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Exploring Plastic-Management Policy in China: Status, Challenges and Policy Insights

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Abstract: Plastic pollution is recognized as one of the most urgent global environmental concerns. China is the top producer and consumer of plastics and creates the most plastic waste globally. To evaluate policy options to control plastic pollution in China, we first reviewed the relevant policies and action plans in place. Then, we examined plastic-material flows and changes at the national level based on officially published data to evaluate the current situation and efficacy of policies at the macro-level. Results showed that 2016, the start of the 13th Five-Year Plan, was a pivotal year in the history of China's plastic policies tackling plastic issues nationally and internationally. Since 2016, the growth trend in the production and consumption of plastic products has slowed and the recycling rate has risen, surpassing 30% in 2021. To further tackle plastic pollution, key suggestions with important policy implications were provided, covering better integration of policies, the combined management of vertical–horizontal governance, tracking-system implementation, the introduction of a quality-certification system, the development of behaviour-based consumer-oriented solutions, the promotion of stakeholder collaboration, and the need for appropriate post-COVID-19 policies.

Keywords: plastic; policy; China; material flow; recycling rate



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1. Introduction

Plastic has played a definitive role in providing many of the socio-economic benefits of modern life as an indispensable and ubiquitous material due to its low cost, durability, flexibility, versatility, availability, and light weight. Global plastic use has increased nearly 200-fold from 2 million tonnes in 1950 to 380 million tonnes in 2015 [1] and is projected to almost triple by 2060 from 2019 levels, driven by economic and population growth, with the largest increases expected in emerging economies in Sub-Saharan Africa and Asia [2]. However, the world's dependence on plastics is also leading to detrimental impacts on various aspects of the environment, such as terrestrial and aquatic ecosystems [3,4], marine ecosystems and biodiversity [5–7], and climate change [8], with potentially negative implications for human health [9]. In recent years, plastic pollution has become a key topic on the global environment agenda, and on 2 March 2022, 175 nations reached an agreement at the UN Environment Assembly (UNEA-5) in Nairobi [10] to develop a legally binding agreement on plastic pollution by 2024, which requires an urgent and international response involving all relevant actors at different levels.

Countries around the world are actively addressing the issue of plastic pollution and implementing various measures to reduce plastic usage and increase recycling. On 30 November 2022, the European Commission announced an update to the “Packaging and Packaging Waste Directive” (PPWD). The objective of the initiative is to make sure that by 2030, all packaging can be reused or recycled in an economically viable manner. The goal is to strengthen the necessary standards for packaging to promote its reuse and recycling, increase the use of recycled materials, and enhance the enforcement of these standards.

Additionally, measures are planned to address excessive packaging and minimize packaging waste [11,12]. The United States Environmental Protection Agency (EPA) has released a draft National Strategy to Prevent Plastic Pollution, in collaboration with the new White House Interagency Policy Committee on Plastic Pollution and Circular Economy (IPC). The draft strategy aims to eliminate the release of plastic and other waste from land sources into the environment by 2040 [13]. France has intensified efforts to reduce waste and end the use of single-use plastics by enacting the “Anti-Waste and Circular Economy Law” on 10 February 2020, which aims to achieve 100% recycling of plastic products by 2025, reduce superfluous single-use plastic packaging, and reduce the sales volume of single-use plastic bottles by half by 2030, with the ultimate aim of achieving zero usage of single-use plastic packaging by 2040 [14]. On 1 April 2022, Japan’s “Plastic Resource Recycling Promotion Law” was officially implemented. This law requires operators with large single-use plastics inputs to reduce the volumes used, and also requires operators in the food service, retail, and hotel industries to reduce plastic-waste generation [15]. To address the issue of plastic waste, Thailand has taken actions to implement the “Plastic Waste Management Roadmap 2018–2030”. The roadmap aims to achieve the goal of reducing plastic marine debris by at least 50% by 2027. It includes specific numerical targets: (1) reusing seven types of plastic, including plastic bags, plastic cutlery, plastic bottles, plastic film, plastic packaging, plastic bottle caps, and thick plastic cups, by 50% by 2022, and (2) reducing the use of or avoiding four types of plastic, namely foam packaging, plastic bags (with a thickness of less than 36 microns), plastic cups (with a thickness of less than 100 microns), and plastic straws [16].

China produces and consumes the largest amount of plastics in the world, and thus generates the most plastic waste globally. It was also the world’s largest importer of plastic waste before instigating an import ban in 2017. Furthermore, the rapid recent rise in e-commerce has resulted in the rapid growth of waste from plastic packaging from express delivery, fast food, and other industries, exacerbated in particular by the lockdown policy during the COVID-19 pandemic through accelerated online food delivery and online-shopping development. This situation has brought new challenges to the prevention and control of plastic pollution.

China has historically struggled to control plastic pollution. It began using plastic fast-food containers on railways in 1986, which were discarded along the line and caused severe damage to the environment [17]. This became known as “white pollution” and woke up China to the problem of plastic waste. Over the last two to three decades, several developments have taken place concerning how the country governs plastic, and since 2016 it has particularly paid more attention to that of plastic pollution [18]. However, to date, the policy and regulatory landscape regarding plastics has remained relatively uncharted due to scant research on the topic [18]. Current policy research mainly focuses on specific policies, such as plastic bans and restriction orders [19–21], as well as specific plastic products, such as plastic packaging [22,23], courier packaging [24], and disposable plastics [25]. Some studies on policy-implementation measures, such as plastic pollution tax policies [26,27] exist, and research on marine plastic policies [28] is also rising.

In 2007, the year before the 2008 Beijing Olympics, the General Office of the State Council issued the Notice of the State Council Office on Restricting the Production, Sales and Use of Plastic Shopping Bags (关于限制生产销售使用塑料袋的通知), which required a nationwide ban (known as the Restrictions on Plastic (限塑令)) on the production, sale, and use of plastic shopping bags with a thickness of less than 0.025 mm, effective 1 June 2008. Owing to the significance of this policy measure, which was aimed at controlling the production and use of plastics, several scholars have studied its effectiveness in addressing plastic pollution. For example, one study found that plastic-bag-reduction policies led to a 49% reduction in plastic-bag use [23]. Another, by Wang et al. (2020), pointed out that certain flaws in the policy design had resulted in an ineffective implementation of the ban [29]. According to Xing et al. (2009), the agriculture sector represented the biggest challenge in implementing the plastic-restriction policy [30]. Wu et al. (2008) noted that

economic regulation can be applied to control the production and use of plastic bags [19], and Yue (2018) commented that the plastic ban/restriction should keep pace with the times and be continuously improved in terms of its governance capacity [31]. A further study analyzed plastic ban/restriction policies at national and provincial/municipal levels [20], suggesting that future plastic-product-control measures need to focus on prevention at the source. A study investigating the impact of replacing plastic straws with paper ones [21] discovered that although most consumers were aware of the ban/restriction, the purpose and importance of the policy had not been communicated, leading to some businesses continuing to use plastic straws, reflecting a weakness of the policy. A further study investigated public single-use plastic-reduction behavior [25] and asserted that incentives and penalties for single-use plastic reduction behavior are essential to raising public motivation in implementing single-use plastic-reduction behavior. A research group evaluating China's plastic-bag policies [22] found that plastic-bag-recycling programs remain underdeveloped and that the uptake of environmentally friendly products for public use had not yet become mainstream. A further study, analyzing plastic bags and express packaging policy [24], proposed that plastic-packaging materials should be selected scientifically and disposed of differently, and that the chief responsibility for recycling should be transferred from the government to plastic-packaging companies. One study, analyzing China's tax policy for restricting plastic use with reference to successful cases abroad, suggested that China should replace fees with taxes and shift the focus of industrial regulation from sellers to producers [32]. In terms of policy-implementation measures, a study aimed at promoting plastic-pollution control through tax policies [27] found that China's current laws, regulations, and plastic-pollution controls are mainly of the administrative directive status and that fiscal and tax policies have yet to become important tools in restricting the production and use of plastic products.

In terms of marine plastic policies, one study, comparing China's marine-litter policy with that of the European Union [33], found that China does not yet have a national-level marine-litter strategy, nor restrictions and regulations for microplastics. A study analyzing China's marine-litter-management policies [34] discovered that although some policies were positive and effective, they cannot address the root causes of the marine-litter problem by changing current consumption patterns.

Fürst and Feng were the first to set out to comprehensively map and analyse the inventory of Chinese plastic-policy documents since 2000, and found that not only have the goals and objectives of legal measures for regulating plastics become more complex, but the types of plastics targeted by the various policies and the different life-cycle stages of the plastics value chain have become more comprehensive, and the regulatory tools and instruments have become more diverse [18]. However, questions as to the actual efficacy of these policies in preventing/mitigating plastic pollution are left unanswered in this research.

Considering the challenges ahead for China as well as its key role in preventing and controlling plastic waste and microplastic pollution nationally and internationally, this paper: (1) presents a comprehensive review of plastic-related policies and action plans that have been put in place; (2) preliminarily examines plastic-material flows and their changes at the national level based on officially published data to evaluate the effectiveness of policies at the macro-level based on the secondary published data; and (3) provides further policy implications to prevent/mitigate plastic pollution.

2. Materials and Methods

In order to evaluate policy options to further prevent or mitigate plastic pollution, this paper: (1) conducted a comprehensive policy review to clarify the plastics-related legislative management system, the medium- to long-term strategy and relevant policies, strategies for plastics waste management, the types of plastics targeted, and the path to achieving plastic reduction (see Section 2.1 below); (2) identified the current situation of plastic flows including plastic production, plastic-waste generation and recycling at the national level

based on secondary published data, while examining the impact of current policies (see Section 2.2 below); and (3) highlighted existing problems and provided recommendations to achieve more effective plastic-waste management going forward.

2.1. Policy Review

In this study, policy retrieval was conducted on the Peking University Law Information Platform using keywords. The search was set to look for titles or full texts containing relevant keywords (as shown in Table 1). A total of 221 policy texts were retrieved. To ensure the accuracy of the sample selection, the policy documents were screened according to the following principles:

- (1) Policy documents with legal effect issued by government departments or party and government organizations;
- (2) Policy documents directly related to the theme of this study;
- (3) Procedural policy documents such as personnel appointments, meeting notices, etc. were excluded.

Table 1. Keywords used to search for relevant policy documents.

English	Chinese
plastic, microplastics, shopping bags, foam plastics, recyclable, agricultural film, marine litter, marine solid waste, municipal solid waste, single use plastics, tires	塑料, 微塑料, 购物袋, 泡沫塑料, 可回收, 农膜, 海洋垃圾, 海洋固体废弃物, 生活垃圾, 固体废弃物, 一次性塑料, 轮胎

After screening, a total of 202 relevant policy documents were obtained, including national policies and local policies. There were 73 national policy documents, which were the final policies analyzed in this study (Table S1, see Figure 1 below).

