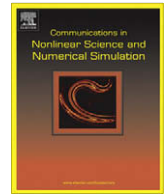




ELSEVIER

Contents lists available at ScienceDirect

## Commun Nonlinear Sci Numer Simulat

journal homepage: [www.elsevier.com/locate/cnsns](http://www.elsevier.com/locate/cnsns)

# Resources use and greenhouse gas emissions in urban economy: Ecological input–output modeling for Beijing 2002

S.Y. Zhou<sup>a</sup>, H. Chen<sup>a,\*</sup>, S.C. Li<sup>b,\*</sup>

<sup>a</sup> State Key Laboratory of Turbulence and Complex Systems, Department of Mechanics and Aerospace, College of Engineering, Peking University, Beijing 100871, PR China

<sup>b</sup> College of Urban and Environmental Sciences, Peking University, Beijing 100871, PR China

## ARTICLE INFO

## Article history:

Received 12 October 2009

Received in revised form 17 November 2009

Accepted 23 November 2009

Available online 27 November 2009

## Keywords:

Energy

Carbon emission

Water resources

Natural resources

Input–output analysis

Urban economy

## ABSTRACT

The embodiment of natural resources and greenhouse gas emissions for the urban economy of Beijing economy 2002 by a physical balance modeling is carried out based on an extension of the economic input–output table into an ecological one integrating the economy with its various environmental driving forces. Included resources and greenhouse gas emissions belong to six categories as energy resources in terms of primary energy and secondary energy; water resource; emissions of CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O; exergy in terms of energy sources, biological resources and minerals; and solar energy and cosmic energy in terms of climate resources, soil, energy sources, and minerals.

© 2009 Elsevier B.V. All rights reserved.

## 1. Introduction

Though various efforts have been made to account natural resources consumption and environmental emissions at the urban scale [1–22], relevant decision making necessitates more systematic analysis of the urban economy in context of environmental resources in general and global climate change in particular, for which the ecological input–output modeling [23,24] could be most helpful.

During the last decades, based on the economic input–output table there have been many researches on the economic embodiment of various natural resources and environmental emissions, such as energy sources [25–41], water resource [11,42–47], greenhouse gas emission [38,48–55], land [56–64], pollutants [23,24,65,66], exergy [23,24], solar and cosmic energy [23,24].

Based on ecological input–output modeling, a systematic account of the embodied resources and emissions for the Chinese economy under the Material Product System (MPS) in 1992 and under the System of National Accounts (SNA) in 2002 has been presented by Zhou [23]. For the embodiment of natural resources and environmental emissions in Chinese economy in the most recent year of 2005 with national statistics availability has been carried out by Chen et al. [24] based on an extension of the economic input–output table into an ecological one integrating the economy with its various environmental resource driving forces. Included resource flows into the primary resource sectors and environmental emission flows from the primary emission sectors belong to seven categories as energy, water, greenhouse gas, industrial wastes, exergy, solar energy, and cosmic energy, along with their main components or sub-indicators.

\* Corresponding authors. Tel.: +86 10 62767167; fax: +86 10 62754280 (H. Chen); Tel.: +86 10 62767428; fax: +86 10 62751187 (S.C. Li).  
E-mail addresses: [huichen@pku.edu.cn](mailto:huichen@pku.edu.cn) (H. Chen), [scli@urban.pku.edu.cn](mailto:scli@urban.pku.edu.cn) (S.C. Li).

Based on the recent ecological input–output modeling framework [24], resources use and environmental emissions by Beijing economy 2002 with most recent availability of the formal economic input–output table is presented in this paper by an extension of the economic input–output table into an ecological one, integrating the economy with its various environmental driving forces to reflect direct resources use and greenhouse gas emissions by industrial sectors, and by a physical balance simulation based on the ecological table to describe the sectoral embodiment (direct plus indirect endowment) of resources use and greenhouse gas emissions. Counted greenhouse gas emissions include CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O, and resources belong to five categories as energy sources; water resource; exergy in terms of fossil fuel resources, biological resources and mineral resources; solar energy and cosmic energy in terms of climate resources, soil, fossil fuels, and minerals.

## 2. Methodology

### 2.1. Ecological input–output table

Beijing Input–Output Table 2002 issued by Beijing Statistics Bureau is adopted to reflect the system structure and industrial interaction of the Beijing economy. Entries in the table are valued in the producers' prices with the unit of 10<sup>4</sup> Yuan. Listed in Table 1 are the 41 formal industrial sectors based on Beijing Input–Output Table, with original Sector 2 and Sector 3 incorporated into the new Sector 2 for numerical reasons as explained below.

With reference to Zhou [23] and Chen et al. [24], an ecological input–output table for the urban economy is built to integrate the economy and its physical driving forces as energy resources and environmental emissions as listed in Table 2. Likewise,  $Q_1$ ,  $Q_2$ , and  $Q_3$  from the monetary balance represent inter-industrial flows, final use from industries, and net economic inputs to industries, while the extended parts of  $Q_0$  and  $Q_0'$  represent the direct entrance of external environmental inputs with separate biophysical indicators (in raw units) and aggregate biophysical indicators (in unified ecological measures).

**Table 1**  
Formal industrial sectors included in the Beijing Input–Output Table 2002.

Sector code	Sector content
1	Agriculture, forestry, animal husbandry and fishery
2	Mining of coal, petroleum and natural gas
3	Metal ore mining
4	Non-metal minerals mining
5	Manufacture of food products and tobacco processing
6	Textiles
7	Wearing apparel, leather, fur, down and related products
8	Sawmills and furniture
9	Paper and products, printing and record medium reproduction
10	Petroleum processing, coking and nuclear fuel processing
11	Chemicals
12	Nonmetallic mineral products
13	Metal smelting and pressing
14	Metal products
15	General and special purpose machinery
16	Transport equipment
17	Electric equipment and machinery
18	Electronic and telecommunication equipment
19	Instruments, meters, cultural and office machinery
20	Other manufacturing products
21	Scrap and waste
22	Electricity, steam and hot water production and supply
23	Gas production and supply
24	Water production and supply
25	Construction
26	Transport and storage
27	Post services
28	Telecommunication, computer services and software
29	Wholesale and retail trade services
30	Accommodation and food serving services
31	Finance and insurance
32	Real estate
33	Rental and business services
34	Travel agency, tour operator and tourist guide services
35	Scientific research
36	Professional, scientific and technical services
37	Other social services
38	Educational services
39	Health, social security and welfare
40	Cultural, sporting and recreational services
41	Public administration and other sectors

متن کامل مقاله

دریافت فوری ←

**ISI**Articles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات