

Da-yuan Li, Min Huang

Industrial Greening of the Dongting Lake Eco-economic Zone

Abstract Extensive industrial development is a major challenge to ecological civilization construction. Industrial energy consumption and environmental pollution reduction are desperately needed. The Dongting Lake district, located in Wuhan and the Changsha-Zhuzhou-Xiangtan (CZT) pilot zone, bears the responsibility to ensure national food security and watershed ecological security, and it is an urgent need for the Dongting Lake district to accept the ecological transition of industries. On the analysis of the industrial development status and problems of the Dongting Lake district, some proposals based on the characteristics and reality of the district are pointed out, such as industrial cooperation, proper space layout, ecological innovation, industrial structure upgrading, building of ecological parks, clean production, elimination of backward production capacity, heavy metals governance and so on, as to develop the industrial ecology of the Dongting Lake district.

Keywords: industrial greening, changing patterns of development, ecological civilization, regional collaboration, the Dongting Lake Eco-economic Zone

1 Introduction

It is now generally acknowledged in China that the construction of an ecological civilization is a long-term policy which is closely related to the people's welfare and nation's development. In China, industry is a focus area of energy consumption and pollutant emissions (Zhang & Cheng, 2009). For instance, in 2011, above-scale industrial energy consumption accounted for 73.74% of the country's total energy consumption; energy consumption of energy-intensive industries accounted for 78.9% of all industrial

energy consumption, which present an increasing trend and are much higher than the world's major economies in the industrialization process (Galli et al., 2012). The development of a greening industry is a priority for the transformation of economic development (Li, Wang, & Yao, 2011).

Dongting Lake, China's second largest freshwater lake is located in the north-east of Hunan and the south of Hubei, in the middle reaches of the Yangtze River. Dongting Lake is the most important impounded lake of the Yangtze River and wetland in the world. It is known as the "Land of Plenty" and the "Ample Barn", bearing the major responsibility of national ecological safety, water safety and food security. Located in the National Comprehensive Reform Trial Center of Resource-conserving and Environmental-friendly Society of Hunan and Hubei province, Dongting Lake has unique geographical advantages; it is linking the east and west, and also the south and north. The State Council gave approval for the Planning of the Dongting Lake Eco-economic Zone in April 2014. The implementation of this project can help to realize the comprehensive and coordinated sustainable development of economy, society, population, resources and environment (Brechin, Wilshusen, Fortwangler, & West, 2002). The National Development and Reform Commission compiled the "Planning of the Dongting Lake Eco-economic Zone" in May 2014, pointing out that the Dongting Lake Eco-economic Zone covers Yueyang, Changde, Yiyang, Wangcheng Districts of Hunan and Jingzhou of Hubei, with a total of 33 counties (cities and districts), area of 60,500 km², a resident population of 22×10⁶ and GDP of 715.2×10⁹ CNY at the end of 2013 (Li, Zhang, & Luo, 2013).

However, in recent years, Dongting Lake has withered and was seriously polluted by ecological destruction (Gao, Yang, Qiao, Yao, & Xu, 2008). Dongting Lake exceeded the third category of the national water quality standard after 2005 (Ju, Zhang, Bao, Römhald, & Roelcke, 2005). Industrial point source pollution is a key factor causing environmental problems of Dongting Lake (Qin et al., 2011). Extensive development has polluted the lake, reduced the wetland area and induced biodiversity loss,

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Da-yuan Li (✉), Min Huang
Collaborative Innovation Center of Resource-conserving & Environment-friendly Society and Ecological Civilization, Business School, Central South University, Changsha 410083, China
Email: bigolee@163.com

which has led to an ecological crisis and ecological imbalance. Therefore, the Dongting Lake Eco-economic Zone urgently needs to change its industrial development pattern, build an eco-industrial system, reduce consumption and pollution, and finally realize a coordinated development of industrial construction and ecological environmental protection.

The rest of the paper is organized as follows: The second part describes the industrial development status of the Dongting Lake Eco-economic Zone. The third part discusses the main problems of industrial greening. In the final part, policy recommendations for industrial greening are presented.

