ENM production and the potential for their direct release into ecosystems. However, many models treat ENM production and use as spatially implicit, without considering the specific geographic location of potential emissions. By not considering geographical context, ENM accumulation or impact may be underestimated. Here, we introduce an integrated predictive model that forecasts likely ENM manufacturing locations and potential emissions to the environment, with a focus on critical environmental areas and freshwater ecosystems. Spatially explicit ENM concentrations are estimated for four case study ENMs that have promising application in lithium-ion battery production. Results demonstrate that potential ENM exposure from manufacturing locations within buffer zones of sensitive ecosystems would accumulate to levels associated with measured ecotoxicity risk under high release scenarios, underscoring the importance of adding a spatial and temporal perspective to life cycle toxicity impact assessment. This predictive integrated modeling approach is novel to the nanomaterial literature and can be adapted to other regions and material case studies to proactively inform life cycle tradeoffs and decision-making.

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食品行业中木质和塑料托盘的生命周期评估比较

作者： Sebastian K. Anil, Junfeng Ma, Gül E. Kremer, Charles David Ray, Shirin M. Shahidi

关键字： 碳排放、碳足迹、产业生态学、生命周期评估、托盘、植物检疫处理

摘要：
在全球贸易中，木质托盘和塑料托盘广泛用于运输成品和产品。本文通过生命周期评估(LCA)比较了经处理的木质和塑料托盘的生命周期性能，并对各种植物检疫处理进行了分析。生命周期评价调查和评估产品在其整个生命周期中因资源消耗和排放而产生的环境影响。托盘对环境的影响以一次运输和十万次运输为基础进行比较。根据环境问题选择影响类别。结果表明，在一次运输的生命周期基础中，采用常规热处理和射频热处理木质托盘总的碳足迹，分别比塑料托盘总的碳足迹低 71.8%和 80.3%。与甲基溴熏蒸处理的木质托盘相比，它们总碳足迹减少了 20%和 30%。托盘射频热处理的资源消耗和排放的理论计算表明，介电技术可以为当前 ISPM 15 批准的处理和塑料托盘提供较低的碳替代物。甲基溴熏蒸托盘(15.95 kg CO2 当量)比常规热处理托盘(12.69 千克 CO2 当量)具有更大的碳足迹。对于十万次运输基线来说，差异更为显著。结果表明，木质托盘比塑料托盘更环保，木质托盘的常规热处理和射频热处理比溴甲烷熏蒸处理具有更高的可持续性。

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Life cycle assessment comparison of wooden and plastic pallets in the grocery industry

Sebastian K. Anil, Junfeng Ma, Gül E. Kremer, Charles David Ray, Shirin M. Shahidi

Keywords: carbon emissions, carbon footprint, industrial ecology, life cycle assessment (LCA), pallet, phytosanitary treatment (PT)

Summary:
Wooden and plastic pallets are used extensively in global trade to transport finished goods and products. This article compares the life cycle performance of treated wooden and plastic pallets through a detailed cradle-to-grave life cycle assessment (LCA), and conducts an analysis of the various phytosanitary treatments. The LCA investigates and evaluates the environmental impacts due to the resources consumed and emissions of the product throughout its life cycle. The environmental impacts of the pallets are compared on a one-trip basis and a 100,000-trips basis. Impact categories are chosen with respect to environmental concerns. The results show that on a one-trip basis, wooden pallets with conventional and radio frequency (RF) heat treatment incur an overall carbon footprint of 71.8% and 80.3% lower, respectively, than plastic pallets during their life cycle; and in comparison with wooden pallets treated with methyl bromide fumigation, they incur 20% and 30% less overall carbon footprint. Theoretical calculations of the resource consumption and emissions of RF treatment of pallets suggest that dielectric technology may provide a lower-carbon alternative to both current ISPM 15-approved treatments and to plastic pallets. Methyl bromide fumigation (15.95 kg CO2 equivalent [eq.]) has a larger carbon footprint than conventional heat treatment (12.69 kg CO2 eq.) of pallets. For the 100,000-trips basis, the differences are even more significant. The results recommend that wooden pallets are more environmentally friendly than plastic pallets, and conventional and RF heat treatment for wooden pallets is more sustainable than methyl bromide fumigation treatment.

