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Industrial Restructuring through Eco-Transformation: Green Industrial Transfer in Changsha–Zhuzhou–Xiangtan, Hunan Province

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Abstract: As industrial activities account for a large part of environmental degradation and carbon emissions in China, the geographic location of industries significantly shapes the environmental performance and quality of life of surrounding areas. Since the late-2000s, China has sought to combat environmental degradation through the relocation of polluting industries particularly from industrial areas within inner cities. Using the concept of industrial transfer, which has been used in the Chinese context to capture not only the relocation of, but also structural and procedural changes to, firms, the paper analyses recent changes to China's industrial structure. These occurred during the so-called eco-transformation, which seeks to improve China's environmental performance. The paper expands the concept of industrial transfer by focusing on the intra-regional processes of this wider policy-led eco-transformation process based on the case studies of three traditional industrial areas in Hunan province. Case study results suggest that the ongoing phase of industrial transfer differs from previous regional transfers as it considers environmental impacts, elevates the relevance of the urban and local scale, involves new actor groups and offers benefits to both original and new locations.

Keywords: industrial transfer; eco-transformation; industrial pollution; urban restructuring

1. Introduction

Industrialisation and urbanisation in China were used as critical strategies to realise modernisation [1] and ensure sustained economic growth [2,3] and were seen as inevitable requirement to realise the Chinese Dream [4]. Industrial transfers that saw politically driven and systematic (re)location of industries contributed to both industrialisation and urbanisation in China. This involved two main phases: international industrial transfer from advanced Western countries to primarily the eastern coastal cities in China during the 1970s to 1980s and a second phase of relocation from these eastern areas to central and western areas of China since the 2000s.

During these phases of industrialisation, little attention was given to environmental consequences resulting in severe environmental pollution in receiving regions. Local governments focused on economic development reflecting the national priority during the primary stage of socialism initiated by the Communist Party and central government in 1980, ignoring environmental implications, particularly where they conflicted with economic growth [5]. China still faces a significant legacy of polluting industries (e.g., chemical industries, nonferrous metallurgy industries, building materials industries, machine manufacturing industries, cement industries and mining industries) which can mainly be found in traditional industrial areas (TIAs) [6]. TIAs were established under the planned economic system in the 1950s–1960s and set the foundation of Chinese industrial development.

Implications of industrialisation were not restricted to serious environmental pollution but also included social and economic consequences. During the last 50 years, TIAs were gradually surrounded by non-industrial neighbourhoods due to urban expansion (driven by a significant increase in the urban population) and over time became centrally located within cities and urban agglomerations [7,8]. The proximity of TIAs to growing numbers of urban dwellers exacerbated the negative consequences of industrial activities and turned these into increasingly urban problems which highly restricted the quality of urban life [7,9–11].

In response, since the 2000s, Chinese central and local authorities have made increasingly vigorous efforts in curbing those problems by internalising environmental performance into industrialisation and urbanisation processes. This paper captures this green transformation as the eco-transformation of industrial areas. Eco-transformation of industrial areas was regarded as a significant strategy for the greening of the economy in China. It not only includes greening of industrial areas, but also the greening of urban development, social and governance mechanisms with industrial activities at their core. As part of this eco-transformation, China is seeking to reduce negative environmental impacts from industrial areas, particularly those located within urban areas. The relocation-based transformation of TIAs is the main strategy of this eco-transformation which was initiated by the state council in 2014 identifying 21 national pilots across 20 provinces. As part of this initiative, polluting industries mainly in TIAs were and still are relocated to other areas [12–15] through an upgrading of transferred industries as well as urban renewal of original TIAs.

This paper analyses these industrial restructuring and relocation processes as a strategy to reduce negative environmental impacts through a regionally focused analysis of industrial transfer drawing on selected TIAs in Hunan Province. As such, it provides a fine-grained understanding of industrial restructuring as part of China's eco-transformation process. Conceptually, it expands on the concept of industrial transfer as applied to China and works on industrial restructuring by emphasising intra-regional processes. It illustrates how industrial restructuring and transfer in its current form is largely government driven, executed by sub-national governments and linked to urban regeneration and environmental protection. Empirically, the paper provides insights into specific eco-transformation processes using three TIAs within the Changsha–Zhuzhou–Xiangtan city agglomeration in Hunan Province as case studies.

The next two sections discuss the literature on industrial transfer and greening of the economy to situate the research. The following section presents the methods used in this paper. Section 5 introduces findings from relocation-based transformation projects as they concern the three case study TIAs including the policy context in Hunan Province, driving forces, implementation processes, achievements and challenges. Section 6 discusses how these relocation projects expand on our existing understanding of industrial transfer and economic development in China. Finally, Section 7 gives the conclusions.

2. Regional Industrial Transfer and the Environment

According to Wang and Zhao (2003), industrial transfer can be understood as the geographical movement and relocation of whole or partial industries from one place to another [16]. As part of this transfer, relocation has occurred at different scales, including across regions and countries [17]. However, some scholars [17,18] argue that a broader definition of industrial transfer is needed as geographic relocation of operations is often accompanied by transfers of capital, technologies and production factors (including land ownership, labour force and raw materials). Industrial transfer can take many forms at the firm level, including the establishment of new production lines, creation of new distribution chains and research and development centres, outward investment and relocation of corporate headquarters [19]. Moreover, industrial transfer also involves the transfer of government policies and practices across regions [18,20]. It is this broad definition of industrial transfer that provides the framework to explore the waves and trends of regional industrial transfers in China including recent changes under eco-transformation.

The industrial transfer strategy played a key role in the process of China's economic development and industrial restructuring. From the 1950s to present, three phases of industrial transfer can be identified, which impacted significantly on industrial and increasingly urban spaces in China. Figure 1 illustrates the first two phases of transformation: (1) a shift in industrial policies from central and western areas to China's east coast in the 1980s and (2) industrial relocation from the east coast to central and western China since the 2000s.