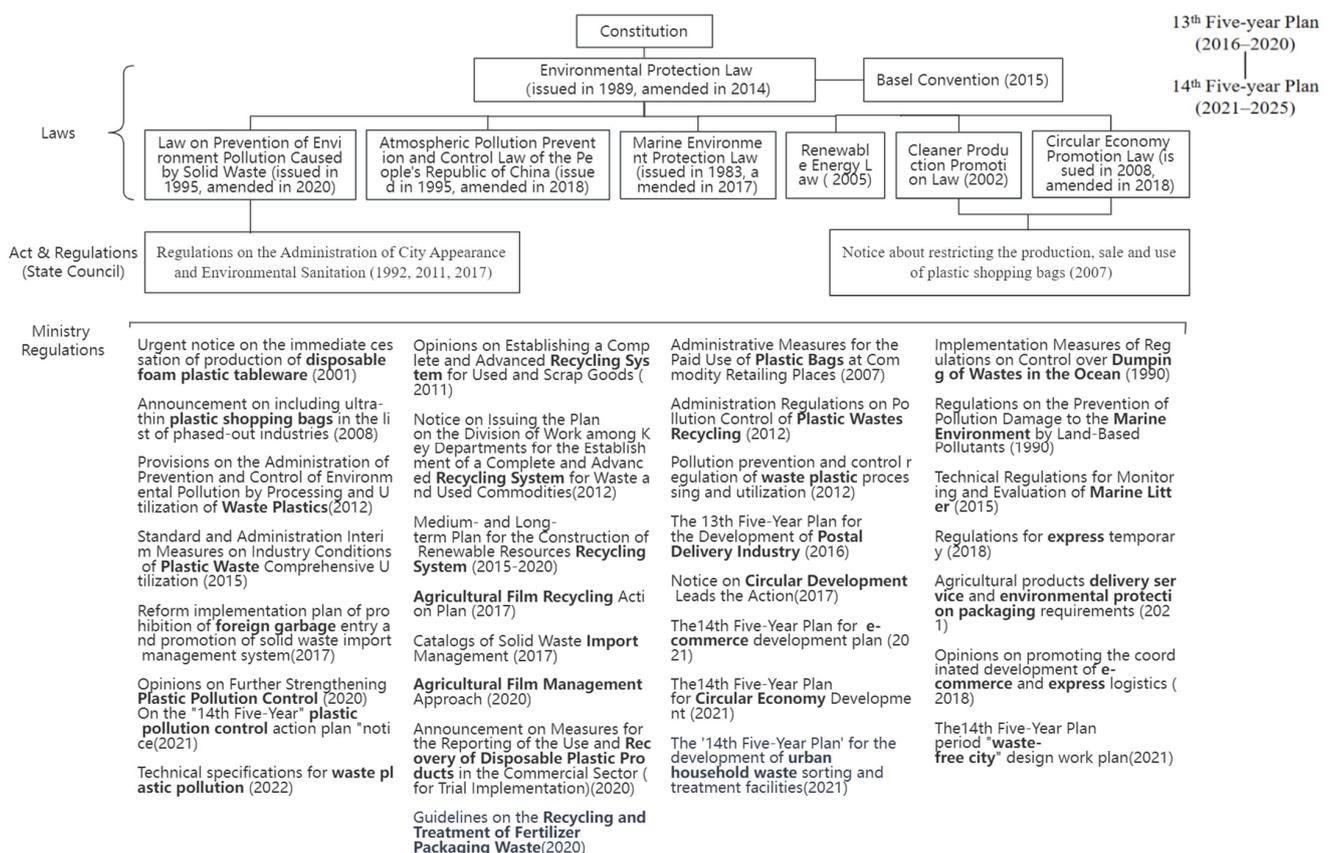


Figure 1. Legal framework of plastic-related policies and strategies.

2.2. Plastic-Material-Flow Analysis

Based on officially published data (listed in Table 2), a plastic-material flow in China in 2019 (see Figure 2 below) and time-series changes in the production and consumption of plastic products, recycling, the import and export of plastic waste, and the recycling rate (see Figure 3 below) were developed.

Table 2. Data and sources.

Data	Source
Import (plastic products)	General Administration of Customs of the People's Republic of China: Import of plastic products, 2005–2021.
Import (plastic waste)	China Recycling Industry Report: Import of plastic wastes, 2005–2021.
Export (plastic products)	General Administration of Customs of the People's Republic of China: Export of plastic wastes, 2005–2021.
Export (plastic waste)	China Recycling Industry Report: Export of plastic waste, 2005–2021.
Import (plastics in primary forms)	General Administration of Customs of the People's Republic of China: Import of plastics in primary forms, 2019.
Import (plastic products)	General Administration of Customs of the People's Republic of China: Import of plastic products, 2005–2021.
Production (plastics in primary forms)	National Bureau of Statistics: production of plastics in primary form, 2020.
Production (plastic products)	National Bureau of Statistics: production of plastic products, 2005–2021.
Use (plastics in primary forms)	China Plastics Processing Industry Association. China plastics industry yearbook. China Light Industry Press, 2019.
Consumption (plastic products)	Huajing Intelligence Network, Huajing Industry Research Institute. China plastic products industry production and consumption analysis. Accessed online: https://www.huaon.com/channel/trend/670690.html (accessed on 18 March 2023)
Plastic waste	China Plastics Processing Industry (2019) [35]
Plastic waste (recycling)	China Recycling Industry Report: Amount of waste plastic recycling, 2005–2021.
Recycling rate	China Circular Economy Association. China Circular Economy Development Report. Beijing: China Circular Economy Association. Status and Thinking of Plastic Wastes Recycling Industry in China under the New Situation [36]
Land filled, Burning, Abandonment	China Materials Recycling Association Recycled Plastics Branch. China recycled plastics industry development report (2019–2020). Beijing: China Materials Recycling Association Recycled Plastics Branch, 2020. Accessed online: www.hnyhgf.com/news/20200407155356431.html (accessed on 18 March 2023)

