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From an eco-industrial park towards an eco-city: a case study in Suzhou, China

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ABSTRACT

As eco-industrial park policies have been in place for years, many mature eco-industrial parks tend to acquire more than just industrial functions and become new urban districts. We investigated this development and conducted empirical research in Suzhou Industrial Park, to obtain insight in how a mature eco-industrial park influences if not leverages the development of an eco-city. To this end we inventoried and analyzed policy instruments and environmental infrastructures and deduced how in Suzhou Industrial Park these led to improved energy efficiency, reduced pollution and contributed to its eco-city development. Eco-efficiency and decoupling theory were used to evaluate the environmental performance relative to economic growth in Suzhou Industrial Park. Our results showed that relative decoupling of environmental performance and economic growth was realized for most eco-efficiency indicators, while non-decoupling and absolute decoupling occurred incidentally. This was caused by the deployment of strict regulatory and economic instruments (such as stricter environmental entry rules and requirements on sulfur dioxide emissions). Moreover, the increasing share of tertiary industry, urban service and residential activities also lead to this result. Thus, the experience in Suzhou Industrial Park reveals that an eco-industrial park may evolve into an eco-city development when it leads to an improvement of its environmental performance and a growth of tertiary industry, develops synergies between its infrastructures for industrial and residential areas and enhances the economic prosperity derived from its industrial sites.

1. Introduction

An eco-industrial park (EIP) aims to facilitate companies to exchange resource flows in order to reduce the environmental impact caused by industrial activities in an industrial cluster (Chertow and Ehrenfeld, 2012). In China, the national demonstration EIP program has been in force for over a decade. The program was launched in 2001 as an approach to remedy the environmental degeneration that resulted from the rapid industrialization in the national industrial zones from the 1980s onwards. So far, eco-transformation of the first-generation industrial parks has led to what could be labeled EIPs in terms of improving energy efficiency and pollution prevention (Geng and Zhao, 2009; Tian et al., 2013; Yu et al., 2014b; Zhang et al., 2010).

Then what would constitute the next step for eco-transformation of Chinese EIPs? As scholars have pointed out, Chinese EIPs are not just industrial areas, but they have also become industrialized towns or urban districts (Liu et al., 2012; Shi et al., 2012; Tian et al., 2013). Unlike the US model, an industrial park in China is often a complex that integrates industrial production and residential functions. When the first batch of national industrial zones was established in the 1980s, many of these development zones were located far away from their mother cities, which allowed them to be developed across a large acreage of land. Some residential buildings were built as auxiliary facilities for accommodating a large number of skilled workers. As more companies started their business in these industrial parks, more

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employees with their families settled down. This required the provision of medical care, education and commercial centers etcetera (Tian et al., 2012). Furthermore, in these industrial parks, the secondary and tertiary sectors[1] began to dominate the economy, which is a typical feature of urban economics and development (Arnott and McMillen, 2006). Another key indicator of initial urbanization is the share of tertiary industry. Tian et al. (2013) investigated 17 national demonstration EIPs in China and found that the proportion of tertiary industry exhibited notable growth, in some EIPs amounting to as much as 60%: 40% (secondary: tertiary). Thus, these industrial parks have shown clear signs of urbanization. The next logical step for eco-transformation of Chinese EIPs then would be to integrate urban and industrial functions to minimize energy consumption and pollution. As a consequence, the related planning, measures and assessment for environmental management need to simultaneously consider the industrial sites and the residential areas.

With respect to the environmental performance of a city, the concepts of eco-city and low-carbon city have been promoted in China to deal with the environmental consequences and energy consumption caused by rapid urbanization (de Jong et al., 2013a; Dong et al., 2013; Joss and Molella, 2013). An eco-city has been defined as a city that can minimize the demands on resources (like energy and water) and reduce waste (Roseland, 1997), in order to provide healthy living conditions. Several principles need to be considered to realize the goals of an eco-city, for instance, resource recycling and conservation, measures in industries to reduce pollution, accessible transportation, affordable and decent housing (Roseland, 1997). The concept of a low-carbon city has substantial overlap with that of an eco-city, as it focuses on the decoupling between urban economic growth and CO_2 emissions (Chen and Zhu, 2013). The principles of environment, land use, economy and social welfare in the urban planning for eco-cities need to be interpreted as a set of measurable indicators which can guide policy making and monitor policy implementation (Devuyst et al., 2013; Li et al., 2009). Besides, due to the complexity of cities, the realization of an eco-city requires coordination among all actors (e.g., local authorities, industries and citizens) (Button, 2002). Thus, it is better to involve the related departments to make joint planning and design indicators. In China, for the implementation of an eco-city program one often selects a district as pilot project. Examples are Sino-Singapore Tianjin Eco-city[2] in Binhai New district and Sino-Finnish Eco-valley[3] in Mentougou, Beijing. The policies regarding environmental management and industrial structure are first introduced in a pilot district where progress can monitored and demonstrated for a wider promotion of nation-wide urban eco-transformation (de Jong et al., 2013b).