2 The industrial development status of the Dongting Lake Eco-economic Zone

2.1 Industrial economy

In recent years, the industry of the Dongting Lake Area has developed rapidly. As presented in Table 1, the ratio structure of the first, second and third industries are 15.9 : 51.2 : 33.0 in 2012, compared with that of 23.3 : 41.1 : 35.6 in 2006. It can be found that the second industry increased by 10.1% and is 5.9% higher than the average level. From 2005 to 2012, the scalable industrial output value of the lake zone developed from 170.998×10^9 CNY to 958.771×10^9 CNY, and the scalable industrial added value increased from 56.49×10^9 CNY to 285.737×10^9 CNY. Industrial added value accounted for 45.4% of the GDP, 6.9% higher than the national average. All of the above indicate that the leading role of the industrial economy is becoming increasingly important.

2.2 Pillar industry

The internal structure of the industry in this district has the following characteristics: First, pillar industries have excellent advantages. The output value of the food

industry, petrochemical industry and equipment manufacturing industry all exceeded 10^{11} CNY in 2012. Second, the lake zone mainly relies on traditional industries and less on high-tech industry. For instance, the added value of high-tech industry was 76.023×10^9 and only accounted for 24.51% of industrial added value, which was 11.85% lower than that of Hunan and 6.48% of Hubei. It indicated that the industry of the Lake District needs to be further accelerated. Third, the degree of industrial agglomeration is increasing and the degree of concentration into industrial parks is continuously improving. There are four national industrial parks and 24 provincial industrial parks, which account for nearly half of the lake's industry.

2.3 Energy saving and emission reduction

As shown in Table 2, the energy consumption of the unit scale industrial added value in the Lake District continues to decline. From 2005 to 2012, it decreased from 3.07 tons of standard coal to 0.76 tons of standard coal, a cumulative decline of 75.24%, which is faster than that of Hunan (72.91%), but slower than Hubei (79.14%). Since 2007, Dongting Lake started governing paper-making enterprises. More than 380 paper-making enterprises were shut down and the lake water quality has been greatly improved consequently. According to the China Environmental State Bulletin, the water quality of Dongting Lake returned to Grade IV in 2010. Currently the lake is in the nutritional status, which is above the medium level in China.

3 The main problems of industrial greening of the Dongting Lake Eco-economic Zone

3.1 Extensive development mode

As a major agricultural producing area and ecological protection zone, the traditional agriculture industry with extensive development accounts for a large proportion of environmental problems. Energy-intensive and environ-

Table 1

Industrial Economic Data of the Dongting Lake Eco-economic Zone in 2012

Region	GDP (billion)	IAV (billion)	IAV/GDP (%)	Added value of hi-tech industry/IAV(%)	Three industry structure
Yueyang	2,199.92	1,110.46	50.5	32.93	11.7:55.5:32.8
Changde	2,038.50	917.0	45.0	16.85	14.8:49.5:35.7
Yiyang	1,020.28	380.20	40.9	23.68	19.9:45.0:35.0
Wangcheng	374.88	215.56	57.5	31.30	7.9:73.8:18.2
Jingzhou	1,195.98	475.34	39.7	17.23	24.5:43.7:31.8
Lake District	6,829.56	3,101.46	45.4	24.51	15.9:51.2:33.0
Hunan	22,154.23	8,562.88	41.3	36.36	13.6:47.4:39.0
Hubei	22,250.45	9,552.35	42.9	30.99	12.8:50.3:36.9
Nationwide	518,942.1	199,900	38.5	15.95	10.1:45.3:44.6

Notes: Adapted from *China Statistical Yearbook*, *Hunan Statistical Yearbook*, *Hubei Statistical Yearbook* and *Changsha Statistical Yearbook* of 2013. GDP—Gross domestic product; IAV—Industrial added value.

mentally damaging industries account for too much pollution; most of them are raw material-based and resource-based industries such as textile industry, building materials industry, non-ferrous industry, paper-making industry, chemical industry, etc. All of the above indicate that the extensive development mode has not been fundamentally changed (Dong, X. Y. & Dong, M. H., 2011). At present, Dongting Lake bears the heavy responsibility to ensure national food security and watershed ecological security, which brings about many restrictions to industrial development, such as land, capital and energy, etc. With the development of industry, the contradiction between environmental protection, demand for energy and raw materials and economic development becomes increasingly prominent. Meanwhile, Dongting Lake is occupied with many high energy consuming and pollution causing industries, and a large amount of industrial waste water is discharged into the lake, which makes industrial greening much more difficult.