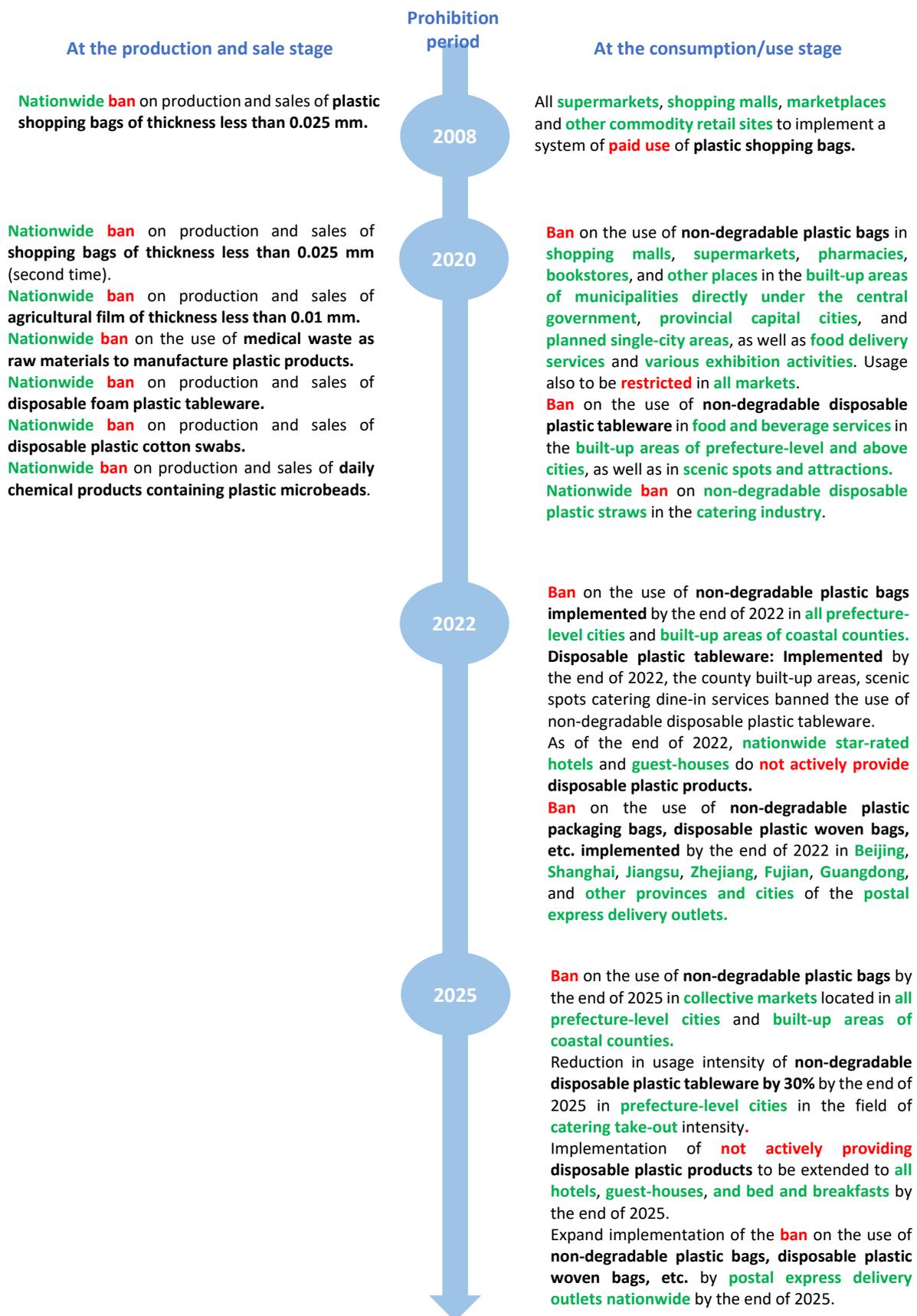


Figure 2. Main content of the ban and restrictions on the use of plastic products. (Green text: Policy targets and scope; Red text: Policy approaches).

