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Comparison of sustainability issues in two sensitive areas of China

Lin Zhen [a,*], *Shuyan Cao* [b], *Yunjie Wei* [a,c], *Oliver Dilly* [d], *Xuelin Liu* [a,c], *Fen Li* [a], *Hannes Koenig* [e], *Karen Tscherning* [e], *Katharina Helming* [e]

[a] *Center for Resources Science, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, 11A Datun Road, Chaoyang District, Beijing 100101, PR China*
[b] *Department of Public Management, Beijing Institute of Petrochemical Technology, 19 Qingyuan North Road, Daxing District, Beijing 102617, PR China*
[c] *Graduate University of Chinese Academy of Sciences, 19A Yuquan Road, Shijingshan District, Beijing 100049, PR China*
[d] *Lehrstuhl für Bodenschutz und Rekultivierung, Brandenburgische Technische Universität, Postfach 101344, 03013 Cottbus, Germany*
[e] *Leibniz-Centre for Agricultural Landscape Research, Eberswalder Strasse 84, D-15374 Müncheberg, Germany*

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ABSTRACT

After 30 years of economic reform since opening to the outside world in 1978, China's Gross Domestic Product (GDP) has increased by 150% over the past 15 years. The sustainability of such intense economic activity has been questioned from the perspectives of the social, environmental, and economic dimensions of sustainability. In this study, we assessed the spatial and temporal trends in sustainable development in two sensitive agricultural areas of China: Dezhou district, a well-developed region, and Guyuan district, an underdeveloped region. We used the pressure–state–response (PSR) model and a participatory approach that involved local experts to select and evaluate 27 area-specific indicators, then calculated changes in their values from 1985 to 2002. We aggregated these indicators into dimension- and PSR-specific indices to assess the sustainability of development in both regions. There two regions differed greatly in sustainability, but the current status of sustainable development raises concerns in both areas, especially from the perspective of balancing the three dimensions of sustainability. In 2002, Dezhou district performed well economically, with an index value of 0.78 (where 1.0 = sustainable), followed by environmental and social sustainability (both with index values of 0.48). All three indices have increased since 1985 (by 0.17, 0.25, and 0.13, respectively). In Guyuan district, environmental sustainability was highest (with an index value of 0.73), followed by economic and social sustainability (values of 0.55 and 0.37, respectively), but economic sustainability has decreased by 0.04 since 1985, whereas environmental and social sustainability increased by 0.18 and 0.12, respectively. To promote sustainable regional development, development priorities should be determined by considering both the regional and temporal variation in the three sustainability indices.

1. Introduction

The scientific and policy-making communities have been focusing their attention on the concept of sustainable development since at least 1987 (e.g., WCED, 1987; Liverman et al., 1988). After more than 20 years of research, the concept of sustainable development has become an essential reference point in the formulation of all public policies, and is becoming increasingly integrated in the behavior of all actors (Rey-Valette et al., 2007). In developing countries like China that are undergoing rapid

* *Corresponding author*. Tel.: +86 10 6488 8196; fax: +86 10 6485 4230.
E-mail addresses: zhenl@igsnrr.ac.cn, linlinzhen@yahoo.com (L. Zhen).
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economic growth, their success in evolving from an agricultural society into an industrial one has led to severe ecological impacts. Since the economic reforms that began in 1978, China's rapid development has followed a resource-intensive Western model, leading to increasing pressure on the environment, energy shortages, harsh environmental pollution, degradation of ecosystem services, increasing welfare differences between urban and rural areas, rapid population growth, and overly rapid urbanization and industrialization. In order to deal with these problems, Chinese scientists and authorities have begun to reconsider the traditional development philosophy and have attempted to create a new path that harmonizes the development of social and economic systems with the health of natural systems. In 1992, the State Council issued *China's Ten Strategic Policies on the Environment and Development*, and in 1994 published the first state-level followup document to United Nations Agenda 21, namely *China's Agenda 21—a White Paper on China's Population, Environment, and Development in the 21st Century* (SEPA, 1994). In 1996, the government officially adopted sustainable development as a major strategy for China's future development, and since then, the implementation of sustainable development has been integrated into China's National Economic and Social Development Plan.