3.2 Industry isomorphism and repeated layout

The natural conditions such as soil, climate, water conservancy, and geology of the Dongting Lake Area are

basically the same, which lead to a high degree of similar industrial structure (Dong, X. Y. & Dong, M. H., 2011). What is more, due to existing institutional policies and management system, all industries are fiercely independent and finally bring about industry isomorphism (Carney, 2004). Table 3 shows that leading industries are substantially similar to other areas in the Lake District except for Changde and Yueyang, where tobacco and petrochemical industries are leading industries, respectively. Especially, almost all cities and counties take food industry as the local leading industry. Industry isomorphism and repeated layout result in inefficient resource utilization, which is not conducive to building a resource-saving and environment-friendly society (Li, S. L. & Li, N., 2010).

3.3 Insufficient technology and talent support

The industrial greening development of Dongting Lake requires strong support from technology and talents. However, floods and droughts hindered the economic and social development (Sun, Huang, & Jiang, 2011), and laggard transportation infrastructure influenced the investment motivation of companies and individuals. Moreover, industrial greening has insufficient capacity (Dong, X. Y. &

Table 2

The Energy Consumption of Units Scale Industrial Added Value (EZZ / million)

Year	Yueyang	Changde	Yiyang	Jingzhou	Wangcheng	Lake District	Hunan	Hubei
2005	3.54	1.8	4.48	3.21	2.32	3.07	2.88	3.5
2006	2.92	1.72	3.83	2.85	2.09	2.68	2.74	3.33
2007	2.64	1.62	3.47	2.57	2.02	2.46	2.51	3.02
2008	2.23	1.36	2.76	2.48	2.19	2.20	1.98	2.68
2009	1.81	1.25	2.21	2.03	1.96	1.85	1.57	2.35
2010	1.55	1.11	1.83	1.85	1.63	1.59	1.36	2.18
2011	1.04	0.83	1.28	1.36	1.04	1.11	0.95	0.91
2012	0.79	0.48	0.74	0.96	0.83	0.76	0.78	0.73
Cumulative decline (%)	77.68	73.33	83.48	70.09	64.22	75.24	72.91	79.14

Note: Adapted from *China Statistical Yearbook*, *Hunan Statistical Yearbook*, *Hubei Statistical Yearbook* and *Changsha Statistical Yearbook*.

Table 3

Leading Industries of the Dongting Lake Zone

Downtown	Leading industry
Yueyang	Petrochemical industry, food industry, mechanical industry, paper-making industry, textile industry, building materials industry
Changde	Tobacco industry, equipment manufacturing industry, food industry, non-ferrous industry, textile industry, building materials industry, paper-making industry, electronics industry
Yiyang	equipment manufacturing industry, food processing industry, electronics industry, electricity industry, textile industry, building materials industry, non-ferrous industry, paper-making industry, chemical industry, advanced materials industry
Wangcheng	Food and medical industry, non-ferrous processing industry, mechanical industry, printing & parking industry, power & energy industry, building materials industry
Jingzhou	Agricultural products processing industry, chemical industry, equipment manufacturing industry, light industry, building materials industry, automobile components industry, textile and apparel industry

Note: Adapted from *The Regional Twelfth Five-Year Plan of the Dongting Lake Area*.

Dong, M. H., 2011). Specifically, Dongting Lake is distant from large cities such as Wuhan and Changsha, and there are not many famous universities or research institutes, which dramatically affect regional independent innovation and technique development (Liu, 2012). For example, most of the company's business is OEM or imitation, so few companies have core technology and their own brand. Meanwhile, the Lake District has given priority to traditional agriculture, with an agricultural population of 12×10^6 , so it lacks experienced industrial workers and a variety of high-quality technicians and managers.

4 Policy recommendations for the industrial greening of the Dongting Lake Eco-economic Zone

Eco-industry is essential to China's new industrialization (Huang, 2006). In order to realize industrial greening under the dual constraints of resource and environment, the lake industry needs to change the existing extensive development mode and explore a new path of green industrialization based on lake characteristics (Yu, Hua, & Yan, 2011).