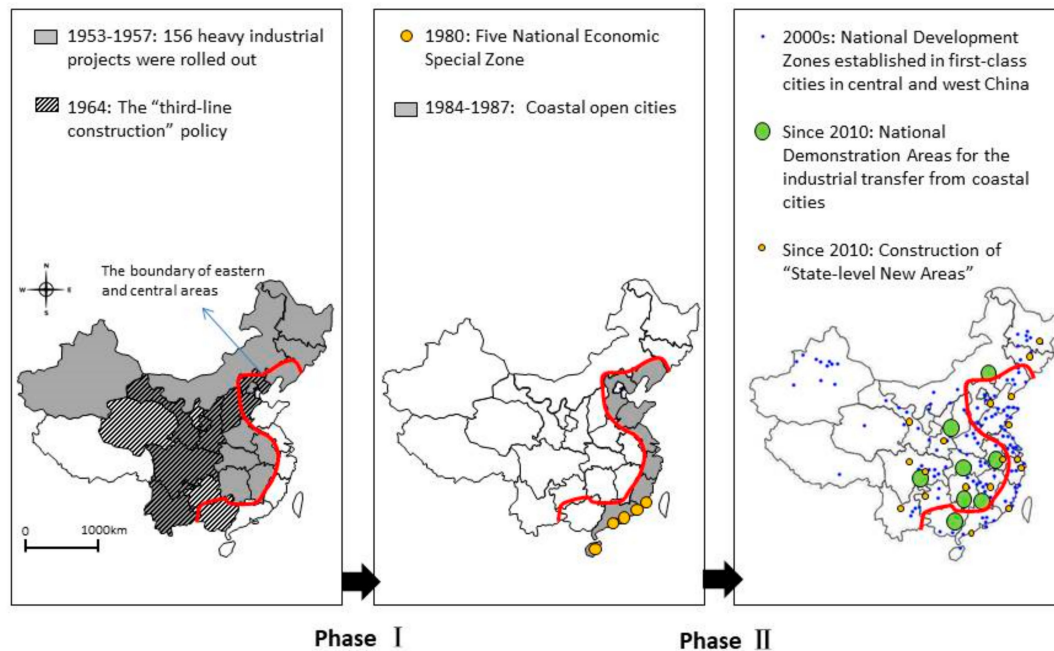


Figure 1. Two phases of regional industrial transfer in China since the 1950s.

After the establishment of the People's Republic of China in 1949 and under a planned economy, industrial development originally focused on the central and western regions of China (Figure 1, left). One reason for the regional focus was the natural resource endowment for resource-intensive industries in central China but locational choice was also driven by the logic to reduce external intervention and influence after the war [21]. For example, the "156 Projects" plan during the 5th Five-Year Plan resulted in the development of 156 heavy industrial factories built mainly in northern and central China with assistance from the Soviet Union between 1953 and 1957. After the 1960s, the Chinese government presented the "Third-line Construction" strategy which led to the construction of industries primarily in central and western China (Figure 1, left). During this stage, the economic structure was characterised by heavy and resource-intensive industries such as steel, cement, chemical and mining industries. These industries were clustered in so-called TIAs.

The first industrial transfer followed the opening up of the Chinese economy and transformation into a market system in 1979 under reformist leader Deng Xiaoping. As a result, large sums of foreign direct investment (FDI) flew into coastal areas in the east due to their low costs and large consumer market (Figure 1, centre) [22]. In the 1980s, the Chinese government controlled the spatialised development through the designation of five National Economic Special Zones (Shenzhen City, Zhuhai City, Xiamen City, Shantou City and Hainan City) and so-called National Coastal Open-up Cities (e.g., Dalian, Qinhuangdao, Tianjin, Yantai, Qingdao, Lianyungang, Nantong, Ningbo, Wenzhou, Fuzhou, Guangzhou, Zhanjiang and Beihai) which were subject to preferential policies designed to attract and absorb FDI and develop industries (mainly manufacturing industries). Despite a growing industrialisation gap between eastern and western China, the national state continued to direct more funds into eastern China accounting for 26.7% of total national investment [23]. The first phase of regional industrial transfer in China is hence primarily characterised by a shifting of development

focus, preferential policies, targeted funds for specific regions and workforces resulting in uneven economic development across China.

After 2000, industrial development strategies in China resulted in industries migrating from east to central and west China (Figure 1, right). Ang (2017) identifies a number of drivers behind this process [18]. On the one hand, the competitiveness of traditional manufacturing sectors in coastal provinces was steadily declining as a result of increasing costs and tighter sub-national state environmental policies. On the other hand, central and western provinces offered lower costs and their local governments were eager to attract “unwanted” industries from the coast. This second phase of industrial transfer is also marked by industrial restructuring of coastal and inland cities [17] as industries moved from more advanced coastal areas to inland cities with lower economic levels along an industrial gradient [24,25]. The migration of industries has been spurred by a rapid expansion of cross-regional infrastructure projects, e.g., “Common Prosperity”, “Rise of the Central Regions” and “Great Western Development” campaigns. In 2010, the state council issued the *Guidance for Central and Western Areas to Undertake Industrial Transfers* designed to spark economic growth in the interior regions, restructure the coastal economy and strengthen China’s competitive advantage [18]. By 2012, Hunan province had undertaken 2608 domestic industrial transfer projects which brought Hunan province 3.79 billion yuan of extra taxes and created an estimated 335,000 new jobs [26].

However, industrialisation without environmental considerations generated severe environmental pollution in China. Environmental implications in receiving areas during the second industrial transfer were not taken into account. The transfer of a high number of resource- and labour-based industries from the eastern coastal cities to China’s central and western areas exacerbated environmental problems in central and western areas significantly [27]. This happened in a context of 50 years of progressive pollution through industrial activities in TIAs, especially, heavy metal pollution of soil and water [6] as well as air pollution. For TIAs located near water resources, pollution through waste water disposal directly into waterways resulted in severe pollution of the whole water basin. Due to rapid urbanisation and spatial expansion, TIAs gradually “moved” to the centre of cities and hence largely impacted on the urban living environment and increased social and economic implications of industrialisation [28]. Since the early 2000s, TIAs suffered industrial decline partly tied to resource exhaustion but also decreasing industrial competitiveness [29] following the path of old industrial areas like the rust belt in the USA and the Ruhr region in Germany.

To address these problems, since the late 2000s, industries in TIAs have been relocated away from the inner city to suburban areas as part of a wider process of eco-transformation driven by regional and local governments [12–15]. In 2014, the state council issued the *Guidance of Moving and Transformation of Old Industrial Areas in Urban Agglomerations* designating 21 national pilots across 20 provinces. Empirical studies on the transfer of old industrial areas, for example, in Jilin Province, Luoyang City and Shenyang City, have shown similar characteristics as previous industrial transfers in China where industries were relocated from one location to another [12,13]. However, in contrast to previous phases of industrial transfer, the current phase shows new characteristics where economic growth imperatives are coupled with green development goals that are directly influenced by environmental regulations [30]. This largely city-scale and intraregional restructuring can be understood as a new, third regional industrial transfer in China. Based on case study evidence, this paper expands the existing understanding of industrial transfer by comparing it with the previous two regional industrial transfers. While some studies [31,32] already documented the regional geographical movement of polluting industries/enterprises within China, they failed to consider that under current environmental policies, regulation and increased environmental awareness, most regions in China are no longer willing to receive polluting industries [33]. According to existing studies [34], the impacts of command environmental regulations on polluting industrial transfer have been neglected. Relocation of polluting industries/enterprises has also been shaped by pressures from citizens and civil societies in departure and receiving areas (departure areas refer to the original areas of industries before relocation, and receiving areas refer to the areas where originally polluting industries were relocated to) [35].

This change in attitude and policy at the regional scale is significantly impacting how current industrial transfer is regulated at the sub-national scale resulting not only in relocation but a restructuring and greening of the industry.