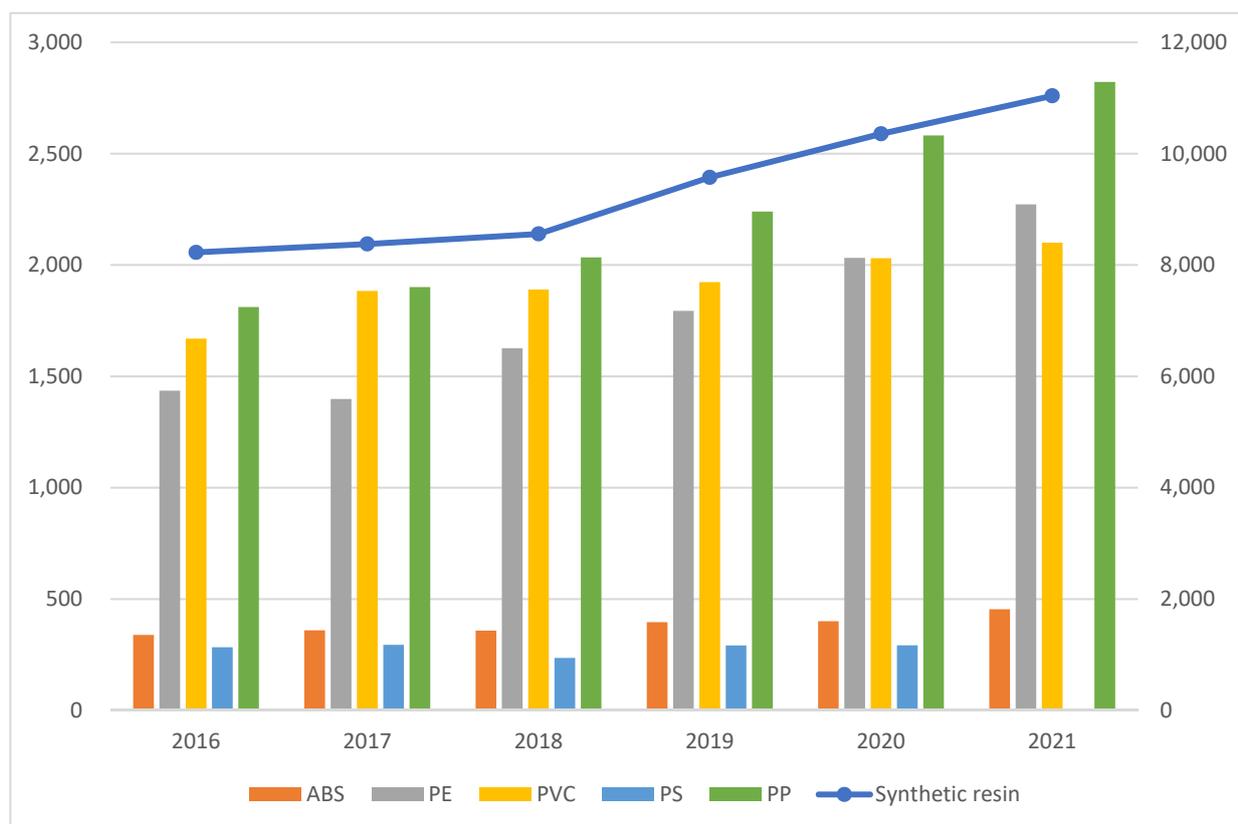


Figure 3. Total production amount of synthetic resins (right axis); production amount of ABS, PE, PVC, PS, PP (left axis).

3. Results

3.1. National Legislation, Regulations and Other Policies Concerning Plastics

Through policy analysis, the legal framework of plastic-related policies and strategies (Section 3.1.1) and the main direction and key objectives of plastic-pollution control (Section 3.1.2) were clarified, and the types of plastics targeted, and the different aspects of the plastic value chain were identified (Section 3.1.3).

3.1.1. Legal Framework of Plastic-Related Policies and Strategies

The overall legal framework related to plastic policies and strategies is summarized in Figure 1. China's legal and policy system is complex, with five levels of laws and regulations: Constitution-level documents (first level), i.e., fundamental laws enacted by the National People's Congress (NPC), which serve as the basis for all legal systems; Laws (second level), formulated or recognized by the state with guaranteed implementation and state enforcement, which are mandatory norms subordinate to the Constitution and a specific embodiment of the Constitution [37,38] (as of June 2022, 292 laws existed; website of the National People's Congress of China); Administrative regulations (third level), formulated by the State Council based on the Constitution and laws and authorized by the NPC [39]; Ministry regulations (fourth level), which are normative documents formulated by ministries and commissions under the State Council in accordance with laws and administrative regulations [40]; and Local government regulations (fifth level), which are normative documents formulated and promulgated by local state power organs with statutory authority to implement them within their administrative regions [41,42].

3.1.2. Main Direction and Key Objectives of Plastic Pollution Control

The following four aspects are important for understanding the landscape of China's plastics-pollution-control regulatory realm: (1) The Five-Year Plan (officially known as

The Outline of the Five-Year Plan for National Economic and Social Development of the People's Republic of China), which forms a key part of China's national economic plan and sets goals and directions for the medium- to long-term development of the economy, culture, and environment. Five-year plans and their related action plans guide decision-making and measure the effectiveness of implementation; (2) Implementation of the ban on foreign waste importation in 2017—a turning point in waste-plastic management globally and nationally, changing the flows of plastics; (3) Introduction of a plastic-recycling and treatment system and relevant policies, including renewable resources recycling systems/circular economy, and solid-waste management/city infrastructure; and (4) Introduction of other related policies to deal with emerging plastic issues, which are respectively described below.

The Five-Year Plan Related to Plastics

Efforts to control plastics greatly accelerated in 2016 as a response to the 13th Five-Year Plan (2016–2020), which greatly raised the level of ambition to improve China's ecological and environmental quality by 2020 [18] and led to a rapid rise in regulations on plastic pollution. As stated in the Protection of Ecological Environment (2016–2020) of the Plan ('十三五'生态环境保护规划的通知), "The overall objective is to improve the environmental quality by 2020. This includes specified targets for promoting green life and production, advancing low-carbon development, notably reducing the total discharge of major pollutants, effectively controlling environmental risks, reversing biodiversity loss, striving for a more stable ecosystem, building ecological security shields, achieving significant strides in modernizing the national environmental governance system and capacity, and of bringing ecological civilization more aligned with the goal of achieving a moderately prosperous society in all aspects." To meet these targets, several policies were drafted under the rubric of prevention in the domains of air, water, and soil pollution; energy efficiency; and addressing plastic issues. The Plan also proposed strengthening connections between MSW (municipal solid waste) classification and renewable-resources recovery, and many cities have begun to integrate these two networks with urban-development plans to raise the levels of collection and the utilization of low-value recyclables, with the goals of developing local recycling industries and reducing MSW-treatment burdens.

The 14th Five-Year Plan (2021–2025) strengthened the above-introduced regulations, such as by proposing to: (1) build a household-waste-treatment system with sorting, collection, transportation, and treatment to strengthen the planning and construction of waste-recycling facilities and improve the urban waste recycling and sorting system; and (2) accelerate measures to build a sustainable and more robust marine ecological environment. Supplementing the above was the issuance of an important policy document: the 14th Five-Year Plan Plastic Pollution Control Action Plan (2021–2025) (National Development and Reform Commission (NDRC) and the Ministry of Ecology and Environment (MEE); September 2021). It aimed at "further improving the management of the entire chain of plastic pollution," and included a key goal of realising robust control of plastic-waste leakage into the natural environment by 2025. It provides detailed measures, specific targets and assigned responsibilities to several state departments for cutting the production and use of plastics, promoting alternatives, developing recycling systems, and reducing landfill plastic waste while boosting incineration capabilities.

