



Insights on the development progress of National Demonstration eco-industrial parks in China



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ABSTRACT

In recent years, concepts drawn from industrial ecology have been used to plan and develop eco-industrial parks (EIPs) in China. Attention for eco-industrial parks development projects has grown considerably among national and regional governments and also industries. Among of them, the National Demonstration Eco-industrial Parks program is the most significant program in China. The National Demonstration Eco-industrial Parks program in China has a clear set of indicators and performance targets, strong government support and direct involvement and strict structures and regulations to support it. This article provides an assessment of the progress of the National Demonstration Eco-industrial Parks Program in China by focusing on the key problems and dilemmas that arise in the course of developing EIPs in different economic regions. The paper draws upon both an extensive survey of EIPs and in-depth interviews conducted at 33 EIPs. It begins by introducing the experience of the National Demonstration Eco-industrial Parks Program, and then discusses the geographic distribution of EIPs and compares regional differences by analyzing data from 33 EIPs. The paper offers some brief suggestions for future development of EIPs in China and, finally, it explores factors that could affect the progress of EIPs drawing upon empirical work conducted in China.

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1. Introduction

The successful operation of the Kalundborg Industrial Symbiosis project boosted the concept of industrial ecology and industrial symbiosis, as well as promoting more practices in Eco-industrial Parks (EIPs) around the world (Heeres et al., 2004). EIPs are industrial parks or industrial cluster areas that use industrial ecology and industrial symbiosis principles to simulate natural ecological systems within the industrial systems. The United Nation Environment Program (UNEP) defines EIPs as the systems-oriented study of the physical, chemical, and biological interactions and interrelationships both within industrial systems and between industrial and natural ecological systems (UNEP-United Nations Environment Program, 2004).

After a few years of development of EIPs, the research field broadened from individual EIP case studies to systematic assessment and comparison of national EIP programs. In recent years a growing body of literature examining EIP practices arose in

developing and developed countries, such as North America (Cote and Cohen-Rosenthal, 1998; Gibbs and Deutz, 2005, 2007), Europe and Australia (Ehrenfeld and Gertler, 1997; Van Leeuwen et al., 2003; Mirata, 2004; Baas and Boons, 2004; Roberts, 2004; Van Beers et al., 2007), Korea (Kim and Powell, 2008), Egypt (Sakr et al., 2011), Brazil (Veiga and Magrini, 2009) and China (Fang et al., 2007; Zhang et al., 2010, 2009; Shi et al., 2010). These literature generally applied the practice of industrial symbiosis to identify appropriate clusters of industries.

Both qualitative and quantitative EIP evaluation studies were developed. The qualitative evaluations addressed the characteristics of EIPs, recommended drivers promoting and limitations restricting their successful development and functioning. The quantitative evaluations used indicator systems to evaluate the performance of EIPs. The empirical survey and study of a number of EIPs reveals that most EIPs are at a very early stage of development because the key features of industrial ecology such as inter-firm networking and collaboration in the form of materials interchange and energy cascading are either absent or in early planning stages. Drawing upon the above literature, the major factors that influence the progress of EIPs can be categorized as industry symbiosis relationships, economic benefits, facility and information

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sharing, and policy and regulatory frameworks. The progress of EIPs clearly calls for, and surely will benefit from, a set of indicators and performance targets that will guide future developments and help monitor the environmental sustainability profile of emerging activities. It is important then to have a sound support system including organizational and institutional setups in place to ensure their long-term viability (Tudor et al., 2007). Meanwhile, some theoretical models such as Coevolutionary games or Evolutionary games were introduced into research about the stability of the ecological industry chain, the results showed and corroborated that the stability of the ecological industry chain in an EIP could be sensitive to government management and guidance in China (Chen et al., 2012; Chen, 2010; Feng and Meng, 2011).

China started ecological evolution activities in industrial parks in 2001. Currently, the National Demonstration Eco-industrial Parks (NDEIPs) program is the most representative program in China. The progress of National Demonstration EIPs in China has a clear set of indicators and performance targets, strong government support and direct involvement, and strict structures and regulations. By the end of 2012, more than 60 industrial parks were included in the NDEIPs work. These EIPs are distributed in different economic regions in China, thus some obvious regional characteristics on both of the development levels and quality emerged. There have been some reviews of the progress of EIP development in China from the perspective of case studies or management policy (Fang et al., 2007; Zhang et al., 2010; Shi et al., 2010). However, little research had focused on development process of EIPs in different economic regions over a multi-decadal timeframe. The role of this research therefore to demonstrate the development progress and the present situation of China's EIPs. The work is based on a thorough literature review of government documents and background materials.