4.1 Strengthening regional cooperation

Dongting Lake is on the edge of two provinces, connecting four cities and a county. In order to carry out effective management, the Zone must discontinue the administrative divisions, integrate the distinct lake districts, establish a negotiation dialogue mechanism, strengthen planning and co-ordination, and promote regional cooperation (Sheng, Tang, & Dai, 2012). There should be an establishment of a Dongting Lake Eco-economic Zone joint conference system of Hunan Province and Hubei Province for regular consultation and cooperation and an establishment of a regional (Yueyang, Changde, Yiyang, Jingzhou, Wangcheng) joint conference system to promote industrial division and cooperation in the region, and finally realize industrial coordination development. When possible, a unified and effective management agency should be established to organize, coordinate, direct and manage eco-industrial tasks under the mature conditions (Wen & Gan, 2009).

4.2 Optimizing space layouts

According to its natural resources and environmental capacity, the Dongting Lake Eco-economic Zone should adhere to the principle of intensive characteristics and advantageous development, and ecological protection (Ludwig, Mangel, & Haddad, 2001), building a "three rings collaboration and three axes linkage" space layout framework of eco-industrial development. The Dongting Lake Area can be divided into three rings: the inner ring, the middle ring, and the outer ring based on characteristics

of the main functional areas. The core of the inner ring are lakes and wetlands, which is for preventing natural ecosystems from economic disturbance, prohibiting unmatched development activities and maintaining ecological function. The middle ring refers to the development zone around the lake, including the water area around the shorelines, whose function is to build an ecological barrier and encourage the development of eco-industries and high-tech industries which can save energy and reduce consumption by using cleaner production methods. The outer ring is the intensive and efficient development area, including Yueyang, Changde, Yiyang, Jingzhou, Wangcheng and other key counties around the lake, which is for promoting industrialization. According to the location conditions, eco-industries are planned along the "tri-axis", i.e., the east axis, the southwest axis and the north axis. The east axis runs along the Beijing-Guangzhou railway which goes through the east of the Lake District and considers Yueyang and Wangcheng as joints. This area should mainly develop petrochemical, modern logistics, new energy, new materials, energy saving and environmental protection industries. The southwest axis takes Shimen-Changsha railway and Changsha-Yiyang expressway as main axis and Changde, Yiyang and Wangcheng as nodes, which should mainly develop equipment manufacturing, food processing, new energy, electronic information, and light industry, etc. The north axis takes the Yangtze Economic Zone and Hangzhou-Ruili highway (under construction) as main axis and Yueyang, Changde, Jingzhou as joints, which should mainly develop modern logistics and green agricultural product processing industry.

4.3 Enhancing eco-innovation capability

Science technology and innovation are important supports for the development of industrial greening (Li & Atuahene-Gima, 2001); the industrial greening development of the lake area should reform the technology development and management systems, enhance the eco-innovation capacity of firms, and encourage social capital to invest in green innovation to transform and upgrade traditional industries and pillar industries. It is essential to establish independent innovation systems, accelerate the development and application of advanced technologies and equipment related to environmental protection and energy conservation. Moreover, it is also necessary to expand diversified financing channels, implement green credit and encourage enterprises to increase innovation investment. Also, companies should be encouraged to increase direct financing by listing, issuing stocks and asset restructuring to establish industrial investment funds for eco-innovation.

4.4 Optimizing industrial structure

Industrial structure is a key factor that affects the change of

the ecological environment (Han & Li, 2010). The Lake Zone should be committed to the adjustment and an optimization of industrial structure. First, the traditional industries should be transformed and upgraded. With professional industrial parks as the carrier, leading enterprises as the base, independent innovation as the driving force, increasing added value as the main direction, pollution control and eliminating backward production capacity as the bottom line, corporate should be encouraged to adopt advanced technologies to upgrade traditional industries and build industrial exit mechanisms to help traditional industries in the lake area achieve optimized transitional, green and innovative development. Second, the Lake Zone should implement brand promotion strategies to support the development of pillar industries. For instance, brand strategies can help to develop some dominant areas, competitive industries, key enterprises and major products. Meanwhile, with the formation of a group of “specialized, sophisticated, special, new and excellent” supporting enterprises, pillar industries can achieve scale expansion and clustered development. Third, the Lake Zone should foster strategic emerging industries such as new energy, new materials, electronic information, environmental protection and modern logistics industry to ensure long-term green development.

