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Chinese lessons on upscaling environmental policy concepts? A review of policy-oriented circular economy research

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Abstract

Circular economy is a policy concept that requires mainstreaming to enable sustainable development through cleaner production and consumption. Unique among CE frontrunners, China's CE implementation is well-documented to be a major experimentation program at different scales. It therefore offers one example of CE upscaling. However, while China is the most studied CE case country, few works have conducted an in-depth analysis of its policy expansion through the scales of implementation. We take advantage of the abundant data source and review 104 scholarly works on Chinese CE policy development and implementation to find out the drivers and barriers behind its CE upscaling process. Our results show that the process was influenced by a complex interplay of centralized governance and multi-level dynamics through a rich portfolio of international, national and sub-national interactions, despite China's authoritarian governance. Yet, our results also suggest that China's macro-level CE development was hindered by implementation barriers stemming from weak multi-level governance. We conclude by drawing three generalizable key policy lessons for other regions and countries. These lessons are relevant for both 'industrialized' regions such as the EU with a longer history of prominent multilevel governance as well as 'industrializing' countries who look to China's development pathway as an alternative model of development to that of liberal democracy.

Keywords: review, circular economy, China, multi-level governance, centralized governance, upscaling

1. INTRODUCTION

Circular economy (CE) is a (re)emerging policy concept that has gained popularity with scholars and practitioners as a solution to resolve the challenges of cleaner production and consumption. Many argue that CE policies need to be upscaled and mainstreamed to realize such goals (Preston 2012; Haas et al. 2015; Geng et al. 2019). Compared to other CE frontrunners such as the European Union, China's CE implementation applies a much more explicit spatial focus, offering a major multi-scalar program of experimentation with designated pilot zones, regions, and cities as well as industrial parks and firms (McDowall et al. 2017). Thus, it provides a good case study to investigate opportunities and challenges in CE upscaling. As China is also the most investigated CE case country in literature and the top source country for CE scholarship (Geissdoerfer et al., 2017; Ghisellini, Cialani, & Ulgiati, 2016; Prieto-Sandoval, Jaca, & Ormazabal, 2018), there is ample scholarly data available and a literature review is therefore a suitable first step to research the drivers and barriers for CE's multi-scalar policy development and implementation.

One challenge of drawing lessons from the Chinese case for broader CE development and implementation in other regions and countries is its top-down governance regime, which is in contrast to liberal democratic models of multi-level governance. However, while Chinese CE policy programs have been described as examples of centralized, top down governance, executed systematically through various strategies at the micro-level (cleaner production), meso-level (eco-industrial development) and macro-level (eco-cities) (Ghisellini et al., 2016; Murray et al., 2017; Sauvé, Bernard, & Sloan, 2016), another body of literature documents China's multilevel environmental and climate

governance (e.g. Schreurs 2017, Hensengerth 2015). To account for this divergence in our study, we formulated the following research questions for our targeted systematic literature review of Chinese CE policy development in the context of its scales of implementation:

1. What can CE literature tell us about drivers and barriers of the Chinese CE policy mainstreaming and upscaling process from the micro to macro scales?
 - a. Was the CE upscaling process driven by centralized or multilevel governance?
2. What can other regions who wish to upscale CE learn from Chinese CE policy literature?

Based on the above questions, this paper will (1) review descriptive categories to identify characteristics about the sources and foci of the Chinese CE policy literature, (2) take stock of the given drivers and barriers for CE policy upscaling in the literature in relation to governance and implementation levels, and (3) identify research gaps and implications for research and practice.

In this paper, we frequently use the terms ‘upscale’, ‘policy’, ‘policy concept’, and ‘level’. We hereby define these vocabularies for the purposes of our study. ‘Upscale’ is defined as ‘expanding, adapting and sustaining successful policies, programs or projects in different places and over time to reach a greater number of people’ (World Bank 2005). ‘Policy’ refers not only to ‘policy objects’ but also to ‘policy processes’. We understand ‘policy processes’ broadly as sequences of events that lead to the formulation of government decisions. Given the Chinese context, ‘policy objects’ include not only laws, regulations, and plans, but also to official documents published by all levels of Chinese government, such as Opinions, Standards, and Indicators as well as official decisions announced in speeches. For example, the Chinese CE Promotion Law, the Five-Year-Plans, as well as decisions announced at the Party Congresses are all policy objects that are part of CE policy development. We use ‘policy concept’ in the constructivist tradition as a policy label based on Silva, Stocker, Mercieca, & Rosano (2016). We employ the term ‘level’ and ‘scale’ interchangeably to mean both physical areas of implementation, such as the ‘micro’, ‘meso’ and ‘macro’ levels, but also the scales of governance, such as ‘international’, ‘national’ and ‘subnational’, and will specify depending on the context in which it is used.

2. METHODS OF THE REVIEW

2.1 Data selection

As an interdisciplinary topic of study, CE cuts across disciplines such as industrial ecology, urban planning, environmental and ecological economics, business and management, resource economics, environmental conservation, engineering, and sustainability science (Ghisellini et al., 2016; Prieto-Sandoval et al., 2018). As Chinese CE is relevant for many of these fields, literature outside of policy related disciplines also cover aspects of CE policies in China. In order to address this diversity, the present article is based on a comprehensive literature review comprising journal articles and books with “China”, “circular economy”, “policy” and related synonyms in the title, keywords, or the abstract.

Literature that discusses CE policies in China without using the term ‘circular economy’ but instead using terminologies such as ‘recycling economy’ or ‘cyclic economy’ were left out. This methodological decision was taken because including all of the works would have resulted in a sample too broad and

too large to analyze in a single in-depth qualitative review. As CE-related terminologies are cited in the generated sample, the various meanings of different wordings are still captured in the analysis.

The literature search was conducted between December 2017 and April 2018, using Web of Science, Google Scholar, and the Chinese database CNKI. These search engines were used to find scientific journal articles and books in English and Chinese from the earliest year each respective database had to offer until April 2018. Title, keyword or abstract searches were conducted using the search term combinations 'China + circular economy + policy/government policy/governance/strategy/law/initiative/plan/legislation/regulation/rule' and its Chinese counterpart '中国循环经济 (Chinese circular economy) + 政策 (policy) / 治理 (governance) / 战略 (strategy) / 法律 (law) / 计划 (plan) / 立法 (legislation) / 规则 (rule)' to retrieve the most relevant articles. The English search string was used in Web of Science and Google Scholar while the Chinese search string was used in CNKI. The slight variations between the English and Chinese search strings are due to nuances in translation, and were selected on the basis that they generated the highest number of relevant results. All searches excluded works focused on 'corporate governance' or 'corporate strategy', as business policies fall outside of the scope of our study, as well as Master's and PhD theses. This returned 286 results in Web of Science and Google Scholar, and 67 results in CNKI. In the two former databases, 87 works in English remained after filtering out conference proceedings, working papers, inaccessible publications, duplicates and removing papers whose contents did not address China, CE and policy, or focused on administrative policies. Inaccessible publications included one retracted publication and three book chapters in Chinese. To ensure relevant articles were selected from CNKI, only articles with abstracts in both Chinese and English were included in the review, as reputable Chinese language journals generally require abstracts in both languages (Flowerdew & Li, 2009). After applying the aforementioned criteria, 17 works in Chinese remained. The complete list of the 104 collected works can be found in Appendix I: Supporting Information.

2.2 Data analysis

We first checked the collected sample for their objective, the scale of implementation addressed, policy program in focus, and geographical context. This analysis enabled us to 1) segment the literature sample into works that focused specifically on CE policy programs and works that focused on CE-related policy programs such as 'cleaner production', 'eco-industrial parks', 'eco-cities' and 'low-carbon zones', and 2) identify at which scales the investigated policy programs were implemented. Table 1 summarizes the segmentation and shows selective literature samples. Figure 1 gives an overview of the geographical contexts for the literature focused on subnational levels.

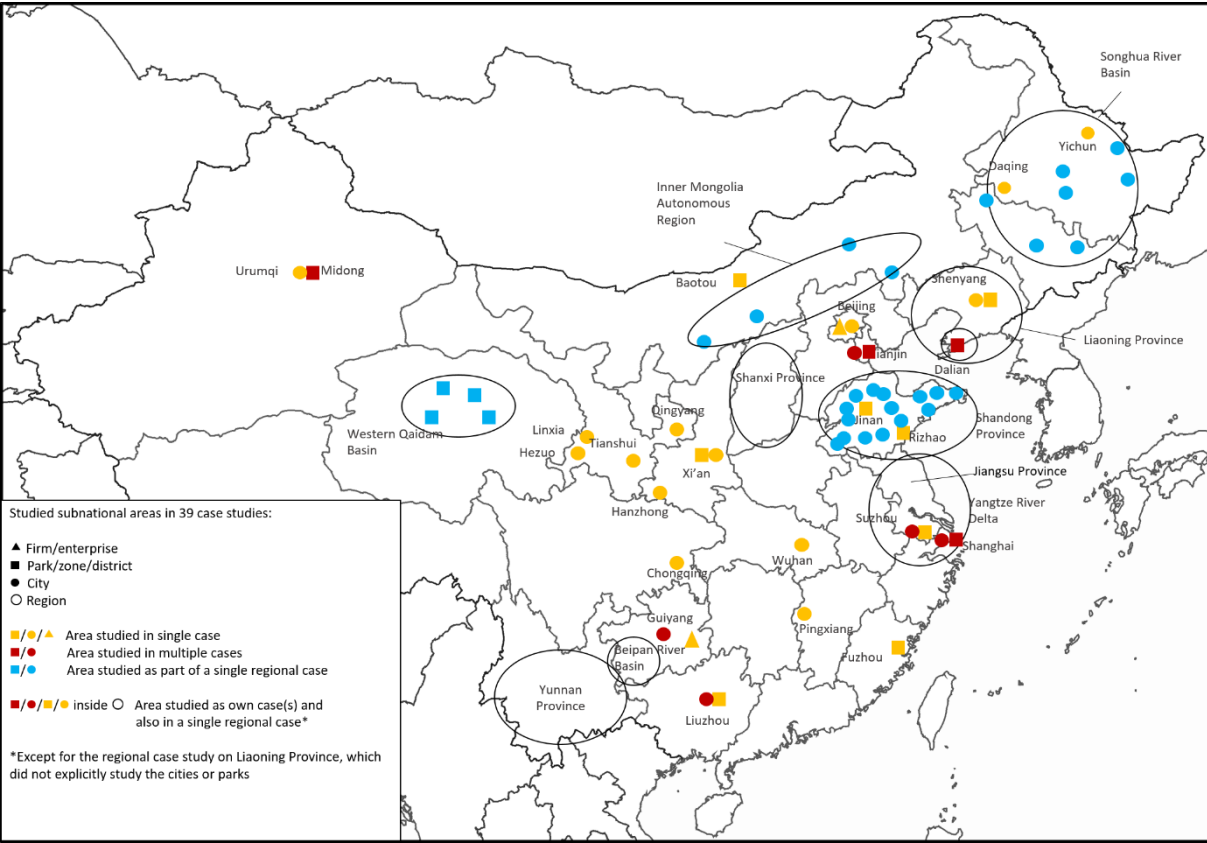
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<Table 1.> **Segmentation of policy-oriented CE literature based on three categories**

Objective	Scale of implementation addressed	Policy program in focus	Selective examples
Policy program overview	International comparison	CE	(McDowall et al., 2017) (Sakai et al., 2011) (Murray et al., 2017) (Winans et al., 2017) (Xiang, 2010)
	National program overview	CE	(Liu et al., 2017a) (Qi et al., 2016) (Naustdalslid, 2013) (Su et al., 2013) (Mathews et al., 2011) (Li and Yu, 2011) (Geng and Doberstein, 2008) (Ren, 2007) (Feng and Yan, 2007) (Yuan et al., 2006) (Li and Lin, 2016) (Zhu et al., 2005) (Lu et al., 2015) (Wang and Chang, 2014) (Li et al., 2008) (Zhu, 2008) (Xin and Zhao, 2010) (Fan, 2008) (Zhu et al., 2005) (Qiao and Ning, 2007)
	National policy analysis	CE	(Wu et al., 2014) (Jiao and Boons, 2017)
	National policy evaluation/ assessment	CE	(Geng et al., 2012)
	Regional policy review	CE, Eco-city	(Geng et al., 2009) (Li and Yang, 2016)
Implementation evaluations	Firm level evaluation	CE, Sustainable Development	(Chen et al., 2017a) (Zhu et al., 2017) (Ma et al., 2015)
	City level comparative evaluation	Eco-city, Eco-industrial park	(Guo et al., 2017a) (Dong et al., 2013b) (Zhang et al., 2009)
	Regional/City level evaluation	Eco-city, Cleaner Production, Low Carbon, Eco-industrial Park, Eco-province	(Li and Jong, 2017) (Sun et al., 2017) (Guo et al., 2017b) (Guo et al., 2016a) (Chang et al., 2014) (Flynn et al., 2016) (Chen et al., 2015) (Guo et al., 2016b) (Geng et al., 2010b) (Geng et al., 2010a) (Chen et al., 2017b)
Policy implications from theory and practice	International practice implications for Chinese CE policy	CE	(Zhu, 2017) (Yue and Xu, 2017) (Tao and Wu, 2005) (Zhang and Zhang, 2007)
	Theoretical implications for eco-industrial park development	Eco-industrial park, CE	(Liu and Côté, 2017) (Liu et al., 2017b) (Geng et al., 2016) (Jiao and Boons, 2014)

	Chinese eco-industrial park practice implications for CE development	Eco-industrial park, CE	(Yu et al., 2015a) (Zhu et al., 2015) (Yu et al., 2015b) (Liu, 2015) (Geng et al., 2014) (Yu et al., 2014) (Shi and Yu, 2014) (Lei and Ming, 2012)
	National practice implications for CE policy	CE	(Li et al., 2013) (Kong, 2010)
	City/Regional theory and practice case study implications for CE	Low-carbon, eco-province	(Xue et al., 2010) (Liu et al., 2012) (Dong et al., 2013a) (Wang et al., 2015)

<Figure 1.> **Overview of geographical context from investigated literature**



Subsequently, we analyzed the literature focusing on the CE as a policy program, using deductive categories derived from our research questions and paying special attention to the upscaling drivers and barriers between the scales of implementation. The results from this textual analysis are summarized in section 3.1.

