


[Log In](#) [Register](#) [Cart](#)
[ACS](#) [ACS Publications](#) [C&EN](#) [CAS](#)

[Home](#) | [ACS Journals](#) | [ACS Books](#) | [ACS Style Guide](#) | [C&EN Archives](#) | [Subscribe](#) | [Help](#)


 Environ. Sci. Technol. All Publications/Website

Article

Thermodynamic Accounting of Ecosystem Contribution to Economic Sectors with Application to 1992 U.S. Economy

Nandan U. Ukidwe and Bhavik R. Bakshi *

Department of Chemical Engineering, The Ohio State University, Columbus, Ohio 43210

Environ. Sci. Technol., 2004, 38 (18), pp 4810-4827

DOI: 10.1021/es035367t

Publication Date (Web): August 17, 2004

Copyright © 2004 American Chemical Society

ACS Section: [Air Pollution and Industrial Hygiene](#)
[Hi-Res PDF](#) [446 KB]

[PDF w/ Links](#) [518 KB]

[Full Text HTML](#)

[Supporting Info ->](#)
[Figures](#)
[Reference QuickView](#)
[Citing Articles](#)

Your current credentials do not allow retrieval of the full text.

Purchase the full-text

- PDF/HTML, figures/images, references and tables, (where available)



Abstract

Incorporation of ecological considerations in decision-making is essential for sustainable development, but is hindered by inadequate appreciation of the role of ecosystems, and lack of scientifically rigorous techniques for including their contribution. This paper develops a novel thermodynamic accounting framework for including the contribution of natural capital via thermodynamic input-output analysis. This framework is applied to the 1992 US economy comprising 91 industry sectors, resulting in delineation of the myriad ways in which sectors of the US economy rely on ecosystem products and services. The contribution of ecosystems is represented via the concept of ecological cumulative exergy consumption (ECEC), which is related to emergy analysis but avoids any of its controversial assumptions and claims. The use of thermodynamics permits representation of all kinds of inputs and outputs in consistent units, facilitating the definition of aggregate metrics. Total ECEC requirement indicates the extent to which each economic sector relies directly and indirectly on ecological inputs. The ECEC/money ratio indicates the relative monetary versus ecological throughputs in each sector, and indicates the relationship between the thermodynamic work needed to produce a product or service and the corresponding economic activity. This ratio is found to decrease along economic supply chains, indicating industries that are higher up in the economic food chain price ecosystem contribution more than the basic infrastructure industries such as mining and manufacturing. The ratio of CEC with and without inclusion of ecosystems indicates the extent to which conventional thermo-economic analysis underestimates the contribution of ecosystems. Such ratios, made available for the first time, provide unique

Tools

- [Add to Favorites](#)
- [Download Citation](#)
- [Email a Colleague](#)
- [Permalink](#)
- [Order Reprints](#)
- [Rights & Permissions](#)
- [Citation Alerts](#)

SciFinder Links

- [Get Reference Detail](#)
- [Get Cited](#)
- [Get Citing](#)

Explore by:

- Author of this Article
- Any Author
- Research Topic
(Now with patent search)

Ukidwe, Nandan U.

History

Published In Issue
September 15, 2004

Received for review
December 6, 2003
Revised manuscript received
May 27, 2004
Accepted June 19, 2004

Recommend & Share

- [ACS Network](#)
- [Facebook](#)
- [Tweet This](#)
- [CiteULike](#)
- [Newsvine](#)
- [Digg This](#)
- [Delicious](#)

Related Content

Thermodynamic Metrics for Aggregation of Natural Resources in Life Cycle Analysis: Insight via Application to Some Transportation Fuels
Environmental Science & Technology

Other ACS content by these authors:

Nandan U. Ukidwe
Bhavik R. Bakshi

insight into the importance of natural capital, and are especially useful in hybrid thermodynamic life cycle analysis of industrial systems. The approach, data compiled in this work, and the resulting insight provide a more ecologically conscious tool for environmental decision-making, and has potential applications at micro as well as macro scales.

View: [Full Text HTML](#) | [Hi-Res PDF](#) | [PDF w/ Links](#)

Citing Articles

[View all 25 citing articles](#)

Citation data is made available by participants in [CrossRef's](#) Cited-by Linking service. For a more comprehensive list of citations to this article, users are encouraged to perform a search in [SciFinder](#).

This article has been cited by 3 ACS Journal articles (3 most recent appear below).



Improvements to Energy Evaluations by Using Life Cycle Assessment

Benedetto Rugani and Enrico Benetto

Environmental Science & Technology

2012 46 (9), 4701-4712



Solar Energy Demand (SED) of Commodity Life Cycles

Benedetto Rugani, Mark A. J. Huijbregts, Christopher Mutel, Simone Bastianoni, and Stefanie Hellweg

Environmental Science & Technology

2011 45 (12), 5426-5433



Flow of Natural versus Economic Capital in Industrial Supply Networks and Its Implications to Sustainability

Nandan U. Ukidwe and Bhavik R. Bakshi

Environmental Science & Technology

2005 39 (24), 9759-9769



1155 Sixteenth Street N.W.
Washington, DC 20036

Products

Journals A-Z

Books

C&EN

C&EN Archives

ACS Legacy Archives

ACS Mobile

Video

User Resources

About Us

ACS Members

Librarians

Authors & Reviewers

Website Demos

Support

Get Help

For Advertisers

Institutional Sales

[Live Chat](#)

Partners

Search ACS Publications

Search Anywhere

[Search](#)