3. Greening of the Economy in China

Since the late 2000s, with the rise of the green economy globally, and since the 2015 announcement of the UN Sustainable Development Goals, the Chinese government has become increasingly concerned about the consequences of economic development on the environment [36,37]. During the executive meeting of the State Council in August 2009, the premier of the State Council, Wen Jiabao, argued that low-carbon development should define economic growth in China and that a pilot demonstration of a low-carbon economy needed to be carried out. The same year, the Standing Committee of the National People's Congress introduced the *Resolution on the Positive Response to Climate Change*, suggesting that China should seize the opportunity to develop a low-carbon economy by accelerating the low-carbon utilisation of high-carbon energies and the development of low-carbon industries. A series of policies on energy, carbon control and industrial restructuring was issued by the central government as guidance for local practices (e.g., “a new road of industrialisation” issued in 2002 and the ambitious greenhouse gas reduction target set by the 13th five-year plan). Facilitating this new economic growth with high energy efficiency, low energy consumption, and low-emissions industry has become characteristic of green economy development in China.

With the development of the concept of a green economy, increasingly attention has been paid to wider perspectives other than those driven by green growth, e.g., the relationship of a green economy with urban development (including urban governance, urban spatial planning, urban living environment, urban economy and urban branding) [38–41], and social inclusivity and equity have been considered in conjunction with environmental aspects of sustainability (including education, health, employment and population wellbeing) [42]. Following this, in the past two decades, the Chinese government has been encouraging approaches to achieve the greening of the economy [43]. Attention was paid not only to the greening of industry, but also to the sustainable development of industries in relation to urban space and social contributions, e.g., construction of a resource-efficient and environmentally friendly society since 2008, construction of an “ecological civilisation” since the 12th five-year plan and the “new-type of urbanisation” issued in 2014. During this greening of industries, the Chinese government desired to protect economic growth whilst making necessary improvements to working and living standards.

In addition, China is also moving towards multi-level [44] and multi-sector [45–48] environmental governance. Environmental responsibilities of local governments have been strengthened through environmental decentralisation and “vertical reform”. The vertical reform of local environmental departments was rolled out by the General Office of the CPC Central Committee in 2016: a few duties and responsibilities shifted from lower levels of the environmental department to superior levels (the provincial to the national level) [49,50]. State actors are not necessarily the only or most significant participants in governance processes [51]. In this regard, and in a mainly European context, scholars have mostly focused on the importance and participation of non-state actors in decision-making processes at different levels of governance [51–54]. Chinese citizens increasingly pressurise officials to uphold public participation as part of environmental governance resulting in various forms of participation, consultation and cooperation of non-state actors (including private companies, NGOs and individuals) [45–48].

Industrial transfers were in the past mainly driven by economic interests [18], but since the 2000s, they have increasingly responded to the Chinese government's eco-transformation request reflecting wider environmental and social considerations. Previous studies about the third regional industrial transfer in China have focused on its impacts on urban regeneration [13], land-use pattern [12] and protection and reuse of industrial heritage [55]. However, little attention so far has been paid to the changing participation/cooperation mode of multiple actors, spatial scales and features of relocation,

and their impacts on the green development (especially in the urban and social perspective). This paper focuses on these processes of economic restructuring as part of a wider eco-transformation process. It understands this largely city-scale and intraregional restructuring as a new, third regional industrial transfer in China, which we argue needs to be understood within broader green transformations and different spatial scales and involving new actor constellations.

4. Case study Context and Methods

In order to analyse and understand the relocation-based transformation of TIAs in China including contextual details, we selected three TIAs within the Changsha–Zhuzhou–Xiangtan (CZT) city agglomeration in Hunan province (as Xiangtan city is called Tan in short in China, “CZT” is used as acronym for Changsha–Zhuzhou–Xiangtan urban agglomeration following Chinese language habit). In 2008, CZT was designated as the national demonstration area for the construction of a resource-efficient and environmentally friendly society (two-oriented society). Consequently, a large number of eco-transformation projects were rolled out, including those related to the location of green industries, pollution control, reduction in resource consumption/demand, environmental regeneration and enhancement of residents’ livelihoods [56]. About 500 polluting industries have been closed down or relocated since the late-2000s. Half of them were located in three TIAs alone—Zhubugang TIA in Xiangtan, Pingtang TIA in Changsha and Qingshuitang TIA in Zhuzhou which form the basis of the empirical analysis of this paper.

Given the adjacent location and close economic cooperation between Changsha, Zhuzhou and Xiangtan, the three cities became a member of the “5 + 9 + 6” system of Chinese urban agglomeration. The “5 + 9 + 6” system of national urban agglomerations in China describes five national level large urban agglomerations, nine regional level medium-sized urban agglomerations and six sub-regional level small-sized urban agglomerations. CZT urban agglomeration is one of the national level urban agglomerations [57]. In 2006, the “3 + 5” strategy was carried out that consolidated the Changsha–Zhuzhou–Xiangtan (CZT) agglomeration and their adjacent five cities (i.e., Yueyang, Changde, Yiyang, Loudi and Hengyang) into an extensive CZT agglomeration [58]. Hence, the three selected TIAs are all located in the CZT city agglomeration in Hunan province, central China (see Figure 2). Moreover, the three TIAs are all located close to the Xiang River.

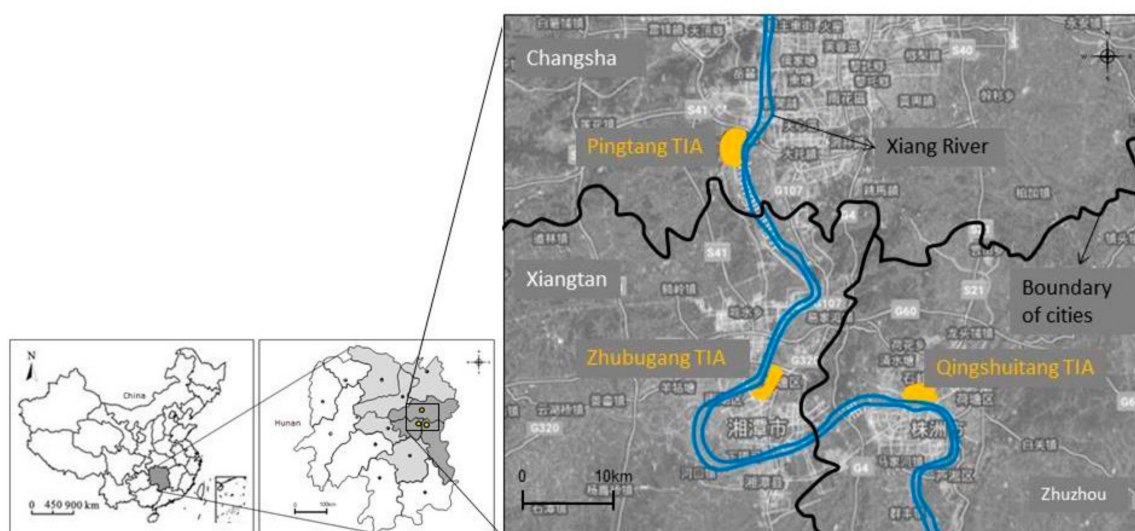


Figure 2. The location of three case traditional industrial areas (TIAs).