In the literature, a few studies have appeared to date regarding the environmental aspects involved in a transition from industrial sites to eco-cities. Urban symbiosis has been elaborated to analyze Japanese eco-towns that use waste from cities as alternative raw materials or energy sources for industrial operations (Geng et al., 2010; Van Berkel et al., 2009). Dong et al. (2013) evaluated how industrial symbiosis in the industrial sites of Liuzhou City in China can facilitate low-carbon city construction. Renewable energy and industrial symbiosis were applied to the forestry industry to integrate the eco-development of two Swedish cities, Linköping and Norrköping (Baas, 2010). The progress of the circular economy at the regional level was reviewed in Dalian City by Geng et al. (2009), who analyzed the policy actions at the city level to encourage industries to reduce energy consumption and recycle waste. Furthermore, urban metabolism has been employed to analyze the flows of energy and waste generated in the technical and socio-economic processes that occur in cities (Kennedy et al., 2007; Simões and Marques, 2012; Wolman, 1965). The literature thus provides valuable knowledge about how to utilize resources in industrial sites to better serve their mother cities. It must be noted, however, that in the literature an industrial park is positioned as a city-component that is developed at a time when the city already has been established. As we have outlined above, in China the order of development is reversed: many industrial parks sparked the growth of what today have become small towns or urban districts. Thanks to preferential policies, effective administration and infrastructure development, these industrial parks develop much faster than those city-components. So instead of a city accommodating an industrial park, it is the industrial park that drives the development towards a flourishing new urban district. Furthermore, as industrial parks increasingly embark on eco-transformation, their influence on the eco-development of their mother cities has been expanding. Thus, when one seeks to implement environmental principles to transform industrial park and city in concert, how can the management of an industrial park incorporate, steer or even leverage the accompanying urbanization? The research to date does not provide answers to this question.

This study therefore aims to provide empirical foundations for understanding what conditions an eco-industrial park may provide for eco-city development. We intend to contribute to the literature of eco-industrial parks that reveal urban features. The structure of this article is as follows. Section 2 introduces the research methods and data collection. Eco-efficiency and decoupling are employed to unravel the relationships between environmental pressure and economic growth. Subsequently in Section 3, we present our empirical research in Suzhou Industrial Park (SIP) and we discuss the insights obtained from the case study. Apart from evaluating SIP's environmental performance through empirical data, we make an attempt to unravel the underlying reasons for our results. Finally, conclusions are drawn regarding the conditions that an EIP may provide to evolve into an eco-city. We anticipate the insights obtained to be useful for eco-transformation of industrialized areas accompanying urbanization.

2. Research methods and data collection

Established in 1994, Suzhou Industrial Park (SIP) was one of the earliest national demonstration EIPs. Currently, SIP has been making efforts to become a "new town" in Suzhou City (Shi et al., 2012; Wang et al., 2013b; Wei et al., 2009). SIP thus presents an interesting case to study the eco-transformation of an industrial park towards an eco-city.

After introducing the general context of SIP, we observe the institutional activities to elucidate what policy instruments SIP has employed and how these have been used to reduce energy consumption and avoid harmful environmental impact. Moreover, synergies among environmental infrastructures are investigated to reveal how the water and energy infrastructures are utilized to connect industrial and residential areas.

To evaluate eco-development in SIP, we would like to integrate environmental performance and economic growth. Several methods can serve to simultaneously consider environment and economy, such as eco-effectiveness and eco-efficiency. Eco-effectiveness points out that waste can be avoided through the redesign of products and the embedded system of industrial material flows

[1] In China, primary industry mainly refers to agriculture, including farming, animal husbandry, forestry and fishery; secondary industry includes mining and quarrying, production and supply of water, electricity, gas, manufacturing, and construction; tertiary industry includes all the other industries not included in the previous ones, mainly involving service sector.

[2] http://www.eco-city.gov.cn/.

[3] http://ecocity.fi/en/projects.