In the next step, we analyzed the remaining literature focusing on CE-related policy programs following the same procedure. We also went back to the first group in an iterative process based on intertextual content analysis techniques, allowing inductive categories to arise and adding an interpretive dimension to access a deeper layer of meaning of the studied literature (Hsieh & Shannon, 2005). Inductive categories that emerged include ‘policy goals’ and ‘implementation barriers’. The results from this contextual analysis are summarized in section 3.2.

Despite this detailed and rigorous iterative process, our analysis is limited by only using academic literature as its data source. When studying CE policy development in country case studies, the use of policy documents, official media, and empirical data such as interviews, should be considered in order to access CE stakeholder perceptions (Leipold & Petit-Boix, 2018) and capture the full scale of policy change. We believe that a review of scientific knowledge on policy development and implementation can provide a useful overview of existing knowledge and serve as a stepping-stone for further empirical analysis.

3. RESULTS

3.1 Centralized governance as main driver for upscaling

In this section, we summarize the results of our analysis of articles that address CE as a policy program, staying close to the text. The results show that CE policy upscaling is driven by international scholarship, policy experience, and competition as well as shifting national policies, actor dynamics, and ideological goals.

3.1.1 International drivers

Although Chinese CE is often portrayed as distinctive from ‘western countries’ (Li et al., 2008; Qi et al., 2016; Ren, 2007; Ren & Wu, 2005; Yuan, Jiang, Liu, & Bi, 2008), various literature document international elements that have influenced its development. First, transnational scholarship and recycling-focused national policy experiences from Germany, Japan and Sweden inspired the original take-up of CE in China (Liu, 2015; Ren & Wu, 2005; Zhu, 2008, 2017) and various Chinese language literature cite ‘western’ CE regulations, implementation and standards as models for the Chinese CE (Yue & Xu, 2017; Zhang & Zhang, 2007; Zhu, 2017).

Second, many CE-related policy concepts, such as Cleaner Production, Eco-Industrial Park, Eco-city, and Low-Carbon Development, were taken from international agreements or documents initiated by the United Nations Environment Programme (UNEP), the United Nations Educational, Scientific and Cultural Organization (UNESCO), and the United National Framework on Climate Change (UNFCCC) (Li et al., 2008; Li & Yang, 2016; Liu & Côté, 2017; Winans et al., 2017).

Third, international competition is often cited as an underlying driver for Chinese CE. Qi et al. (2016) and Li & Yang (2016) explain China’s prioritization of high-speed growth as a form of ‘catching up’ to developed countries, a consequence of China’s modern historical experience of imperial aggression from industrialized countries. Chinese CE is thus a means to achieve long-term national goals such as sustainable development (Li et al., 2008; Mathews, Tang, & Tan, 2011; Zhu, 2008), ecological modernization (Li et al., 2008; Park et al., 2010; Zhu, Geng, Sarkis, & Lai, 2015), decoupling of economic growth from resource use and environmental impact (Geng, Liu, Liu, Zhao, & Xue, 2011; Mathews et al., 2011; Zhu, 2017), building a well-off/moderately prosperous/Xiao Kang society (小康社会) (Feng & Yan, 2007; Ren, 2007; Ren & Wu, 2005) and national rejuvenation (Li & Yang, 2016; Qi et al., 2016). CE should help the country avoid the ‘western’ development pathway of ‘pollute first, treatment later’ (先污染, 后治理), instead achieving ‘leapfrog development’ past the worst problems of ‘western’ industrialization and into a sustainable economic structure (Geng & Doberstein, 2008; Li et al., 2008; Su, Heshmati, Geng, & Yu, 2013). CE is also projected to increase China’s national competitiveness and national security by improving its sustainable resource and materials management and help China

comply with growing green standards in international trade (Feng & Yan, 2007; Li et al., 2008; Zhang, 2011).

3.1.2 National-level drivers

New or revised national-level policy documents are often cited as drivers of CE policy development (Li, Chen, & Chang, 2008; Li & Lin, 2016). Li et al. (2008) cite the 2005 State Council Opinion ‘On Accelerating CE Development’, the 11th Five-Year-Plan (5YP) and the 16th Party Congress as key drivers for changing CE policy focus from environmental protection to sustainable economic development in the form of industrial restructuring and upgrading. The 2005 State Council policy and the 11th 5YP account for the expansion and scaling up of the national demonstration pilots around China (Li et al., 2008; Wu, Shi, Xia, & Zhu, 2014). The Circular Economy Promotion Law (CEPL) is recognized as upscaling the scope of CE, linking CE projects to the city level, instituting long-term development strategies and establishing CE as a comprehensive measure for the 17th National Congress as well as leading it into the 12th 5YP period (Jiao & Boons, 2014; Kong, 2010; Xin & Zhao, 2010). CE’s link up to low-carbon development is seen as a result of the 12th 5YP (Chang, Leitner, & Sheppard, 2014; Wang & Chang, 2014; Winans, Kendall, & Deng, 2017; Xue et al., 2014).

Another commonly cited reason for CE policy changes is the dynamics of actors at the national level. Jiao & Boons (2014) argue that the State Council’s appointment of the National Development and Reform Commission (NDRC) to take over as the major coordinator for CE promotion from the State Environment Protection Agency (SEPA) showed its support of CE in terms of sustainable economic development in lieu of SEPA’s environmental interpretation. The change in responsible actor also led to the kick-off of the National Program of CE pilots, a significant upscaling from SEPA’s CE guidelines in the Eco-Industrial Park pilots. In Jiao & Boons (2017), the authors elaborate on this theory. They stress that it was due to the NDRC’s take-up of CE that a centralized alliance between multiple ministries developed based on the economic oriented interpretation, increasing CE awareness in regional actors and local practice. Liu, Z. et al. (2017) imply a similar driver behind CE’s link up to low-carbon development, arguing that, in addition to the Ministry of Environmental Protection and the NDRC, it was the involvement of the Ministry of Industry and Information Technology in establishing national demonstration industrial parks that led to the policy shift in developing industrial symbiosis as a tool for GHG emission mitigation.