This article focuses on the similarities and differences of NDEIPs from different economic regions. The research is in two parts. Basic background information such as location, level of economic development of the 64 NDEIPs, and the geographical distribution is shown in the first part of the study. To further study the geographical distribution discrepancy in the initial research phase, ten performance indicators which represent EIPs' development level from the perspective of economic development, resource consumption and reuse, and generation and pollutant emissions were selected. Data from 33 EIPs were collected and processed by statistical analysis. In addition to the performance indicators, the industrial structural of each EIP was surveyed and discussed. Following the data and results, the problems and dilemmas that arise in the course of developing EIPs in different economic regions are discussed with several suggestions for future development of EIPs in China. Finally, we tentatively explored factors that could affect the progress of EIPs. The outcomes and lessons learned from the evaluation should contribute to the country's economic, environmental, and social policies related to industrial development and EIPs.

2. The development process of EIPs in China

2.1. The generation and development of NDEIPs

China introduced the ecological industry concept in the late 1990s, and then started ecological evolution activities in industrial parks. In 2001, these activities were called EIP development. After a decade of development, China has dozens of eco-industrial parks. According to some published reviews on EIP practices in China, EIPs are mainly composed of NDEIPs and National Pilot Circular Economy Zones (NPCEZs) (Fang et al., 2007; Zhang et al., 2010). The NPCEZs are aiming at the promotion of the development of circular

economy at the enterprise level, industrial cluster area level and regional level. National Development and Reform Commission (NDRC) is the driving force behind the development of NPCEZs. NDEIPs were largely initiated by the Ministry of Environmental Protection of P.R. China (MEP). Following the initial projects, MEP worked with the Ministry of Science and Technology of P.R. China (MOST) and the Ministry of Commerce of P.R. China (MOFCOM) on NDEIPs. NDEIPs are mainly formed on the bases of state or provincial Economic and Technological Development Zones and High-Tech Development Zones. Although the NPCEZ was defined at the level of industrial cluster area, NDEIPs offer more detailed specifications and more measures at the level of industrial parks.

The Dalian Economic and Technological Development Zone, the first domestic industrial park in China, was established in 1984 (Liu, 2011). Due to its preferential policies on tax and land, a large number of companies moved into these industrial clusters, vigorously developing industrial parks in China. After going through three stages – “start”, “grow up” and “develop” – China's industrial development system based on industrial parks was established around 2000 (Shi and Wang, 2010). China's industrial parks system can be divided by administrative levels – state and provincial – and by policy type – Economic and Technological Development Zone (ETDZ), High-Tech Development Zone (HTDZ), Bonded Area (BA), Export Processing Zone (EPZ), Border Economic Cooperation Zone (BECZ), etc. By the end of 2006, there were 1568 industrial parks at the national and provincial level (Ministry of Land and Resources of the P.R. China, 2006). By the end of 2012, there were 145 national ETDZs, 106 national HTDZs in China (MOFCOM, 2012). The number of cumulative ETDZs and HTDZs of each year are shown in Fig. 1.

Enterprises in traditional industrial parks have typically sought high economic output and the resulting benefits without realizing the “costs” of environmental degradation. This has led to many industrial parks turning into “pollution disaster zones”. These industrial parks present a serious threat to the ecological environment and public health. As the scale and number of industrial parks expanded, the concerns about high pollution intensity and potential environmental risk are becoming more prominent and serious.

To resolve these emerging environmental pollution problems and lead to a sustainable development path, China began to explore planning for and establishing EIPs. In 1999, MEP and UNEP decided to jointly implement “the project of environmental management of Chinese industrial park” and introduced the concept of ecological industry. In 2001, Guigang industrial park, Guangxi province, carried out the planning and construction work on symbioses with cane sugar manufacturing. Following approval by MEP, construction of the first NDEIP in China was started, formally starting the practice of NDEIPs all over the country.

China's NDEIP is a new pattern of industrial park that is designed and created by following the concept of circular economy, principles of industrial ecology and requirements of cleaner production. Its design relies largely on ecological evolution activities and presents a significant upgrade from traditional industrial park to EIP. The development of EIPs could speed up the transition to an ecological civilization in industrial parks, and promote the transition from the old growth mode of industry into sustainable development and stimulated high-tech industry development, thus eventually alleviating some of the environmental pollution pressure.

After in the exploration stage between 2001 and 2006, EIPs became a new development concept and were more accepted by industrial parks. The industrial parks that were first to adopt ecological evolution activities generally focused on sector-specific parks such as sugar, electrolytic aluminum, salt-to-chemicals industry. Gradually, ecological evolution activities were extended to multi-sector parks.

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