Ban on Foreign Waste Importation

In July 2017, signaling a change in China's regional policy, the General Office of the State Council issued the Implementation Plan for Prohibiting the Entry of Foreign Garbage and Advancing the Reform of the Solid Waste Import Administration System (禁止洋垃圾入境推进固体废物进口管理制度改革实施方案; hereinafter referred to as the Ban on Waste Import). The ban covered 24 types of foreign waste imports, including plastic wastes from domestic sources, unsorted wastepaper, waste textiles, and vanadium slag, and naturally resulted in significant impacts on the global-waste trade, as China had previously ac-

counted for nearly 60% of the world's waste-plastic trade (UN Comtrade Database). Large buildups of solid waste resulted in many developed countries, promptly forcing them to implement domestic-waste reduction and recycling or export waste to other developing countries in Southeast Asia and Africa [43]. It also fundamentally transformed China's plastic recycling industry, shifting it away from the processing of plastics-waste imports toward setting up a domestic recycling system, with the goal of effective use of resources toward a circular economy.

Plastic Recycling System and Related Policies

China has a complex recycling framework comprised of basically two management systems—one for MSW and one for renewable resources. China's renewable-resources system was established at an early stage. During the 1950s and 1960s, the Chinese government vigorously promoted the collection and recycling of waste materials as a response to severe material scarcity. Since the 1990s, in order to facilitate resource reuse and mitigate environmental pollution, the government has introduced a series of preferential policies to support the recycling industry. The main policies directing renewable-resources management are summarized in Table 3, such as the Administrative Measures for the Recovery of Renewable Resources (再生资源回收管理办法; issued in 2007 and amended in 2019), the Opinions on Establishing a Complete and Advanced Recycling System for Used and Scrap Goods (关于建立完整的先进的废旧商品回收体系的意见), and the Medium- and Long-term Plan for the Construction of Renewable Resources Recycling System (2015–2020) (再生资源回收体系建设中长期规划 (2015–2020)). Adding to this in order to improve recycling rates of major waste, the Circular Economy Promotion Law (循环经济促进法) and the Circular Development Leading Actions (循环发展引领行动) were also issued. The 14th Five-Year Plan for the Development of Circular Economy (十四五循环经济发展规划), issued in 2021, aims to improve the overall efficiency of resource use by focusing on industry, social life, and agriculture, and sets out key actions for the plastics industry, such as promoting green design for key products and improving the waste-materials recycling network. It also aims to tackle the whole chain of plastic pollution by promoting the reduction of plastics at the source and encouraging the public to reduce the use of disposable plastic products.

The key policies of China's MSW management system are summarised in Table 4. The Law of the People's Republic of China on Solid Waste Pollution Prevention and Control 中华人民共和国固体废物污染防治法, promulgated in 1995, is the primary national legislation for solid-waste management, revised in 2020 to include waste source separation as a mandatory regulation. Mirroring the increased level of concern internationally in recent years, the central government has issued many policies to strengthen the top-level design of plastic-pollution prevention and control, which are listed below.

- (1) In January 2020, the National Development and Reform Commission (NDRC) and the Ministry of Ecology and Environment (MEE) announced the Opinions on Further Strengthening the Control of Plastic Pollution (关于进一步加强塑料污染治理的意见; hereinafter referred to as the New Restrictions on Plastic), specifying that by 2025 China expects to control plastic pollution effectively, substantially reduce the amount of plastic waste in landfills of key cities, establish a complete plastics-management system along the whole supply chain and achieve progress in developing alternative products.
- (2) In May 2021, the National Development and Reform Commission and the Ministry of Housing and Urban-Rural Development issued the 14th Five-Year Plan for the Development of Urban Domestic Waste Separation and Disposal Facilities (十四五“城镇生活垃圾分类和处理设施发展规划) aimed at accelerated establishment of a domestic-waste-treatment system with sorting, collection, transportation, and treatment. Specific targets were set, such as the improvement of domestic-waste classification and treatment capacity in 46 key cities, the construction of domestic-waste classification and treatment systems in prefecture-level cities and other regions, and

encouragement of other regions to improve their waste-separation coverage and treatment facilities. Its goals are a national resource-utilization rate of about 60% by the end of 2025 for urban domestic waste, a national waste separation and transportation capacity of about 700,000 tonnes/day by the end of 2025, and a national urban waste-incineration treatment capacity of about 800,000 tonnes per day by the end of 2025, with the urban domestic-waste-incineration treatment capacity accounting for about 65%.

Table 3. Main policies of China’s renewable resources recycling system.

No.	Representative Policies	Issuing Date	Issuing Division	Main Content
1	Administrative Measures for the Recovery of Renewable Resources	27 March 2007	Ministry of Commerce, National Development, Reform Commission and other six departments	Regulating the development of the recycling industry, saving resources, and protecting the environment
2	Opinions on Establishing a Complete and Advanced Recycling System for Used and Scrap Goods	31 October 2021	State Council of the People’s Republic of China	By 2015, the initial establishment of a sound network, advanced technology, sorting and processing of good, standardized management of modern waste commodity recycling system
3	Pollution prevention and control regulation of waste plastic processing and utilization	24 August 2012	Ministry of Environmental Protection, Development and Reform Commission, Ministry of Commerce	Strengthen the pollution prevention of waste plastics processing and utilization, protect the health of the people, protect environmental safety, and promote the healthy development of the circular economy
4	Medium- and Long-term Plan for the Construction of Renewable Resources Recycling System (2015–2020)	4 February 2015	Ministry of Commerce, Ministry of Land and Resources and other five departments	Encourage all types of domestic and foreign capital to enter the recycling, sorting and processing of renewable resources
5	Notice of the General Office of the State Council on Printing and Distributing the Implementation Plan of the Extended Producer Responsibility System	25 December 2016	General Office of the State Council	Producers bear more responsibility in product design, production, sales, recycling, and other stages.
6	Circular Economy Promotion Law	12 December 2017	State Oceanic Administration	Promote the development of circular economy, improve the efficiency of resource utilization, protect and improve the environment, and achieve sustainable development
7	Circular Development Leading Actions	5 May 2017	National Development and Reform Commission and other 14 departments	Promote circular production methods, establish a circular development system in towns and cities, and make an effective connection between domestic waste classification and recycling of renewable resources.
8	Agricultural Film Recycling Action Plan	6 May 2017	Ministry of Agriculture and Rural Affairs	Strengthen the treatment of agricultural film pollution and improve the resource utilization of used agricultural film
9	Agricultural Film Management Approach	3 July 2020	Ministry of Agriculture and Rural Affairs and four other departments	Encourage support for units and individuals to recycle agricultural films and encourage research and development of agricultural film recycling technology
10	14th Five-Year Plan for the Development of Circular Economy	9 November 2021	National Development and Reform Commission	With the main line of improving the overall efficiency of resource use, focusing on three major areas: industry, social life, and agriculture.