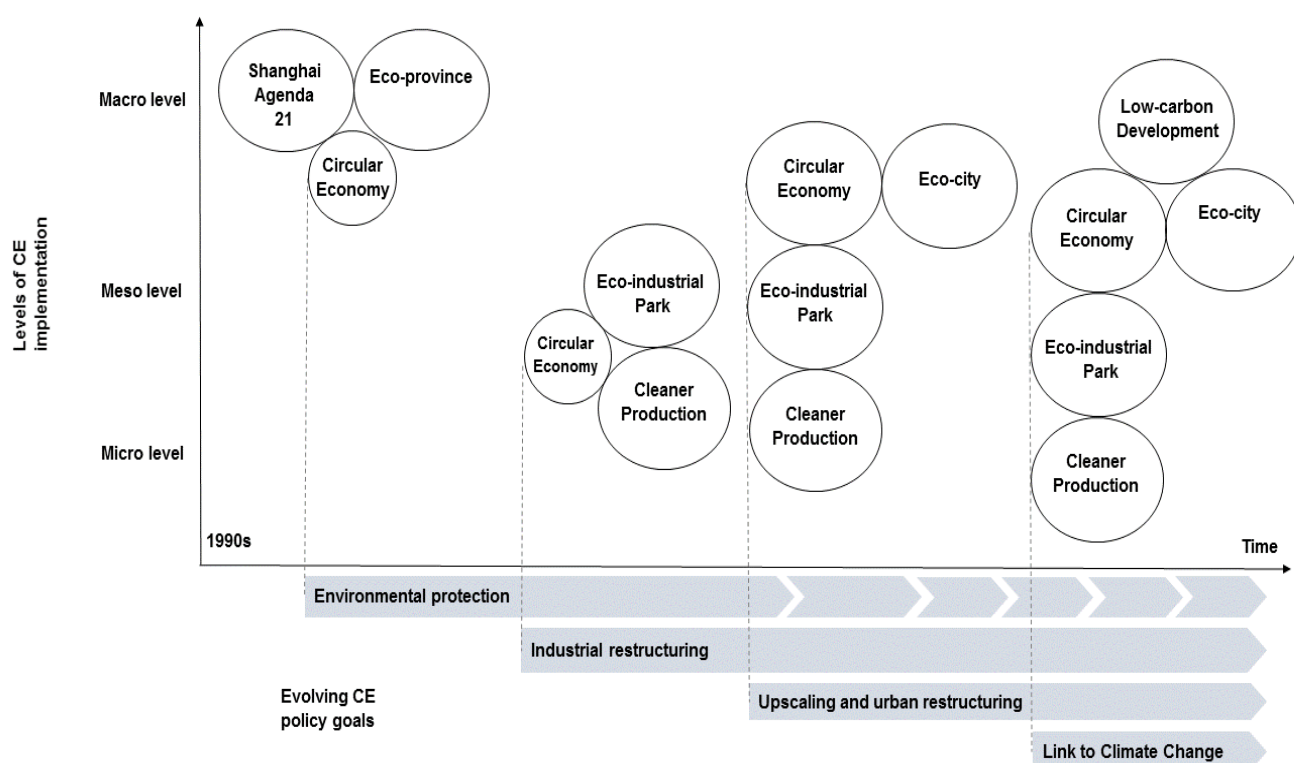
In other instances, literature explains policy shifts at the national level in terms of theoretical or ideological goals. Some explain the shift from an environmental to economic focus in terms of a technical reorientation from end-of-life waste management to earlier supply chain source management (Ren & Wu, 2005; Yu, Han, & Cui, 2015; Zhang, 2011). Ren & Wu (2005) argue that this phenomenon is also a sign of Chinese environmental protection turning from single to comprehensive mechanisms, combining environment and economic concerns, and solving environmental problems through development. Jiao & Boons (2014) claim the State Council supported the NDRC’s economic direction more than SEPA’s environmental focus because it was more suitable to the Chinese context as a developing country. Li et al. (2008) imply that CE was taken up as a national development strategy in 2002 in response to the National People’s Congress setting goals to achieve a moderately prosperous society and to double GDP by 2020; CE is expected to help achieve the latter by harmonizing economic growth and socio-environmental well-being.

3.2 Co-evolution of CE policy goals through the subnational levels

This section summarizes the contextual analysis that brings literature focused on CE as well as CE-related policy programs together. The results demonstrate how CE policy goals evolved as CE traversed

different subnational levels, starting with environmental protection, industrial restructuring, moving towards upscaling and urban restructuring, as well as linking up with climate change.

<Figure 2.> Overview of changing relationships between policy concepts as CE policy goals evolved through the levels of implementation. Circle clusters represent changing concept relationships. The size of circles indicate relative importance of policy concepts.



Environmental Protection

When first introduced by Chinese academia, the intended policy goal of the CE was environmental protection against damage from China's rapid industrialization (Geng & Doberstein, 2008; Ren, 2007; Yuan et al., 2008; Yuan, Bi, & Moriguchi, 2006). Studies that discuss the two early macro-level policy concepts that implemented CE ideas, Shanghai Agenda 21 and National Demonstration Program of Eco-zone, portray their goals as environment-focused, prioritizing waste and pollution control (Jiao & Boons, 2017; Yu, 2017). The common goal of environmental protection brought CE together with

‘Cleaner Production’ and ‘Eco-industrial Park’ (EIP), two pre-existing policy concepts that had received pilot projects under SEPA. Further, SEPA’s *Guideline for CE Plan Making (2000)* provided official rules for integrating CE activities into EIPs, in addition to existing goals pushing for cleaner technology, eco-design and other eco-industrial approaches such as the 3Rs: “Reduce, Reuse, Recycle” (Liu, 2015; Ren, 2007). *The Cleaner Production Promotion Law (2003)* developed alongside the subnational pilots and was the first Chinese national legislation to explicitly define CE (Winans et al., 2017). SEPA’s promotion of CE via Cleaner Production and EIP projects across the country increased CE’s policy profile while also refining its goals (Geng et al., 2009; Geng et al., 2010; Liu, 2015; Liu, L. et al., 2017; Park et al., 2010). This expansion led to the transition of CE’s problem framing from environmental protection towards industrial restructuring for sustainable economic development (Yuan et al., 2006).

Industrial Restructuring

CE policy goals began to change focus, settling on industrial restructuring in 2002, coinciding with official recognition at the 16th National Party Congress where the CE was formally accepted as China’s new sustainable development model (Geng & Doberstein, 2008). Yuan et al. (2006) describe the shift as influenced by implementation challenges due to cost or technological barriers from previous engineering driven CE-related projects, which focused on closing waste loops between companies. It became increasingly acknowledged that CE would be better realized if the SEPA pilot projects shifted their attention from waste recycling to industrial restructuring for efficiency, as well as developed new technologies and reformed industrial policies as a main part of the national scientific development strategy (Yuan et al., 2006). The State Council confirmed this shift in focus by appointing the NDRC as the new responsible agency to roll-out CE as a state economic development policy that also fulfils environmental goals, replacing SEPA’s approach to the CE as a purely environmental strategy (Jiao & Boons, 2017; Yuan et al., 2006; Zhu, 2008).