Although the Chinese per capita GDP has grown from US$190 in 1978 to US$2 360 in 2007 (using the 2 January 2007 exchange rate of US$1 = 7.82 RMB), regional inequality has increased significantly. For instance, the ranking of per capita GDP in Shandong province and the Ningxia Hui Autonomous Region, two of China's major agricultural production regions, were 7th and 23rd of all Chinese provinces in 2007, respectively, but the corresponding GDPs ranked 2nd and 29th. Therefore, the income gap is huge between relatively developed and underdeveloped rural areas, and this gap has increasingly expanded; for instance, the ranking of the Ningxia Hui Autonomous Region's per capita GDP decreased from 10th in 1978 to 19th in 1999, 21st in 2000, and 22nd in 2006, making the province lag far behind the rest of the country. This increasing income gap will have definite environmental and social consequences for affected regions. Research has shown that the values of the coupling index and the coordination index[1] for economic and environmental development in 2005 were 0.617 and 0.618, respectively, for Shandong, versus 0.082 and 0.140 for Ningxia. The high values in Shandong reveal a better balance between economic development and the environment than in Ningxia, possibly because a high regional income permits greater investment in environmental protection and rehabilitation than is possible in Ningxia (Wu and Zhang, 2008). Such regional income disparities are also likely to lead to conflicts among regions and a potential crisis in the stability of disadvantaged regions. With the rapid industrialization and economic changes now taking place, it is time to consider whether China will be sustainable in the future in terms of coordinated regional development.

Some authors have proposed that locally sustainable development must account for three distinct components of development: environmental, economic, and social. Sustainable development involves balancing these three components (Barbier, 1987; Smith and McDonald, 1998; Lo and Xing, 1999). To assess the sustainability of development, approaches are needed that can assess each of these aspects and their balance. In this regard, many researchers have developed indicators that cover thematic fields such as the environment, social issues, and the economy, and have used these indicators to trace and predict development trends (e.g., Walz, 2000; Boulanger, 2007; Dale and Beyeler, 2001; Onno and Verbruggen, 1991). In contrast, others (e.g., Zhen and Routray, 2003; Tellarini and Caporali, 2000) have developed a "least set" of operational indicators for measuring the sustainability of more narrow fields such as farming for both developing and developed countries based on a consideration of site-specific characteristics. The creation of sustainable development indicators is increasingly popular, and indicators such as the ecological footprint have gained wide support because they adopt a broader conception of policy-making and of the role that indicators play in this activity (Boulanger, 2007). In China, the regional level has been recognized as an appropriate scale for tackling sustainable development problems (Lv and Liu, 1998); this scale falls between the often too-broad national scale and the too-narrow scale of individual municipalities, and thus represents an acceptable compromise between excessive generality and excessive specificity. As a result, indicators of sustainable development are now commonly constructed at regional scales (Zhang, 1994; Liu and Shen, 1997; Yu et al., 1998; Jia et al., 2004; WSDCAS, 1999, 2001, 2006).

In the present study, we developed indices of economic, environmental, and social sustainability, and used them to examine the sustainability of China's development through a case study that compared a developed area with an underdeveloped area. Because China's sustainable development is based on three main objectives (maintaining economic growth and development, promoting social equity, and preserving natural resources and the environment; Lo and Xing, 1999), the basic question becomes whether the current policy will allow China's environment to sustain the current economic and social growth without major disruptions such as high costs or environmental damage. We begin our analysis by selecting suitable, commonly used indicators for representative regions, then continue by assessing sustainability based on a comparison of temporal differences between two environmentally sensitive regions by evaluating the indicators and

[1] The coupling index (C_u) is based on the physical concept of "capacitive coupling", and is defined as the magnitude of the connection between two or more systems as a result of their interactions. C_u is calculated using the following equation:

$$C_u = \frac{u_1.u_2.,\ldots,.u_m{}^{1/n}}{\prod(u_i + u_j)}$$

where u_i is the normalized value of a development index for system i (similar to the indices I_{SSD}, I_{EnSD}, and I_{EcSD} developed in the present study), m represents total number of development index, ij represents jth indicator of the ith system, and n is the number of systems involved. For example, when $n = 2$,

$$C_o = \left[\frac{u_1 \cdot u_2}{2(u_1 + u_2)}\right]^{1/2}$$

The coordination index (C_o) is the coupling index for system i ($i = 1, 2, \ldots, n$) after considering the weighted geometric average of development index of all systems (T), which equals to the geometric average of C_u and T:

$$C_o = (C_u T)^{1/2}$$

where $T = [\prod(w_i u_i)]^{1/n}$ and w represents weight of the ith system (Wu and Zhang, 2008).