Some general information about the three TIAs is listed in Table 1. The TIAs were all established in the 1950s as part of the “three-line” construction. Hunan province has abundant mineral resources and has been coined the “home of non-ferrous metals”. This provided great conditions for resource-intensive

and heavy industries with high energy demands. Industrial companies in these three TIAs included state-owned companies and private companies, however, state-owned companies (especially, central state-owned companies) played the dominant role in terms of the share of the value of production.

Table 1. General information of three case TIAs.

City	Name of TIA	Industry
Changsha City	Pingtang TIA	Mining Industry, Cement Industry, Chemical Industry, Building Materials Industry
Zhuzhou City	Qingshuitang TIA	Smelting Industry, Chemical Industry, Building Materials Industry, Energy Industry
Xiangtan City	Zhubugang TIA	Mining Industry, Chemical Industry, Electrolytic Manganese Dioxide Industry

The case study design allows for a detailed and nuanced understanding in real-life settings. The case study research involved stakeholder interviews and site visits, as well as policy and document analyses. From February 2017 to November 2019, 21 interviews with stakeholders from seven groups of organisations which have close relationships with the transformation of the three TIAs were conducted. Respondents included local government sectors, state-owned industrial companies, private industrial companies, private pollution treatment companies, state-owned finance companies and developer companies (so-called platform companies, PCs), spatial planning agencies and environmental NGOs. Using the guidance of reference [59] on content analysis, the data were analysed according to the following four steps: familiarizing with the data, dividing up the text into meaning units, formulating codes and developing the text into meaning units. Site visits to the TIAs provided insights on the process of urban restructuring and examples of how transformation processes were communicated to the public which were recorded largely through photographs.

Secondary data analysis included policy documents, news items, official government reports, business reports from enterprises and work reports from environmental NGOs. In terms of the sources, most secondary data were accessed through official websites of related organisations and some secondary data were collected from books and brochures published by organisations including yearbooks published by local governments. In some cases, secondary data were provided by interviewees, e.g., undisclosed reports from government or companies.

5. Industrial Ecological Restructuring in Hunan Province

The industrial restructuring of TIAs is certainly influenced by market competition which has triggered demand for new production lines and facilities. This translates into demand for space which is scarce in inner-city TIAs. Land value has risen with progressive urbanisation over time geographically restricting the expansion of industrial production. Despite market pressures and increased costs, government policies that—as during previous phases of industrial transfer—control the spatial dynamics of relocation processes are key to this third phase of industrial transfer.

Sub-national policies which drove the relocation-based transformation of the three TIAs in Hunan province are listed in Table 2. These include a range of policies introduced since 2008 that present different objectives and were issued by different departments. Even though policies used various approaches, they all describe the goal to move or close down polluting industries in TIAs with wording such as “relocate”, “clear out”, “weed out”, “shut down”, “replace”, “upgrade” and “transform”.

Table 2. Policies regulating relocation-based transformation of TIAs in Hunan Province.

	Focus	Policy	Release Date	Publisher
Sustainable Development of Urban Space	Construction of “Green Heart Ecological Area” in the Centre of CZT Urban Agglomeration	<i>Plan of CZT Urban Agglomeration (2008–2020)</i>	2008	“Two-Oriented” Office in CZT
		<i>Plan of “Green Heart Ecological Area” in CZT (2010–2030)</i>	2010	“Two-Oriented” Office in CZT
		<i>Conservation Regulation of “Green Heart Area” in CZT</i>	2012	Standing Committee of Hunan Provincial People’s Congress
Renewal of Old Urban Areas		Construction plan of Changsha Forerunner Area (renamed as Xiangjiang New Area in 2015) as the national pilot of “two-oriented society”	2008	Hunan Provincial Government
		Two cities of CZT (i.e., Zhuzhou and Xiangtan) have been designated as the national demonstration pilots for the transformation of old industrial cities and resource-based cities	2017	National Development and Reform Commission, Ministry of Science and Technology, Ministry of Industry and Information Technology, Ministry of Land and Resources, China Development Bank
Pollution Control	Pollution Treatment of Xiang River Area	<i>The Implementation Plan of Heavy Metal Pollution Control of Xiang River in Hunan Province</i>	2012	Hunan Provincial Government
		<i>The First Three-Year-Plan for Heavy Metal Pollution Control of Xiang River (2013–2015)</i>	2013	Hunan Provincial Government
		<i>The Second Three-Year-Plan for Heavy Metal Pollution Control of Xiang River (2016–2018)</i>	2016	Hunan Provincial Government
	Air Pollution Control	<i>Action Plan for the Prevention and Control of Air Pollution</i>	2016	Hunan Provincial Government
Industrial Restructuring		<i>Supply-side Structural Reform</i>	2016	Hunan Provincial Government
		<i>The Four-Year Plan for the Upgrading of Industrial Structure (2016–2020)</i>	2016	Hunan Provincial Government

Firstly, relocation-based transformation of TIAs is used as a strategy for sustainable development and the greening of urban areas. Policies enforcing the construction of the Green Heart Ecological Area in the centre of CZT urban agglomeration restricted the development of polluting industries and prohibited resource-intensive industries and other secondary sector industries, which led to the closure and relocation of polluting industries in this area. *The Plan of Green Heart Ecological Area in CZT (2011)* foresees the establishment of a nature reserve and ecological space for environmental protection within the urban agglomeration as a demonstration project for the “creative use of ecological resources/capital” [60] (p. 2). The Chinese State Council issued *The Spatial Plan of Main Functional Areas* in 2010. This plan divided national land into four categories based on different carrying capacities of natural resources, existing development intensity and development. Under this guidance of the central government, Hunan provincial government divided the Green Heart Ecological Area into two classes with different development intensities: zones with controlled development and zones where development is prohibited. By the end of 2018, about 400 polluting industrial enterprises were expected to be closed down or moved away from the Green Heart Ecological Area, including 299 industrial enterprises in Changsha City, 52 industrial enterprises in Zhuzhou City and 48 industrial enterprises in Xiangtan City [61–63].

Policies on urban renewal in TIAs also led to the relocation of polluting industries within urban areas. Taking the Qingshuitang TIA as an example, the average distance between factories and workers’ residential area was about 1–2 km as residential areas were distributed in proximity around industrial land uses [64]. Most old residential areas developed to house workers from adjacent TIAs are considered “shanty areas” with the average living space amounting to no more than 6 m² per resident. “Shanty areas” refer to the old town and old industrial areas with a long history and degraded environmental quality. The shanty areas in city centres are referred to as “urban villages”. With urban growth and expansion, many TIAs “moved” into the city centre, which led to serious urban problems. Furthermore, in the 2000s, the recession exacerbated living conditions through increased employment insecurity and poverty in shanty areas [65]. The relocation of industries in TIAs as a strategy for urban renewal was driven not only by the desire to increase citizens’ quality of life and improve working conditions in shanty towns but also to reduce negative effects of shanty areas surrounding factories on the development of city centre areas.