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第一次和第二次工业革命中的隐含能源

作者：Christopher Kennedy

关键字： 资本形成，煤炭，经济增长，产业生态学，投入产出分析，英国

摘要：
了解经济体隐含能源的性质对于评估其可持续增长或转型的潜力至关重要。作为第一个进行工业化的国家，对工业革命期间的英国的研究对于理解转型过程尤为重要。历史记载描述了英国煤炭储量的开采是如何支持钢铁生产、铁路和其他行业发展的。然而，对英国 18/19 世纪经济的重建发现，煤炭开采对经济增长的贡献相对较小。文中使用了 1841 年和 1907 年的经济投入产出模型来计算隐含在资本投资、消费和出口中的煤炭。1841 年，大部分煤炭隐含在消费中，到 1907 年，出口的隐含煤炭增长十分迅速。资本所隐含的煤炭规模较小，但投资的能源强度约为消费能源强度的 4 倍。建设资本存量所隐含的煤炭，大部分用于生产钢铁和砖块等材料，对经济增长和转型具有重要意义。根据历史数据估计，在 1760 年至 1913 年间约有 11 亿吨煤炭（34,000 PJ）被用于建设英国的资本资产。本文开发的概念模型有助于解释能源在经济增长中的作用，增进对当代可持续发展的认识。

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The energy embodied in the first and second industrial revolutions

Christopher Kennedy

Keywords: capital formation, coal, economic growth, industrial ecology, input-output analysis, United Kingdom

Summary:
Understanding the nature of energy embodied in economies is essential to assessing their potential to grow or transform sustainably. As the first country to undergo industrialization, study of the United Kingdom during the Industrial Revolution is particularly important for understanding transformational processes. Historical accounts describe how exploitation of Britain's coal reserves supported the evolution of steel production, railways, and other industries; yet reconstructions of the UK's eighteenth/nineteenth century economy have found relatively small contributions from coal mining to economic growth. Here, economic input-output models for 1841 and 1907 are used to calculate the coal embodied in capital investment, consumption, and exports. Most of the coal was embodied in consumption in 1841, with coal embodied in exports growing particularly fast by 1907. The coal embodied in capital was smaller, but the energy intensity of investment was about four times larger than the energy intensity of consumption. The coal embodied in building the capital stock, much of it used for production of materials such as iron, steel, and bricks, was important for economic growth and transformation. Using historical proxy data, it is estimated that ~1.1 billion imperial tons of coal (34,000 PJ) were used to build the UK's capital assets between 1760 and 1913. The conceptual model developed here helps to explain the role of energy in economic growth and is important to contemporary sustainable development. This article met the requirements for a gold – gold JIE data openness badge described at http://jie.click/badges.

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芬兰木材使用行业的结构变迁对净碳排放量的影响

作者： Elias Hurmekoski, Tanja Myllyviita, Jyri Seppälä, Tero Heinonen, Antti Kilpeläinen, Timo Pukkala, Tuomas Mattila, Lauri Hetemäki, Antti Asikainen, Heli Peltola

关键字： 生物经济学，碳排放，林产品，产业生态学，国家森林清单，替代

摘要：
森林及林业可以通过从大气中封存碳（即将其存储在生物质中），并制造可替代温室气体排放密集型材料和能源的产品，为缓解气候变化做出贡献。本研究旨在为实现木材产品市场的多样化寻找替代方案，并确定日益多样化的市场结构如何影响芬兰林业的净碳排放量。通过使用森林管理模拟和优化模型（主要针对森林和土壤）以及分离模型（针对森林产品的碳存储和替代效应），本文分析了 2016-2056 年间芬兰林业部门的净碳排放量。芬兰森林每年封存的碳约 70 兆 m3，接近 2016 年工业和能源所需圆木的采伐量。结果表明，若以 2016 年的市场结构为参考情景，替代效益将达到 9.6 Mt C（35.2 MtCO2 当量）。若通过更改市场结构，效益将进一步增加 7.1 Mt C（26 Mt CO2 当量）。本研究的另一项关键产出，即与增加原木采伐量相比，增加副产品在纺织品和木塑复合材料中的使用，替代原来所应用的牛皮纸浆和生物燃料，总替代效益会更高。