Table 4. Main policies of China’s MSW-management system.

No.	Representative Policies	Issuing Date	Issuing Division	Main Content
1	Regulations on the Administration of City Appearance and Environmental Sanitation	20 May 1992	State Council of the People’s Republic of China	Strengthen the city’s urban and environmental health management, to create a clean, beautiful urban working and living environment
2	The Law of the People’s Republic of China on Solid Waste Pollution Prevention	30 October 1995	Standing Committee of the National People’s Congress	Protect and improve the ecological environment, prevent and control solid-waste pollution of the environment, protect public health, maintain ecological safety, promote ecological civilization, and promote sustainable economic and social development
3	Policy on urban household waste treatment and pollution prevention and control technologies.	29 May 2000	Ministry of Construction, State Environmental Protection Administration, Ministry of Science and Technology	Strengthen the management of the entire process of garbage generation to reduce the generation of garbage at the source.
4	Notice on Further Strengthening Urban Domestic Waste Management	19 April 2001	State Council	By 2030, China will basically achieve harmless treatment of urban household garbage and fully implement the collection and disposal of household garbage classification.
5	Reform implementation plan of prohibition of foreign garbage entry and promotion of solid waste import management system	27 July 2017	State Council of the People’s Republic of China	Comprehensive ban on the entry of foreign garbage, strengthen the management of solid waste recycling
6	Notice by the General Office of the State Council of Issuing the Work Plan for the Pilot Program of “Zero-Waste City” Building	29 December 2018	State Council of the People’s Republic of China	Promote the source reduction and resource utilization of MSW, reduce the amount of landfill and the environmental impact of MSW
7	Notice on Promoting the Development of Industrial Clusters for Comprehensive Utilization of Bulk Solid Waste	9 January 2019	General Office of the National Development and Reform Commission, General Office of the Ministry of Industry and Information Technology	Accelerate the promotion of resource utilization, harmlessness, reduction and recycling of solid waste; Encourage the construction of large-scale solid waste comprehensive utilization bases in key cities and industrial parks.
8	Notice on the Comprehensive Implementation of Domestic Waste Classification Work in National Cities at and Above the Prefecture Level	26 April 2019	Ministry of Housing and Urban-Rural Development, etc.	Accelerate the establishment of a household waste management system that includes classification of waste disposal, collection, transportation, and processing.
9	Plan for the Construction of Waste-Free Cities during the 14th Five-Year Plan Period	20 December 2021	Ministry of Ecology and Environment	During the “14th Five-Year Plan” period, about 100 prefecture-level and above cities will be promoted to carry out “zero waste city” construction.

Other Related Policies to Deal with Emerging Plastic Issues

Regarding specific emerging plastic issues, the challenges of plastic waste related to agricultural plastic film, e-commerce delivery industries, marine litter, and microplastics are a key policy focus, and the latest policies related to these issues are described below.

(1) Agricultural plastic film

To promote the recycling of agricultural plastic film, the Ministry of the Ecology issued the Soil Pollution Prevention and Control Action Plan (土壤污染防治行动计划) in 2016, and the Ministry of Agriculture issued the Agricultural Film Recycling Action Plan (农膜回收行动方案) in 2017, which included establishing a recycling and processing system to achieve a seasonal mulch recycling rate of over 80% and exploring the establishment of systems to incentivize recycling of pesticide packaging waste. Moreover, in September 2020, the Ministry of Agriculture and Rural Affairs and four other departments jointly issued the Agricultural Film Management Approach, which includes requirements for producers, sellers, and users of agricultural films to ensure compliance with national standards, proper labeling and record-keeping, and the responsible use of such films.

(2) E-commerce express delivery industry plastic control

China has issued several policies for greening the e-commerce and express logistics industry (Table 5), such as the 14th Five-Year Plan for the Development of Commercial Logistics, which provides comprehensive coverage of this sector, as well as regulations aimed at waste reduction, reusable materials, and green packaging, and discouraging the use of non-degradable plastics. These measures were supported by the “9917” project, covering excessive packaging, plastic pollution, and a ban on non-degradable plastic-packaging bags, tapes, and disposable woven bags at postal services outlets from 2025.

Table 5. Main policies of e-commerce express delivery industry plastic control in China.

No.	Representative Policies	Issuing Date	Issuing Division	Main Content
1	The 13th Five-Year Plan for the Development of Express Delivery Industry	13 February 2017	National Post Office	Reduce environmental pollution in the process of receiving, sorting, sealing, transporting and delivery.
2	Opinions on promoting the coordinated development of e-commerce and express logistics	2 January 2018	State Council of the People’s Republic of China	Develop and implement green and reduced packaging standards for e-commerce and establish and improve the extended producer responsibility system for express packaging.
3	Regulations for express temporary	2 March 2018	State Council of the People’s Republic of China	Encourage express enterprises and senders to use environmentally friendly packaging; encourage express enterprises to recycle express mail packaging.
4	Green packaging standards for mail and express delivery	12 June 2020	National Post Office	Adhere to the standardization, reduction, and recyclability of green packaging for mail and express mail.
5	Notice on Accelerating the Green Transformation of Express Delivery Packaging	20 November 2020	State Council	Strengthen the governance of express delivery packaging and promote the green transformation of express delivery packaging.
6	Notice by the General Office of the Ministry of Commerce of Promoting the Green Development of E-commerce Enterprises	7 January 2021	Ministry of Commerce	Green transformation of express packaging; promote express packaging reduction; promote the application of recyclable packaging.
7	Measures for the management of express mail packages	8 February 2021	Ministry of Transport	Prohibit or restrict the use of disposable plastic products such as non-biodegradable plastic bags; Encourage the use of alternative products that are recyclable, easy to recycle, and biodegradable.
8	The 14th Five-Year Plan for e-commerce development plan	9 October 2021	Ministry of Commerce, Central Internet Information Office, Development and Reform Commission	Establishment of green packaging standards for each link and certification of green products for express packaging.