Secondly, relocation-based transformation of TIAs was also driven by pollution control policies to reduce pollution levels particularly concerning water (Xiang River) and air quality. As many industries in TIAs rely on water (e.g., cement industries), three TIAs in CZT are located close to the Xiang River which flows through six cities (including three cities of CZT) in Hunan province serving as source of drinking water for 20 million people. Waste water has been directly disposed into the Xiang River and generated severe pollution to the whole water basin. Pollution from the Qingshuitang TIA alone caused severe heavy-metal pollution along 5 km of the riverside resulting in polluted bottom sludge in a depth of up to 20 meters [66] (p. 5). Pollution control policies include *The Implementation Plan of Heavy Metal Pollution Control of the Xiang River in Hunan Province (2012)* which mandated the reduction of heavy metal pollution by 50%, and the closure and relocation of polluting industries of TIAs along the Xiang River. *The 1st and 2nd Three-Year-Plan for Heavy Metal Pollution Control of Xiang River (2013; 2016)* identified seven TIAs in Hunan Province all located along the Xiang River as “main battlefields” for relocation and transformation including Zhubugang, Pingtang and Qingshuitang. Moreover, serious air pollution problems, for example in Zhuzhou which has been ranked amongst the top-ten most air-polluted cities in China by the Ministry of Environmental Protection for three consecutive years from 2003 to 2005, were directly linked to Qingshuitang TIA [67]. The *Action Plan for the Prevention and Control of Air Pollution* was to prohibit all coal-fired boilers and chimneys which failed to meet environmental standards in city centres. These restrictions helped drive the closure and relocation of polluting industries in TIAs in the city centres as well.

Like previous industrial transfers, relocation-based transformation of TIAs was driven by industrial restructuring but the relationship is reciprocal (Dai and Wang, 2008). Industrial transfers similarly

accelerate the restructuring of industrial systems. The difference from previous industrial transfers is in the greening of industrial systems. Polluting industries in TIAs in the city centres were advised to close down and were replaced by greener industries (e.g., hi-tech, tourism, logistics and tertiary industries). In sum, the relocation-based transformation of TIAs was driven by the objective of a triple win for the natural environment, urban and economic development. Here, the intention goes beyond industrialisation to greener industries.

In response to the discussed industrial relocation strategy promoted by policies (Table 2), municipal governments published specific implementation plans for TIAs where relocation was required, such as *The Implementation Plan for Transformation of Pingtang TIA (2008)*, *The Implementation Plan of Relocation and Transformation of Zhubugang TIA (2013)*, and *The Implementation Plan for Transformation of Qingshuitang TIA (2015)*. Therefore, obsolete industries, identified by local governments following central guidelines and taking into consideration local circumstances, were forced to close while other polluting industries were ordered to relocate and undertake a green transformation.

5.1. Driving Forces behind Policies

The relocation of polluting industries during the eco-transformation of TIAs in Hunan province was motivated by a number of circumstances. Firstly, the fierce debate about the environmental performance of dam projects increased the pressure on government to tackle water pollution. In 2008, different levels of government within Hunan Province (including Hunan provincial government and Changsha municipal government) planned to build three dams on the Xiang River in CZT section. However, local environmental NGOs, researchers and local environmental departments objected as they believed that the dams would slow down water velocity, reduce the river's self-purification capacity and aggravate the environmental problems caused by TIAs along Xiang River. Opposition quickly gained public support with the result that the original opening date was delayed until pollution control of the Xiang River was on the political agenda. This concerted opposition to national policy from local policymakers and non-governmental groups including the public resulted in actions such as the *Prevention and Control of Pollution in Dam Areas* by the provincial government in 2012 and provided the initial impetus for the relocation-based transformation of TIAs surrounding the Xiang River.

However, the large scale of relocation of industries requires not only considerable resources (e.g., financial, human and time) but also threatens to weaken the regional economy including mass unemployment. As a result, relocation policies were not uncontested, encountering criticism from companies, residents and local and regional officials. A "circular transformation" approach was proposed before the implementation of a relocation strategy. Based on a national policy [68], circular transformation is a common strategy to respond to central state legislation and the increasing environmental problems linked to industrial areas. Plans to promote the implementation of circular economy activities among existing polluting industrial enterprises (such as industrial symbiosis networks) in the Qingshuitang TIA were proposed by scholars and the municipal government of Zhuzhou City [69,70]. Examples include reuse of sulphur, heat energy and water among enterprises, and the industrial symbiosis chains built between industrial enterprises of non-ferrous metals, chemical engineering and building materials based on the principle of clean production. However, this circulation transformation approach for TIAs was criticised by other government officials and experts as unsuitable for TIAs in Hunan Province. TIAs are the result of over 50 years of industrialisation and pollution. Approaches like circular transformation were not seen as far-reaching enough to address serious pollution in the long-term. The potential for rapid improvement of the living and working environment in TIAs and industrial restructuring is seen as limited through the circular transformation approach. Additionally, within the positive effects of pioneering practices of other sub-national governments about relocation (e.g., Pingtang TIA and Zhubugang TIA), the national government published a guidance about the relocation of polluting industries during the eco-transformation of TIAs in 2016 (i.e., policy in No. 7 [2016] of General Office of the CPC). As a result, in 2017, the Zhuzhou City sub-national government insisted on the relocation of polluting industries in Qingshuitang TIA.

They believed that only this strategy could solve the complex and fundamental problems caused by TIAs. Banners justifying the short-term costs and challenges linked to industrial transfer and the long-term benefits to be gained could be commonly found across the case study area, for example, in Qingshuitang TIA (Figure 3).



Figure 3. A banner slogan promoting industrial relocation in Qingshuitang TIA: “Short-term pains during the relocation project will achieve long-term development—Leading Group of the Comprehensive Environmental Treatment Project in Qingshuitang TIA [a local government agency]”. (Source: Author, 2017).

Responding to different opinions, local government (mainly governmental departments in the district level) directly communicated and consulted with stakeholders (including industrial enterprises to be relocated, workers to be reemployed and residents to be moved) through symposiums held by government, public surveys and site visits but also through letters from the public to government departments, door stepping by officials and even public protests. Details about the relocation process and welfare allowances were discussed, and relocation projects advanced only with the engagement of a range of stakeholders. This position can also be illustrated by banners encouraging support and participation from multiple stakeholders (Figure 4a,b).



Figure 4. Two banners issued by local government agencies to gain public support and participation. The banner (a) reads, “It’s my responsibility and honour to support and participate in the renovation of shanty areas”. The banner (b) reads, “Everyone is witness, creator and developer of a new era”. (Source: Author, 2019).

A small number of industrial companies (mainly small-sized private industrial companies) took the initiative to relocate prior to relocation policies coming into effect. This was mainly driven by

growing costs tied to increasingly strict environmental standards as well as the lack of available space to expand operations. However, these companies relocated without any technological upgrades and without optimising their facilities for better environmental performance and did not move to industrial parks. As a result, negative environmental externalities moved with them to their new locations. Market forces as drivers for greening of industries are not strong enough in China compared to other countries. Supervision and regulations through the government are needed. This is also one of the reasons why local governments play a leading role during the third regional industrial transfer.