Upscaling and Urban Restructuring

Articles began referring to CE as having its own policy goal after it had gained its own pilots at the micro and meso levels and following incorporation into the 11th Five-Year-Plan (5YP) for National Economic and Social Development (Chang et al., 2014; Qi et al., 2016; Ren, 2007; Winans et al., 2017; Zhang et al., 2009). CE’s new status as a national level goal facilitated linkage with the macro-level ‘eco-city’ policy concept. Both became officially linked to high-profile goals such as ‘ecological civilization’, China’s long-term vision for sustainable development (Li & Yu, 2011; McDowall et al., 2017; Naustdalslid, 2013; Ren, 2007).

The policy goals of merging CE ideas with the macro-level ‘eco-city’ concept included concentrating efforts to integrate environmental concerns into urban social development (Chang et al., 2014; Flynn, Yu, Feindt, & Chen, 2016; Li & Yang, 2016). ‘Eco-city’ sought to reframe previous goals of urban economic development to prioritize pollution mitigation and environmentally friendly public infrastructure, reduce resource consumption, and conserve and restore natural areas (Kennedy, Zhong, & Corfee-Morlot, 2016). The ‘CE eco-city’ has the same definition except the means to achieve these goals focus on green technology, CE principles and scientific methods (Chang et al., 2014). Critiques on the implementation of CE and ‘eco-city’ development state that indicators for measuring effectiveness are overly technical and do not consider communities that live within the cities (Flynn et al., 2016; Li & de Jong, 2017). While eco-city construction is a means of achieving ecological civilization, and should enable these cities to achieve a ‘moderately prosperous society’, improve living standards,

and provide a beautiful environment while sustaining rapid economic growth, literature portray ‘eco-city’ development to be in its early stages, and current examples are often economically deprived cities that need revitalization (Li & Yang, 2016).

Linking Up with Climate Change Mitigation

More recent literature suggests policy linkages between CE and ‘eco-city’ and the similarly promoted meso-level concept of ‘low-carbon development’, indicating an overlap of CE with climate change mitigation at the macro-level (Jiao & Boons, 2014; Liu, 2015; Liu & Côté, 2017; Zhu et al., 2015). The 12th 5YP period conceptualizes CE as one of various policy instruments for fighting climate change and associates it with carbon dioxide emissions reduction targets (Chang et al., 2014; Wang & Chang, 2014; Winans et al., 2017; Xue et al., 2014). Specifically, the National New-Type Urbanization Plan (2014-2020) includes goals to integrate ecological civilization into the urbanization process: “to promote green, circular, low-carbon development and environmental protection and ecological restoration, and to form a new mode of green low-carbon production and urban life” (Li & de Jong, 2017).

3.3 Upscaling challenges through implementation barriers

While articles did not refer directly to barriers for upscaling CE policy, many referenced it indirectly by pointing out barriers to CE implementation at the meso/industrial park and macro/urban/regional scales. While few barriers were reported at the micro scale and pollution control goals of CE appear effective, the key barriers at the meso and macro scale comprise:

- 1) lack of external support, including fragmented legal and regulatory systems, and inadequate technology, investments and incentives to engage private stakeholders (e.g. Qi et al. 2016; Geng et al. 2009; Geng et al. 2010; Su et al. 2013);
- 2) regional differences and uneven development (e.g. Wu et al. 2014; Zhu et al. 2015);
- 3) poor coordination between implementing agencies, between central and local agencies, as well as poor diffusion of successful experiences to new pilots (e.g. Chang et al. 2014; Geng et al. 2008; Feng & Yan 2007); and
- 4) spatial limitations between pilots (e.g. Liu et al. 2017; Yu et al. 2015).

The first barrier reflects the conflicts between CE policies and historical economic and environmental policies as well as the challenges of implementing agencies to achieve both economic and environmental targets. The second barrier refers to the uneven development stages of different geographical contexts as well as their budgets for carrying out CE implementation. Institutional, technological and knowledge capacities vary significantly between regions and make vertical diffusion difficult. The third barrier builds on the second barrier as it hinges on a key capacity difference which is public and official awareness of CE. A lack of awareness or prioritization can lead to unwillingness to coordinate and share information. Lack of civil participation and consumption side activities also leads to poor CE implementation, especially at the macro level where it requires citizen participation. The fourth barrier with regards to spatial limitation reflects the issue that some pilots were too small or too large for the desired symbiosis activities to effectively produce the desired environmental outcomes.

4. DISCUSSION & CONCLUSION

Our literature analysis shows that, even in authoritarian China, an interplay of centralized governance and multilevel dynamics played reinforcing roles as drivers of CE in its policy mainstreaming and upscaling. However, weak multilevel governance contributes to many implementation barriers at subnational scales, indirectly hindering further macro-level upscaling. While the dynamic interdisciplinary literature offers a rich portfolio of drivers of Chinese CE policy upscaling and mainstreaming, it offers little specific information on upscaling challenges, but does provide a plethora of implementation barriers that center around weak coordination between centralized and multilevel governance. We find that these implementation barriers prevent further upscaling of CE policy in China and call for more research on linking implementation challenges to research on upscaling environmental policy such as CE.

We derive three general policy lessons with a scalar focus from the Chinese CE policy literature for regions and countries who wish to adopt, mainstream and upscale CE policy. By focusing on CE and its development across multiple scales/levels in China in this review, we identify a common denominator between China's authoritarian and western liberal democratic contexts and contribute to CE literature by adding an entry point for future comparisons of CE development and implementation across diverse governance contexts. We discuss in the following section each lesson with relation to our literature analysis, followed by suggestions for future research to integrate CE together with more spatially-focused research, such as scholarship on centralized and multi-level governance.

First, it is crucial to consider what combination of centralized and multilevel governance is needed for each respective locales of CE implementation. Our textual analysis of articles that address Chinese CE as a policy program show that CE policy upscaling to be driven primarily by shifting national policies, actor dynamics, and ideological goals. Our contextual analysis, which brings together literature focused on CE as well as CE-related policy programs, demonstrates how such ideological goals evolved as CE traversed different subnational levels, starting with environmental protection, industrial restructuring, moved towards upscaling and urban restructuring, as well as linking up with climate change. China has a long history of using 'decentralized experimentation' to inform its national legislations and subsequent centralized governance (Heilmann, 2018). While China's model may not be easily replicable in non-authoritarian countries, Skene (2018) suggests that China's CE approach has already influenced the EU, a model region for multilevel governance, and its adoption of more top-down transnational engagement in its CE policies. It is therefore not about choosing between centralized and multilevel governance but a question of how to integrate the two effectively. CE upscaling research would benefit from future studies that examine how to improve coordination between different levels of governance because as our study has shown, also in China, multilevel dynamics occur within a variety of governance regimes.