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Impact of structural changes in wood-using industries on net carbon emissions in Finland

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Keywords: bioeconomics, carbon emissions, forest products, industrial ecology, national forest inventory, substitution

Summary:
Forests and forest industries can contribute to climate change mitigation by sequestering carbon from the atmosphere, by storing it in biomass, and by fabricating products that substitute more greenhouse gas emission intensive materials and energy. The objectives of the study are to specify alternative scenarios for the diversification of wood product markets and to determine how an increasingly diversified market structure could impact the net carbon emissions (NCEs) of forestry in Finland. The NCEs of the Finnish forest sector were modelled for the period 2016–2056 by using a forest management simulation and optimization model for the standing forests and soil and separate models for product carbon storage and substitution impacts. The annual harvest was fixed at approximately 70 Mm3, which was close to the level of roundwood removals for industry and energy in 2016. The results show that the substitution benefits for a reference scenario with the 2016 market structure account for 9.6 Mt C (35.2 Mt CO2 equivalent [CO2 eq]) in 2056, which could be further increased by 7.1 Mt C (26 Mt CO2 eq) by altering the market structure. As a key outcome, increasing the use of by-products for textiles and wood–plastic composites in place of kraft pulp and biofuel implies greater overall substitution credits compared to increasing the level of log harvest for construction.

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污水处理厂侧流去除和氮回收的生命周期评估

作者： Rosalie van Zelm, Raquel de Paiva Seroa da Motta, Wan Yee Lam, Wilbert Menkveld, Eddie Broeders

关键字： 分配、氨、硫酸铵、循环经济、肥料、养分回收

摘要：
本研究从循环经济的角度所开发的 Nijhuis 氨回收系统（AECO-NAR）不仅可以去除废水中的氮，还可以生产硫酸铵（AS），其中硫酸铵可以用作植物的肥料。本文的目的是通过 Nijhuis 氨回收系统量化侧流氨回收对环境的影响，并将其与侧流脱氮结合 SHARON（部分硝化）-厌氧氨氮装置的影响进行比较。为此，研究使用处理 1 kg 总溶解氮流入量为功能单元(FU)进行生命周期环境影响评估。由于 Nijhuis 氨回收系统获得的是氨气去除过程的副产品，因此分配基于系统扩展。前景库存数据是从大型工厂获得的。ReCiPe2016 评价方法用于确定对人类健康和生物多样性的影响。结果表明，由于在集成的水处理和生产系统中生产硫酸铵，因此 Nijhuis 氨回收系统避免了硫酸铵生产的影响，从而导致负的环境影响评分。随着氨的流入浓度增加，功能单元的环境影响降低。主要的改进方案是使用可再生能源和用一种可持续的替代品替代清洁化学品柠檬酸。由于生产硫酸铵肥料产品，Nijhuis 氨回收系统与生物 SHARON 厌氧氨氧化系统相比，总影响更小。又由于化肥生产步骤被整合到侧流处理中，整个系统比单独的氨回收和废水处理系统更有利。

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Life cycle assessment of side stream removal and recovery of nitrogen from wastewater treatment plants

Rosalie van Zelm, Raquel de Paiva Seroa da Motta, Wan Yee Lam, Wilbert Menkveld, Eddie Broeders

Keywords: allocation, ammonia, ammonium sulfate, circular economy, fertilizer, nutrient recovery