In sum, pressures from the public for environmental protection and better living and working conditions paired with a lack of initiative from industrial enterprises regarding environmental responsibilities resulted in government at multiple scales taking the leading role in the eco-transformation of industrial areas. A relocation strategy was adopted by sub-national government earlier on, and was later promoted by the national government nationwide. During implementation, local government considered interests of different stakeholders. The sustainable development strategy hence considers not only environmental concerns (particularly through pollution control), but also the longer-term urban and economic development.

5.2. Industrial Transfer in Practice: Achievements and Challenges

The relocation-based transformation of TIAs is a long-term and multi-dimensional restructuring process. The relocation and closure of polluting industries in TIAs and industrial transfer as part of the eco-transformation include pollution treatment and urban renewal through land redevelopment and new economic development. Hence, the transformation process is seen to take significant time and state-owned organisations in the case study region used billboards to communicate project timelines and gain public support for the lengthy process. In the case of the Qingshuitang TIA, the transformation was foreseen as a 10-year project.

5.2.1. Closure and Relocation

Based on local government records, there are an estimated 500 industrial enterprises in CZT urban agglomeration that have moved or closed down, half of which were located in the three case study TIAs (see Table 3). Industries which did not meet the environmental, quality, safety and technology standards were ordered to suspend production. Industries could relocate to other areas where they complied with environmental standards, but cases of gross violation were directly closed down [49,50]. Industries that relocated or shut down were mainly polluting industries and resource-based industries (e.g., industries centred on chemicals, nonferrous metallurgy, building materials, papermaking, cement, glass, machine manufacturing and mining).

Table 3. General information on industrial enterprises which moved or closed in three case TIAs (Source: Governmental records and interviews).

City	TIA	Timeline for Closure and/or Relocation *	Total Number of Industrial Enterprises for Transformation	Closed	Moved
Changsha	Pingtang TIA	2008–2010	21	/	/
Xiangtan	Zhubugang TIA	2011–2014	28	9	19
Zhuzhou	Qingshuitang TIA	2017–2018	172	102	70

* Some large-scale industrial enterprises can take up to three years to relocate or close down, which made them exceed the set timeline.

Figure 5 maps the physical relocation of industries within the three TIAs in CZT based on the location of the departure areas within three case TIAs and new locations (receiving areas). Most enterprises moved to areas within the extensive urban agglomeration within a 170 km radius, or even stayed within the same city within an 80 km radius. The lower costs of relocating in proximity

to the original location may have been a factor for the spatial relocation, but the main reason was seen in the policy guidance set out in “Transformation within City, Relocation within Province”. Both the Hunan provincial government and municipal governments of departure areas and receiving areas offered a series of preferential policies and hosted many referral and marketing events to attract and guide the decision of industrial companies about relocation. As a result, taxes paid by relocating industries continued to generate profits for the same city or province. Moreover, most companies moved from city centre areas to suburban areas, for example, the Hunan Jiangxi Xianglong Chemical Industry Enterprise.

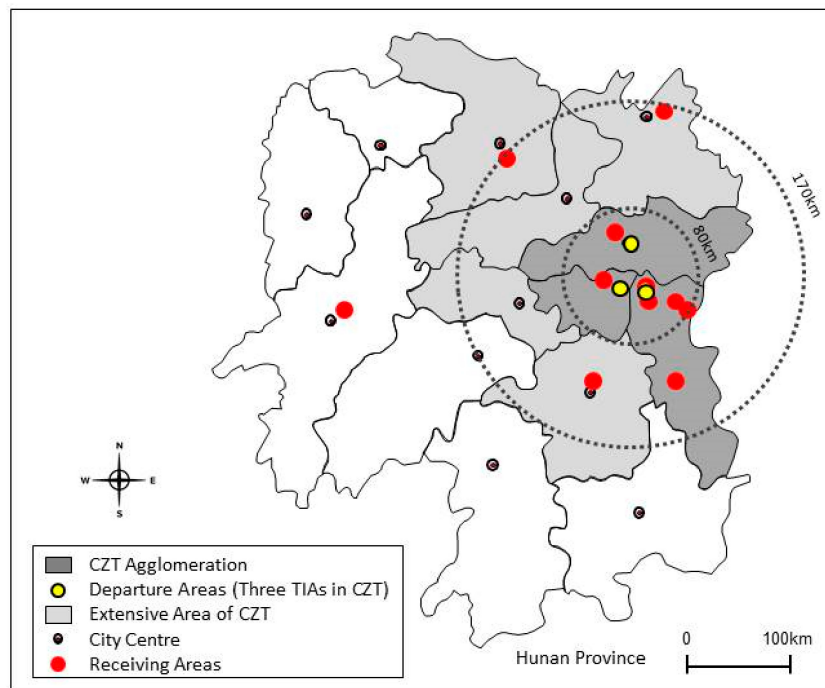


Figure 5. Relocation of industries from the three TIAs. The few enterprises that moved to neighbouring provinces, i.e., Jiangxi Province, are not included due to their small number. (Source: Based on local governmental draft records and interviews).

5.2.2. Environmental Consideration during Relocation

To ensure receiving areas do not carry environmental costs from industrial activities after relocation, a number of strategies were carried out under the supervision of both local government and citizens. Firstly, polluting industries could not simply relocate from one area to another area, but had to transform or improve their material consumption and inputs, production processes and products to meet the technical and environmental standards. For example, Zhuzhou Xinyuanda plastic products company invested 30 million yuan to upgrade their production line (e.g., artificial intelligence production line) and also changed the business direction (i.e., a new green product based on Cu-Pb-Zn polymetallic ore) as part of their relocation.

Secondly, polluting industries could not locate anywhere in receiving areas, but all located in designated industrial parks largely driven by policy strategies focused on integrated development. This was also driven by growing public environmental awareness which made it difficult for polluting industries and local governments to allow relocation in urban agglomerations without any green transformation. The strategy of moving to designated industrial parks also aimed at improving material recycling and reuse as well as centralised treatment of industrial wastes. Industrial parks are usually found in suburban areas meaning industrial activities were relocated from TIAs in urban centres to suburban areas. According to interview respondents, lower environmental standards in

suburban areas were not the main criteria for location choice, even though they were one driving factor. Rather, companies focussed more on the availability of space, availability of infrastructure, distance from original location, access to raw materials, political support and upstream–downstream industrial systems for future development in the new location. Many companies moved to the National Green Chemical Industrial Park in Yueyang City mainly due to the advanced upstream–downstream industrial system and excellent services provided by the industrial park. An interviewee indicated that their company moved to Hubei Province as the main raw materials come from Hubei and the transport costs could be optimized.