4.5 Promoting the construction of eco-industry parks

Clusters and eco-parks are inevitable trends for industrial greening (Baldwin, Murray, Winder, & Ridgway, 2004). According to the principles of industrial base, intensive and high efficiency, resource superiority and ecological protection, the lake industrial development should insist on the idea of park industrialization to achieve industrial cluster and specialization of labour division. The main task is to support a number of advanced industrial clusters and accelerate the development of leading industry clusters. With the support of a group of large companies and famous brands which have prominent main business and core competitiveness, the Lake Zone should encourage the development of professional supporting productions of SMEs, promote the transformation and upgrading of SMEs and finally enhance the development of industrial clusters.

The Lake Zone should coordinate all the characteristics in park development based on resource prerequisites, industrial base and geographic conditions of Dongting Lake. The tasks involve propelling urban corporates and enterprises around the lake into parks and attracting investment into the cities for developing a productive service industry. Also, there is an urgent need to rationally define the industrial positioning of 4 national parks and 24 provincial parks, and each park should contain 2–4 distinguished leading industries. In addition, it should be supported to establish new national and provincial eco-parks to promote industrial greening development.

4.6 Implementing cleaner production

Cleaner production can greatly reduce the end-treatment burden, which is an important means of controlling environmental pollution (Zhang, Tang, Zhang, Yang, & Mao, 2012). Therefore, the Zone should actively carry out technology pilots and templates of cleaner production, support demonstration projects and application projects about cleaner production technology, promote the R & D and application of cleaner production for key industries and corporates. Moreover, the zone should optimize technological processes, implement cleaner production technical reformation, and control product process of pollutants, governance, and emissions. In addition, it is necessary to strengthen the cleaner production audit, to perfect the evaluation system of cleaner production, to guide enterprises, consulting services and intermediary organizations to carry out the audit work and establish a local industry department in charge of cleaner production implementation systems. With the above methods, the lake industry can achieve economical, clean and safe development and an ultimately cleaner production can be realized.

4.7 Closing down outdated production facilities

The Zone should strictly implement access conditions and plans of eliminating obsolete capacity of high energy consumption and environment pollution industries, adhere to reduction and replacement, promote mergers and acquisitions, strengthen technological innovation and control capacity expansion. Meanwhile, the Zone should insist on establishing and improving long-term mechanisms of closing obsolete capacity, further optimizing the capacity stock and strictly controlling increment. According to the National Guidance Catalogue of Eliminating Obsolete Capacity, a project list for the elimination of obsolete capacity of the Dongting Lake Ecological Economic Zone should be established to regulate the elimination of outdated equipment and prohibit the unauthorized expansion transformation. In addition, economic and legal means and technological progress, such as green credit, differential pricing, environmental enforcement, and quality supervision, should be comprehensively implemented to close down contaminative enterprises and eliminate outdated capacity.

4.8 Preventing heavy metal pollution

Dongting Lake is the terminus of the Xiangjiang River, Zijiang River, Yuanjiang River and Lishui River; these rivers go through a large number of places with a concentration of mining and smelting enterprises, which brings about very heavy metal pollution to the lake (Yi, Yang, & Zhang, 2011). Based on the principle of comprehensive prevention and control of the whole process

(preventing pollution from source, blocking process, cleaner production and end-of-pipe control), it is necessary to pay great attention to the prevention of heavy metal pollution of the Dongting Lake district. First, access conditions to prohibit new construction, renovation and expansion activities which would increase contamination in the area should be strictly formulated. Second, report systems of environmental impact assessment and water and soil conservation schemes of construction projects should be implemented and the “three simultaneous” system (the prevention and control of pollution of the facilities shall be designed, constructed and put into operation simultaneously with the main project) and responsibility system should be strictly carried out. Third, the implementation of industrial pollution control engineering is needed. In order to minimize the pollution, advanced production technologies need to be introduced. Fourth, infrastructure construction for controlling heavy metal pollution should be strengthened. For instance, enterprises can generalize the use of automatic monitoring of pollution and install online control devices to monitor heavy metal pollutants. Fifth, regional comprehensive improvement must be executed. This process should be centered on the Xiangjiang River and the Dongting Lake Area and seize the opportunity of being an ecological compensation pilot in the Yangtze valley. Finally the establishment of an ecological compensation mechanism for the Dongting Lake Eco-economic Zone is an urgent need.

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