Summary:
In the light of a circular economy, the Nijhuis Ammonia Recovery system (AECO-NAR) was developed to not only remove nitrogen from wastewater streams, but also produce ammonium sulfate (AS), used as fertilizer, in a single plant. The goal of this paper was to quantify the environmental impacts of side stream ammonia recovery with the AECO-NAR system and compares them with the impacts of side stream nitrogen removal combined SHARON (partly nitrification)-anammox plant. For this, an environmental life cycle assessment was performed with a functional unit (FU) of the treatment of 1 kg of total dissolved nitrogen inflow. Since AS obtained by the AECO-NAR is a by-product of the ammonia removal process, allocation was based on system expansion. Foreground inventory data were obtained from a full-scale plant. ReCiPe2016 was used to determine human health and biodiversity impacts. Results show that due to the production of AS in an integrated water treatment and production system, the AECO-NAR avoids impacts of current AS production, leading to negative impact scores. Impacts per FU decrease with increasing inflow concentrations of ammonia. Main improvement options are the use of renewable energy and the replacement of the cleaning chemical citric acid with a sustainable alternative. Total impacts of the AECO-NAR system diminish when comparing the system to the biological SHARON-Anammox system, due to production of AS fertilizer product. Due to the fertilizer production step being integrated in the side stream treatment, the complete system is beneficial over ammonia recovery and wastewater treatment as separate systems.

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中国水泥行业的二氧化碳排放——来自供需双方的分析

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关键字： 水泥部门，CO2减排，需求侧，产业生态学，供给侧

摘要：
中国是世界上最大的水泥生产国和消费国，水泥生产会释放大量二氧化碳(CO2) 。由于水泥部门是中国经济的一个关键部门，了解供求因素的作用可能有助于加快 CO2 减排。然而，很少有研究基于供需双方的综合视角来分析影响该部门 CO2 排放的关键因素。
在这项研究中，我们制定了一个综合框架，其中包括 11 个指标，涵盖供需双方。结果表明，改进水泥生产技术不能抵消水泥需求增长所产生的二氧化碳排放。尽管改进水泥供应方面的技术将大大减少中国水泥生产中的 CO2 排放；然而，在快速的城市化、GDP 增长和需求侧超高固定资本形成比率的共同拉动下，1990 年至 2015 年的 CO2 排放量增加了近 25 倍。值得注意的是，一些需求方面的因素也有减少 CO2 排放量的作用。固定资本形成单位的使用存量和单位使用存量的产出减少了 3.32 亿吨的 CO2 排放量，这与技术进步的贡献相当。基于这些结果，我们研究了为什么这些需求侧因素会对中国水泥行业的 CO2 排放产生重大影响，并为政策制定者提供了关于这个 CO2 密集部门的碳减排建议。

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CO2 emissions from the Chinese cement sector: Analysis from both the supply and demand sides

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Keywords: cement sector, CO2 emission mitigation, demand side, industrial ecology, supply side

Summary:
China is the largest producer and consumer of cement worldwide, and cement production entails the release of substantial carbon dioxide (CO2) emissions. As the cement sector is a crucial sector of the Chinese economy, understanding the role of supply- and demand-side factors may help accelerate efforts to mitigate CO2 emissions. However, few studies have analyzed the critical factors affecting CO2 emissions in the sector based on a combined supply- and demand-side perspective. In this study, we developed an integrated framework that included eleven indicators covering both the supply and demand sides. Results revealed that improving cement production technology cannot offset CO2 emissions from the growth in demand for cement. Improving technology on the supply side would considerably reduce CO2 emissions from Chinese cement production; nevertheless, the combination of rapid urbanization, GDP growth, and an ultra-high fixed capital formation ratio on the demand side increased CO2 emissions nearly 25-fold from 1990 to 2015. Notably, some demand-side factors also had an effect that reduced CO2 emissions. The in-use stock per unit of fixed capital formation and output per in-use stock reduced CO2 emissions by 332 million metric tons, which is comparable to the contribution of technological progress. Based on these results, we examine why these demand-side factors substantially influence CO2 emissions in the Chinese cement sector, and we provide recommendations for policy-makers on carbon-reduction measures in this CO2-intensive sector.