Thirdly, governments in departure areas supervised the environmental performance during every step of the relocation. However, relocation still resulted in environmental problems in receiving areas. A representative of a private company for pollution treatment indicated that pollutant leakage problems occurred during the demolition of industrial devices for relocation and close down. The head engineer of an industrial enterprise disclosed that a minority of polluting industrial companies did not locate in industrial parks but other areas without changes to industrial processes and hence no reduction in negative environmental externalities were achieved. In 2018, the national government found that a main receiving area, the Hunan Yueyang Green Chemical Industry Park, suffered severe pollution problems. The park illegally occupied natural lake areas for space expansion, discharged water waste furtively, and operated under loose environmental management. This example illustrates the need for stronger environmental supervision during every step of relocation as well as assuring continued environmental assessment and compliance after relocation. An environmental supervision mechanism for projects across administrative boundaries is expected to be established, but there are challenges and question marks as to how this will be put into practice.

5.2.3. Pollution Treatment after Relocation

After industrial relocation and before land redevelopment, polluted sites of TIAs were treated by the cooperation of the polluting industrial companies in TIAs, state and local governments, PCs and private companies working in environmental detection and pollution treatment. During field visits to Qingshuitang TIA in 2019, there were about 100 small- and medium-sized private companies implementing pollution detection and treatment in cooperation with the general contractors, the Qingshuitang Investment Company (a PC) and the CCCC Third Harbour Engineering Co. Ltd. (a state-owned company for urban investment and construction).

Environmental conditions in departure areas were improved visibly. The soils that had not been disposed of were covered by black manganese ore slags, suffering serious settlement problems in the terrain, and almost no plants would grow there (Figure 6, left). However, after pollution treatment and landscape reconstruction, the sites featured green surroundings and many facilities and amenities, such as basketball courts and kiosks, where people gathered and participated in sporting events together (Figure 6, right), illustrating positive impacts through pollution treatment and landscape projects.



Figure 6. Untreated (left) and treated and restored areas (right) in the Manganese Ore Industrial Heritage Ecological Park (Source: Author, images taken in February 2017).

However, a representative of a private company for pollution treatment stated that they also encountered some dilemmas. The objective of pollution treatment is to treat the water and soil and return it to its pre-industrialized state. However, there are no records and samples of pre-industrialized water or soil in Hunan Province. Therefore, it is hard to determine what would qualify as the current base or best (level of) pollution treatment. Local governments addressed this problem by starting to record environmental quality before any land development or industrial operations/use in 2017. As a result, pollution treatment, on the one hand, currently aims to eliminate pollutants (mainly heavy metals in Hunan Province) that exceed the provincial environmental standard; on the other hand, it also aims to keep contaminants at a stable and controllable level. Large amounts of polluted soil were buried in the deep ground after simple treatment, which generates hidden dangers for the environment in the future.

5.2.4. Renewal of Old Urban Areas

After relocation and pollution treatment, the renewal of TIAs as old urban areas was central to local government (see Figure 7), including resettling of residents from shanty areas, infrastructure construction, green space development and establishment of new and greener industries. Some buildings that used to host the industry were reused for new industries, some were demolished according to masterplans.



Figure 7. Government banner announcing the final step of relocation-based transformation of Qingshuitang TIA as “remoulding old urban areas and building new homes” (Source: Author, image taken in Qingshuitang TIA, November 2019).

In a first step, residents of old and often dangerous buildings in shanty areas were relocated to areas and buildings with better facilities and a higher living standard. By 2018, about 2000 residents in Pingtang TIA, 3504 residents in Zhubugang TIA and about 30,000 residents in Qingshuitang TIA were affected by this resettlement into new buildings under the guidance of local government (Government’s Reports).

Following clearance, TIAs were developed into new urban areas with greener economic activities (e.g., tertiary industries and high-tech industries). According to development plans issued by local governments, the three TIAs adopted different development directions based on factors such as distance to the city centre, eco-tourism resources and ecological capacities. Based on Pingtang TIA’s accessible location, the local government of Changsha City developed the site into a large-scale resort area (including Pingtang Ice World). Both Zhubugang TIA and Qingshuitang TIA are located in central urban areas. The local governments of Xiangtan and Zhuzhou City are transforming those two TIAs into new ecological urban areas that house environmentally friendly and high-tech industries (e.g., logistics, commercial, machinery and rail traffic industries). All three redevelopment projects considered how economic use could be balanced with other urban functional spaces, e.g., green spaces, residential areas, transportation and utilities, commercial areas and educational sites.

However, environmental performance after redevelopment requires further research and critical assessment. Taking the Pingtang Ice World as an example, the sustainability is questionable due to the expected high carbon footprint of the development both in construction and under operation. An ice arena of the planned 920,000 m² requires significant amounts of energy for cooling, material demands through the construction of the resort and the infrastructure, plus resulting carbon dioxide emissions from visitors. By its nature, it is highly questionable whether this can be considered a sustainable land use considering the energy use of an artificial ice world and related impact from expected visitor streams.

Another challenge relates to the time required to attract and establish new industries. The gap between the relocation of old industries and the establishment of new ones may risk losing young generations resulting in an ageing population of affected areas. A small number of young people followed relocating companies, and most young people moved to other areas for new jobs. From an employment perspective, dirty jobs were transformed into greener jobs. For example, from 2010 to 2018, employment in mining industries in Hunan Province was reduced from 154,000 to 53,400 employees, meanwhile, employment in retail increased from 186,000 to 276,500 (Yearbooks of Hunan Province).

Local government has taken actions to tackle this problem. For example, a vacant plot from an air compressor factory in Qingshuitang TIA was used to build nursing homes by the local government. Nursing homes not only provide for an ageing population but also offer employment. Furthermore, many free job training and recruitment fairs were held by local government in the area. At the same time, the local government also attempted to introduce large-scale industrial companies as early as possible in the transformation process. At the end of 2019, Sany (a manufacturer of heavy machinery in China) signed a contract with the local government aiming to invest five billion yuan to build a research and development centre for petroleum intelligent equipment in this area (i.e., Qingshuitang TIA). The location of a large-scale company like Sany is estimated to bring at least 10,000 new jobs to revitalize the region. The local government believes that the loss of young people and the ageing population are only a temporary problem. The vice general manager in a PC argued that a large number of young workers would return once the redevelopment projects are completed.

6. Discussion

According to the broad definition of industrial transfer, three phases of regional industrial transfer since the 1970s can be identified for China. Compared to the previous two regional industrial transfers in China discussed above, the third regional industrial transfer happened between TIAs in city centres with industrial parks in suburban areas starting in the late 2000s. The third wave was guided mainly by sub-national governments and reflects consideration of environmental, economic and social interests. There are further characteristics that are summarized in Table 4 and discussed below.

Table 4. Characteristics of the three phases of regional industrial transfer in China (References: [19,26,49–53], interviews and governmental reports).