Second, it is important to preempt how CE goals might interact and evolve with existing policy goals at the scales of implementation, e.g. land-use planning, infrastructure construction, social policy etc. CE policy goals are not pre-given and static at any scale and will co-evolve, either compete, harmonize or merge, with other dominant policy goals at that level. Chinese CE policy goals are linked to 'Cleaner Production' at the micro-level, EIP at the meso level and eco-city at the macro level. However, at the macro scale, 'CE eco-city' also began competing with low-carbon development for conceptual dominance in urban environmental governance. To ensure effective CE implementation, CE goals will need to be prioritized especially as their complexity increases at the macro levels. In the Chinese case, CE implementation was successful when it referred only to the singular goal of pollution control. Once

the concept evolved into a more complex idea and re-emerged together with eco-city at the macro-level to drive urban restructuring, the goals of CE began fluctuating with the priorities of the city as well as the nation, and continues to evolve. Future research could further investigate the interlinkages between CE policy goals and the levels of implementation, specifically what dynamics lead to successful policy integration and what leads to obsolescence.

Third, macro scale CE development is still in its infancy and requires more conceptualization, coordination and silo-breaking between relevant stakeholders. Although Chinese CE is an exemplary case of CE upscaling, our analysis shows that its implementation barriers, especially those at the macro levels, obstruct further development. Weak multilevel governance resulted in contentious implementation of CE policies that have negative or ambiguous consequences for the environment. It also creates difficulties for other implementation necessities such as technology development, information sharing, public awareness raising, and local official training. Without an adequate conceptualization or delineation of what macro-scale CE is, it is difficult to develop indicators and evaluations of larger scale CE implementation. Future research needs to develop macro scale CE both conceptually and practically in order to link production and consumption systems with wider social and cultural systems. Investigating coordination between CE development at different international, national and subnational scales through relational lenses may help to overcome the challenge of aggregating lower scale implementations. As regional differences and uneven development are a key implementation and assessment barrier, researchers could investigate both how this challenge could be overcome but also the scale limitations of CE. For example, which scales of implementation is CE most effective at? Does upscaling always bring improved socio-environmental impacts?

In summary, Chinese CE cannot be reduced to a top-down policy directive as it is influenced by a rich portfolio of international, national and sub-national interactions, alternating between centralized and multi-level governance. However, weak applications of multi-level governance create implementation barriers that lead to stagnation in further CE upscaling. To understand CE policy development and implementation, we require research that incorporates political and relational dynamics of the case country and addresses the interface between centralized and multi-level governance. This is particularly important as CE implementations at the macro-level require further theoretical and practical research to gain conceptual coherence in China and elsewhere. As many CE implementations continue to occur in a fragmented manner, it remains a challenge for researchers and practitioners to create platforms for systemization. Furthermore, as scholars and practitioners have defined the globalization of CE as an important task (Ellen Macarthur Foundation, 2014; Geng, Sarkis, & Bleischwitz, 2019), more research is needed to explore how different countries or regions engaging with CE interact in the international domain. As CE pertains to issues of sustainable resource use and global environmental change, it will be important to pay attention to how geopolitics influences its development. The various drivers and barriers identified by this review could serve as a starting point for such new CE research that explores the interface of international, national and subnational levels in China and beyond.

Author contributions

Anran Luo was responsible for the design of the study, undertook data collection and analysis and took the lead in writing the manuscript. Sina Leipold provided substantial input during conception and design, data collection, analysis and interpretation and critically revised the draft for important intellectual content. All authors gave their final approval to the manuscript. The authors declare no conflict of interest deriving from publication.

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Legends for figures and supplementary materials

Figure 1. Overview of geographical context from investigated literature

Figure 2. Overview of changing relationships between policy concepts as CE policy goals evolved through the levels of implementation. Circle clusters represent changing concept relationships. Size of circles indicate importance of CE policy concept.

SUPPORTING INFORMATION

This Supporting Information provides a complete list of the analyzed literature.

443 References

- 444 Berg, B. L. (2007). *Qualitative research methods for the social sciences* (6th ed.). Boston,
445 London: Pearson/Allyn & Bacon.
- 446 Blomsma, F., & Brennan, G. (2017). The Emergence of Circular Economy: A New Framing
447 Around Prolonging Resource Productivity. *Journal of Industrial Ecology*, 21(3), 603–614.
448 <https://doi.org/10.1111/jiec.12603>
- 449 Chang, I.-C. C., Leitner, H., & Sheppard, E. (2014). A Green Leap Forward? Eco-State
450 Restructuring and the Tianjin–Binhai Eco-City Model. *Regional Studies*, 50(6), 929–943.
451 <https://doi.org/10.1080/00343404.2015.1108519>
- 452 Ellen Macarthur Foundation (2014). *Towards the Circular Economy, vol. 3: Accelerating the*
453 *scale-up across global supply chains*. Cowes: Ellen Macarthur Foundation.
- 454 Feng, Z., & Yan, N. (2007). Putting a circular economy into practice in China. *Sustainability*
455 *Science*, 2(1), 95–101. <https://doi.org/10.1007/s11625-006-0018-1>
- 456 Flowerdew, J., & Li, Y. (2009). English or Chinese? The trade-off between local and
457 international publication among Chinese academics in the humanities and social sciences.
458 *Journal of Second Language Writing*, 18(1), 1–16.
459 <https://doi.org/10.1016/j.jslw.2008.09.005>
- 460 Flynn, A., Yu, L., Feindt, P., & Chen, C. (2016). Eco-cities, governance and sustainable
461 lifestyles: The case of the Sino-Singapore Tianjin Eco-City. *Habitat International*, 53, 78–
462 86. <https://doi.org/10.1016/j.habitatint.2015.11.004>
- 463 Geissdoerfer, M., Savaget, P., Bocken, N. M.P., & Hultink, E. J. (2017). The Circular Economy
464 – A new sustainability paradigm? *Journal of Cleaner Production*, 143, 757–768.
465 <https://doi.org/10.1016/j.jclepro.2016.12.048>

- Geng, Y., & Doberstein, B. (2008). Developing the circular economy in China: Challenges and opportunities for achieving 'leapfrog development'. *International Journal of Sustainable Development & World Ecology*, 15(3), 231–239. <https://doi.org/10.3843/SusDev.15.3:6>
- Geng, Y., Liu, Y., Liu, D., Zhao, H., & Xue, B. (2011). Regional societal and ecosystem metabolism analysis in China: A multi-scale integrated analysis of societal metabolism(MSIASM) approach. *Energy*, 36(8), 4799–4808. <https://doi.org/10.1016/j.energy.2011.05.014>
- Geng, Y., Sarkis, J., & Bleischwitz, R. (2019). Globalize the circular economy. *Nature*, 565, 153–155. <https://doi.org/10.1111/jiec.12732>
- Geng, Y., Zhang, P., Ulgiati, S., & Sarkis, J. (2010). Emergy analysis of an industrial park: The case of Dalian, China. *The Science of the Total Environment*, 408(22), 5273–5283. <https://doi.org/10.1016/j.scitotenv.2010.07.081>
- Geng, Y., Zhu, Q., Doberstein, B., & Fujita, T. (2009). Implementing China's circular economy concept at the regional level: A review of progress in Dalian, China. *Waste Management (New York, N.Y.)*, 29(2), 996–1002. <https://doi.org/10.1016/j.wasman.2008.06.036>
- Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production*, 114, 11–32. <https://doi.org/10.1016/j.jclepro.2015.09.007>
- Guo, F., Lo, K., & Tong, L. (2016). Eco-Efficiency Analysis of Industrial Systems in the Songhua River Basin: A Decomposition Model Approach. *Sustainability*, 8(12), 1271. <https://doi.org/10.3390/su8121271>
- Haas, W., Krausmann, F., Wiedenhofer, D., & Heinz, M. (2015). How Circular is the Global Economy? An Assessment of Material Flows, Waste Production, and Recycling in the European Union and the World in 2005. *Journal of Industrial Ecology*, 19(5), 765–777. <https://doi.org/10.1111/jiec.12244>

491 Heilmann, S. (2018). *Red Swan: How Unorthodox Policy Making Facilitated China's Rise*.
 492 Hong Kong: The Chinese University of Hong Kong.