	Phase I	Phase II	Phase III
Time Period	1970–1980s	Since the early 2000s	Since the late 2000s
Regional Focus	Central and Western China → Eastern China	Eastern Coastal China → Cities in the Central and Western Regions	City Centres → Suburban Areas; TIAs → Industrial Parks
Industrial Transfer Type	<ul style="list-style-type: none"> International Perspective: 3rd and 4th international industrial transfer from developed to developing countries; Industrial gradient transfer; Deindustrialisation of developed countries/ cities for the development of the neo-Fordist city Chinese Domestic Perspective: changed development focus, preferential policies, developable spaces and workforces 	<ul style="list-style-type: none"> Shifting locational choice of FDI Industrial gradient transfer Restructuring of industrial system and urban regeneration of eastern cities Rise of inland cities after eastern areas 	<ul style="list-style-type: none"> Relocation-based transformation of polluting industries in TIAs Regeneration of old urban areas Greener industrial restructuring Improvement of working and living environment
Main Transferred Industry	Industrialisation policy: changed focus from heavy industries in the inland areas to the development of resource-based, capital-intensive, labour-intensive industries in eastern coastal areas	Resource-based, capital-intensive and labour-intensive industries	Polluting industries and resource-based industries (i.e., chemical industries, nonferrous metallurgy industries, building materials industries, machine manufacturing industries, cement industries and mining industries) in TIAs
Driver	Economic development in China after the Reform and opening-up (especially, the economic opening-up policy of coastal cities)	<ul style="list-style-type: none"> Increasing production costs in the east Policies: “Rise of Central China” (2004), “West Development” (2000), “Drawing Investors” policy in central and western areas Sufficient resources available in central and western areas to develop industries relocating from the east 	<ul style="list-style-type: none"> Urban development and landuse issues (old industrial urban cores) Greener industrial restructuring Increasing environmental public awareness
Actors	Central government following market principles	Central and local government following market principles	Mainly local government following market principles; increased participation of non-state actors
Main Policy Instrument	Incentive Economic Policy	Incentive Economic Policy, Incentive Environmental Policy	Compulsive Environmental/Urban Planning/Economic Policies
Vision	“Let a part of the region get rich first”, access to global market, socialist modernisation, east China as the economic centre nationally and internationally	“The rich first pushing those becoming rich later”, then realising “Common Prosperity” and balanced national development	Triple win of environment, economy and social interests

First, industrial transfer happened at different scales at different times. Different from the deindustrialisation process in advanced Western countries (e.g., UK and USA), industrialisation space shifted domestically within China during the three phases of industrial transfers. The first two transfers were interregional whereas the third wave of relocation is primarily intraregional and, in some cases, even intra-urban (at the urban agglomeration scale). This is partly due to lower industrial gradients between regions meaning that regions no longer rely on attracting industrial development at any price to boost their economy. Through intraregional and intraurban relocations, economic growth remains within the region or city. For continuing tax revenue, local governments intentionally seek to keep companies within the same city or province.

Second, environmental performance of both departure areas and receiving areas was considered as a central element of relocation-based transformation of TIAs. Rising environmental standards in departure areas indirectly affected the first two industrial transfers in China. Industries directly relocated to new areas where environmental regulation was weak. During the third industrial transfer, environmental quality in the departure areas was the main cause, and steps have been taken to “green” the industry as part of relocation and pollution control in receiving areas. The third phase of industrial transfer, hence, uses relocation as a means for environmental protection as well as greening of the economy and urban areas. Environmental equity of regions of different economic levels was hence taken more seriously during this last industrial transfer.

Third, more attention is being paid to social issues during the industrial transfer than in the past, including quality of life and working conditions, wellbeing of citizens, green jobs and provision for the aged. However, further research is needed in order to evaluate the actual impact of the ongoing transfer including questions of marginalisation and just development.

Fourth, sub-national governments played a more critical role in guiding this industrial transfer. Similar to previous industrial transfers in China and following [18], the third industrial transfer in China also followed profit-seeking motives of enterprises. However, state actors set wider objectives besides economic growth: environmental benefits, urban development, land-use and social interests are reflected in the introduction of a range of government policies. The fact that most relocated industries are state-owned industrial enterprises facilitates policy implementation. Moreover, under the environmental decentralisation mode, central government policies and directives are broader and practices for specific regions still require a sub-national government’s embodiment.

Last, and differently from environmental governance processes in advanced Western countries, public participation and inclusion in the decision-making process of environmental policies are still relatively weak and under development. In China, environmental regulations or greening projects of industries in the region are mainly led by the sub-national governments and public participation and consultation processes are guided by the sub-national governments. However, public awareness of environmental issues and civic environmental rights are increasing. The positive effects of non-state actor involvement during environmental projects and environmental governance are recognised by the government. China clearly does not adopt the same forms of public participation in environmental governance as, for example, in Europe and understanding of environmental governance processes in China requires further critical analysis and discussion.

7. Conclusions

This paper has provided an original analysis of the processes and the environmental implications of the third industrial transfer in China, which we term green industrial transfer. Based on interviews, observations and extensive document analysis of case study TIAs within the Changsha–Zhuzhou–Xiangtan city agglomeration in Hunan Province, we have argued that the third industrial transfer differs significantly from previous relocation processes in both intention and process. It is a multi-faceted process involving new actors, clearly shifting responsibilities to various sub-national government levels as well as economic restructuring, urban regeneration, environmental protection and public welfare improvement. Notably, as these industrial transfers are an intra-regional process, the same regulatory

and governmental bodies have authority over both departure and receiving areas. Thus, green transfers attempt to achieve economic and environmental benefits for both the source and destination regions, also to some extent consider social implications. By contrast, previous transfers in China tackled environmental problems by displacement and economic benefit was the primary motivation for both locations and the national government overseeing the process. The situation is very different to Western-originating transfers, characterized by the industry-driven relocation of heavy industries overseas (not least to China). For the West, this has been a process of deindustrialisation rather than an environmental strategy.

Questions remain with respect to the outcome of these green industrial transfers in the Chinese context, particularly related to policies, implementation and stakeholder engagement. Firstly, environmental supervision mechanisms for intra-regional projects are expected to be established but questions remain particularly regarding the implementation of and compliance with these procedures. Secondly, the environmental performance of industries newly built after relocation of TIAs needs further verification. Tools and guidelines to assess the environmental performance during relocation projects need to be strengthened as recommended by others [71]. There appears to be a need for greater collaboration between local jurisdictions, and an enhanced role for regional-scale bodies in environmental oversight. The evolving scales of environmental governance and their implications for eco-transformation are the subjects of ongoing research.

Insights from ongoing industrial restructuring and transfer in China can inform policy recommendations and reference for other regions and also countries with a similar industrial structure. For example, governments and scholars in Vietnam and Indonesia are considering the environmental problems of TIAs and implementing industrial relocation strategies [72,73]. Chinese practices could push other countries to think more about the environmental performance in receiving areas and stakeholder engagement during industrial relocation for a broader understanding of sustainable development. Since different countries and indeed regions have different environmental problems, development purposes and institutional mechanisms, the industrial transfer process in different regions and countries will differ; how this might impact potential outcomes should be the subject of further research.

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