493 Hensengerth, O. (2015). *Multi-Level Governance of Hydropower in China? The Problem of*
 494 *Transplanting a Western Concept into the Chinese Governance Context*. Multi-Level
 495 Governance: The Missing Linkages (Critical Perspectives on International Public Sector
 496 Management, Vol.4), Emerald Group Publishing Limited, Bingley, 295-
 497 320. <https://doi.org/10.1108/S2045-794420150000004012>

498 Hsieh, H.-F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis.
 499 *Qualitative Health Research*, 15(9), 1277–1288.
 500 <https://doi.org/10.1177/1049732305276687>

501 Jiao, W., & Boons, F. (2014). Toward a research agenda for policy intervention and facilitation
 502 to enhance industrial symbiosis based on a comprehensive literature review. *Journal of*
 503 *Cleaner Production*, 67, 14–25. <https://doi.org/10.1016/j.jclepro.2013.12.050>

504 Jiao, W., & Boons, F. (2017). Policy durability of Circular Economy in China: A process
 505 analysis of policy translation. *Resources, Conservation and Recycling*, 117, 12–24.
 506 <https://doi.org/10.1016/j.resconrec.2015.10.010>

507 Kennedy, C., Zhong, M., & Corfee-Morlot, J. (2016). Infrastructure for China's Ecologically
 508 Balanced Civilization††Note: This paper is not intended to represent views endorsed by the
 509 OECD nor by its member countries. *Engineering*, 2(4), 414–425.
 510 <https://doi.org/10.1016/J.ENG.2016.04.014>

511 Kong, L. (2010). To Promote Circular Economy Development during Economy Recovery -
 512 Based on the analysis of the policy of replacement of household electrical appliance
 513 implementation. *China Development*, 10(2).

514 Leipold, S., & Petit-Boix, A. (2018). The circular economy and the bio-based sector -
515 Perspectives of European and German stakeholders. *Journal of Cleaner Production*, 201,
516 1125–1137. <https://doi.org/10.1016/j.jclepro.2018.08.019>

517 Li, H., & Jong, M. de (2017). Citizen participation in China's eco-city development. Will 'new-
518 type urbanization' generate a breakthrough in realizing it? *Journal of Cleaner Production*,
519 162, 1085–1094. <https://doi.org/10.1016/j.jclepro.2017.06.121>

520 Li, J., & Yang, T. (2016). *China's Eco-city Construction*. Berlin, Heidelberg: Springer Berlin
521 Heidelberg.

522 Li, J., & Yu, K. (2011). A study on legislative and policy tools for promoting the circular
523 economic model for waste management in China. *Journal of Material Cycles and Waste*
524 *Management*, 13(2), 103–112. <https://doi.org/10.1007/s10163-011-0010-4>

525 Li, W., & Lin, W. (2016). Circular Economy Policies in China. In V. Anbumozhi & J. Kim
526 (Eds.), *Towards a Circular Economy: Corporate Management and Policy Pathways*.
527 (2014th ed., pp. 95–111). Jakarta: ERIA.

528 Li, Y., Chen, W., & Chang, G. (2008). China's Environmental Policies Evolution and Circular
529 Economy Development, Their Implications to Realize Ecological Modernization. *China*
530 *Population, Resources and Environment*, 18(5).

531 Lieberthal, K. (2004). *Governing China: From Revolution Through Reform* (Second). New
532 York: W.W. Norton.

533 Liu, C., & Côté, R. (2017). A Framework for Integrating Ecosystem Services into China's
534 Circular Economy: The Case of Eco-Industrial Parks. *Sustainability*, 9(9), 1510.
535 <https://doi.org/10.3390/su9091510>

536 Liu, D., Li, H., Wang, W., & Dong, Y. (2012). Constructivism scenario evolutionary analysis
537 of zero emission regional planning: A case of Qaidam Circular Economy Pilot Area in China.

538 *International Journal of Production Economics*, 140(1), 341–356.
539 <https://doi.org/10.1016/j.ijpe.2011.04.008>

540 Liu, L., Liang, Y., Song, Q., & Li, J. (2017). A review of waste prevention through 3R under
541 the concept of circular economy in China. *Journal of Material Cycles and Waste*
542 *Management*, 19(4), 1314–1323. <https://doi.org/10.1007/s10163-017-0606-4>

543 Liu, L. (2015). Institutional context of eco-industrial park development in China: environmental
544 governance in industrial parks and zones. In Pauline Deutz, Donald Lyons, Jun Bi (Ed.),
545 *International perspectives on industrial ecology*. Cheltenham: Edward Elgar.

546 Liu, Z., Adams, M., Cote, R. P., Geng, Y., Chen, Q., Liu, W., . . . Yu, X. (2017). Comprehensive
547 development of industrial symbiosis for the response of greenhouse gases emission
548 mitigation: Challenges and opportunities in China. *Energy Policy*, 102, 88–95.
549 <https://doi.org/10.1016/j.enpol.2016.12.013>

550 Lo, K. (2015). How authoritarian is the environmental governance of China? *Environmental*
551 *Science & Policy*, 54, 152–159. <https://doi.org/10.1016/j.envsci.2015.06.001>

552 Mathews, J. A., Tang, Y., & Tan, H. (2011). China's move to a Circular Economy as a
553 development strategy. *Asian Business & Management*, 10(4), 463–484.
554 <https://doi.org/10.1057/abm.2011.18>

555 McDowall, W., Geng, Y., Huang, B., Barteková, E., Bleischwitz, R., Türkeli, S., . . .
556 Doménech, T. (2017). Circular Economy Policies in China and Europe. *Journal of Industrial*
557 *Ecology*, 21(3), 651–661. <https://doi.org/10.1111/jiec.12597>

558 Milios, L. (2018). Advancing to a Circular Economy: Three essential ingredients for a
559 comprehensive policy mix. *Sustainability Science*, 13(3), 861–878.
560 <https://doi.org/10.1007/s11625-017-0502-9>

561 Murray, A., Skene, K., & Haynes, K. (2017). The Circular Economy: An Interdisciplinary
562 Exploration of the Concept and Application in a Global Context. *Journal of Business Ethics*,
563 140(3), 369–380. <https://doi.org/10.1007/s10551-015-2693-2>

564 Naustdalslid, J. (2013). Circular economy in China – the environmental dimension of the
565 harmonious society. *International Journal of Sustainable Development & World Ecology*,
566 21(4), 303–313. <https://doi.org/10.1080/13504509.2014.914599>

567 Park, J., Sarkis, J., & Wu, Z. (2010). Creating integrated business and environmental value
568 within the context of China’s circular economy and ecological modernization. *Journal of*
569 *Cleaner Production*, 18(15), 1494–1501. <https://doi.org/10.1016/j.jclepro.2010.06.001>

570 Pearce, D. W., & Turner, R. K. (1989). *Economics of natural resources and the environment*.
571 Baltimore: The Johns Hopkins University Press.

572 Prieto-Sandoval, V., Jaca, C., & Ormazabal, M. (2018). Towards a consensus on the circular
573 economy. *Journal of Cleaner Production*, 179, 605–615.
574 <https://doi.org/10.1016/j.jclepro.2017.12.224>

575 Qi, J., Zhao, J., Li, W., Peng, X., Wu, B., & Wang, H. (2016). *Development of Circular*
576 *Economy in China. Research Series on the Chinese Dream and China's Development Path*.
577 Singapore: Springer Singapore.

578 Ren, Y. (2007). The circular economy in China. *Journal of Material Cycles and Waste*
579 *Management*, 9(2), 121–129. <https://doi.org/10.1007/s10163-007-0183-z>

580 Ren, Y., & Wu, Y. (2005). Discussion on Connotation and Relevant Theoretic Issues of the
581 Concept of Chinese Circular Economy. *China Population, Resources and Environment*,
582 15(4).

583 Sauvé, S., Bernard, S., & Sloan, P. (2016). Environmental sciences, sustainable development
584 and circular economy_ Alternative concepts for trans-disciplinary research. *Environmental*
585 *Development*, 17, 48–56.

586 Schreurs, M. (2017). Multi-level Climate Governance in China. *Environmental Policy and*
587 *Governance*, 27(2), 163–174. <https://doi.org/10.1002/eet.1751>

588 Silva, A., Stocker, L., Mercieca, P., & Rosano, M. (2016). The role of policy labels, keywords
589 and framing in transitioning waste policy. *Journal of Cleaner Production*, 115, 224–237.
590 <https://doi.org/10.1016/j.jclepro.2015.12.069>

591 Skene, K. R. (2018). Circles, spirals, pyramids and cubes: Why the circular economy cannot
592 work. *Sustainability Science*, 13(2), 479–492. <https://doi.org/10.1007/s11625-017-0443-3>

593 Su, B., Heshmati, A., Geng, Y., & Yu, X. (2013). A review of the circular economy in China:
594 Moving from rhetoric to implementation. *Journal of Cleaner Production*, 42, 215–227.
595 <https://doi.org/10.1016/j.jclepro.2012.11.020>

596 Wang, N., & Chang, Y.-C. (2014). The development of policy instruments in supporting low-
597 carbon governance in China. *Renewable and Sustainable Energy Reviews*, 35, 126–135.
598 <https://doi.org/10.1016/j.rser.2014.03.021>

599 Winans, K., Kendall, A., & Deng, H. (2017). The history and current applications of the circular
600 economy concept. *Renewable and Sustainable Energy Reviews*, 68, 825–833.
601 <https://doi.org/10.1016/j.rser.2016.09.123>

602 World Bank (2005). *Reducing Poverty, Sustaining Growth: Scaling Up Poverty Reduction.*
603 *Case Study Summaries, A Global Learning Process and Conference in Shanghai, May 25-*
604 *27, 2004.*

605 Wu, H.-q., Shi, Y., Xia, Q., & Zhu, W.-d. (2014). Effectiveness of the policy of circular
606 economy in China: A DEA-based analysis for the period of 11th five-year-plan. *Resources,*
607 *Conservation and Recycling*, 83, 163–175. <https://doi.org/10.1016/j.resconrec.2013.10.003>

608 Xin, Y., & Zhao, H. (2010). The Motivation, Evolution, Characteristics and Evaluation of
609 Circular Economy in China. *Chinese Public Administration*, 10.

610 Xue, B., Mitchell, B., Geng, Y., Ren, W., Müller, K., Ma, Z., . . . Tobias, M. (2014). A review
611 on China's pollutant emissions reduction assessment. *Ecological Indicators*, 38, 272–278.
612 <https://doi.org/10.1016/j.ecolind.2013.11.020>

613 Yu, F., Han, F., & Cui, Z. (2015). Evolution of industrial symbiosis in an eco-industrial park in
614 China. *Journal of Cleaner Production*, 87, 339–347.
615 <https://doi.org/10.1016/j.jclepro.2014.10.058>

616 Yu, X. (2017). Coal mining and environmental development in southwest China.
617 *Environmental Development*, 21, 77–86. <https://doi.org/10.1016/j.envdev.2016.12.001>

618 Yuan, Z., Bi, J., & Moriguchi, Y. (2006). The Circular Economy: A New Development
619 Strategy in China. *Journal of Industrial Ecology*, 10(1-2), 4–8.
620 <https://doi.org/10.1162/108819806775545321>

621 Yuan, Z., Jiang, W., Liu, B., & Bi, J. (2008). Where will China go? A viewpoint based on an
622 analysis of the challenges of resource supply and pollution. *Environmental Progress*, 27(4),
623 503–514. <https://doi.org/10.1002/ep.10300>

624 Yue, Z., & Xu, T. (2017). EU New Strategy of Circular Economy and Its Implications to
625 China. *Teaching and Research*, 10.

626 Zhang, H., Hara, K., Yabar, H., Yamaguchi, Y., Uwasu, M., & Morioka, T. (2009).
627 Comparative analysis of socio-economic and environmental performances for Chinese EIPs:
628 Case studies in Baotou, Suzhou, and Shanghai. *Sustainability Science*, 4(2), 263–279.
629 <https://doi.org/10.1007/s11625-009-0078-0>

630 Zhang, X., & Zhang, Q. (2007). Institutional Perspective of Circulation Economy: International
631 Experience and its Significance to China. *World Regional Studies*, 16(3), 85–92.

632 Zhang, Y. (2011). Strategic Adjustment from Waste Management to Sustainable Materials
633 Management. *China Population, Resources and Environment*, 21(12).

634 Zhu, D. (2008). Background, Pattern and Policy of China for Developing Circular Economy.
635 *Chinese Journal of Population Resources and Environment*, 6(4), 3–8.
636 <https://doi.org/10.1080/10042857.2008.10684889>

637 Zhu, D. (2017). A review of circular economy development in European countries over the last
638 decade and its implications to deepen Chinese's circular economy. *China Population,*
639 *Resources and Environment*, 27(8), 9–16.

640 Zhu, Q., Geng, Y., Sarkis, J., & Lai, K.-H. (2015). Barriers to Promoting Eco-Industrial Parks
641 Development in China. *Journal of Industrial Ecology*, 19(3), 457–467.
642 <https://doi.org/10.1111/jiec.12176>

643

644