(3) Policies on marine litter and microplastics

China's first comprehensive law to protect the marine environment was the Marine Environmental Protection Law, issued by the Standing Committee of the National People's Congress on 23 August 1982 and amended in 1999, 2013, 2016 and 2017. In 2007, marine litter monitoring was launched, to which was added marine microplastics in 2016. China's earnest intentions to prevent and control marine litter and microplastics are evident from the successive regulations and policies released (Table 6).

Table 6. Main policies of marine litter and microplastics in China.

No.	Representative Policies	Issuing Date	Issuing Division	Main Content
1	Marine Environmental Protection Law	23 August 1982	Standing Committee of the National People's Congress	Protect and improve the marine environment, protect marine resources, prevent and control pollution damage, maintain ecological balance, protect human health, and promote sustainable economic and social development
2	Prevention and control of marine engineering construction projects pollution damage to the marine environment management regulations	19 September 2006	State Council of the People's Republic of China	Control over the number of marine engineering pollutants discharged into the sea in key waters
3	Technical Regulations for Monitoring and Evaluation of Marine Litter	18 December 2015	State Oceanic Administration	Clarified the content and methods of monitoring marine floating and seabed litter
4	Notice on Marine Standardization Management Approach	23 June 2016	State Oceanic Administration	Identified marine norms, including marine ecology and environmental protection, integrated management of marine areas, etc.
5	Notice on the preparation of provincial coastal zone comprehensive protection and utilization master plan pilot work guidance	12 December 2017	State Oceanic Administration	Adhere to the integration of land and sea, and pay more attention to land development based on the sea; Research and demonstration of marine microplastics monitoring, assessment, and prevention technologies.
6	Opinions on further strengthening the management of plastic pollution	16 January 2020	National Development and Reform Commission, Ministry of Ecology and Environment	Strengthening research on plastic waste and microplastic pollution mechanisms, monitoring, prevention and control technologies and policies for rivers, lakes and seas.
7	Notice on the strengthened promotion of plastic pollution control	10 July 2020	National Development and Reform Commission, Ministry of Ecology and Environment, Ministry of Industry and Information Technology	Regulate the collection and disposal of plastic waste Strengthen the supervision and inspection related to the ban on the production and sale of daily chemical products containing plastic microbeads.
8	Notice on establishing a sound marine ecological early warning and monitoring system	26 July 2021	Ministry of Natural Resources	Coastal provinces, autonomous regions and municipalities directly under the Central Government to implement early warning monitoring of marine litter and microplastics
9	Notice on the issuance of the "14th Five-Year" plastic pollution control action plan	8 September 2021	National Development and Reform Commission, the Ministry of Ecology and Environment	Conduct marine plastic litter and microplastic monitoring surveys. Increase the placement of garbage collection facilities at beaches and other activity sites and improve the frequency of garbage removal. Instigate microplastics pollution mechanisms, monitoring, and prevention technology in rivers, lakes, and seas.
10	Guidance on deepening the administration by the law in the field of ecology and environment and continuously strengthening the governance of pollution based on law	9 November 2021	Ministry of Ecology and Environment	Strengthen the Bohai Sea outfall traceability, marine microplastic pollution control, mariculture pollution ecological environment supervision, and marine engineering supervision.

3.1.3. Types of Plastics Targeted and the Path to Achieving Plastic Reduction and Ban

The types of plastics targeted and the means of implementing the restrictions were announced in the Restrictions on Plastic (限塑令; 2007) and New Restrictions on Plastic (新限塑令; 2020).

Referring back to the plastic shopping bag ban mentioned earlier, this policy was initially highly effective, achieving a two-thirds reduction in shopping bag use (equal to 270,000 tons of plastic) within a short timeframe of five years (based on data from National Development and Reform Commission) [44]. However, the use of plastic bags rebounded thereafter to become widespread. To counter the problem more comprehensively, the New Restrictions on Plastic (新限塑令) were issued in 2020 (also known as Opinions on Further Strengthening the Control of Plastic Pollution; 关于进一步加强塑料污染治理的意见), which reiterated the thickness ban and expanded the scope of prohibited and restricted plastic products and added further target sectors and regions. Efforts addressing plastic pollution are unfolding on a tiered, step-by-step, field-specific, and region-specific manner, with specific timelines for 2020, 2022, and 2025, with a focus on specialized governance measures for issues such as agricultural mulch film and express packaging. The plastics targeted and implementation restrictions thereof are summarized in Figure 2.

3.2. Plastic Flow and Its Change during 2000–2019

Using officially published data, trends in the production of plastic raw materials, time-series changes in the production and consumption of plastic products, recycling, import and export of plastic waste and recycling rate as well as the plastic-material flow in China in 2019 were elucidated.

3.2.1. Trends in Production of Plastic Raw Materials

The production of plastic raw materials (excluding recycled materials), also referred to as plastics in primary forms, synthetic resins, or plastic resins, has displayed a consistent trend of growth in recent years. In 2021 it reached a historic peak of 110.39 million tonnes, representing 28% of total global production. Of this, polyethylene (PE) and polypropylene (PP) accounted for 45% of synthetic resin production, with polyolefins being used mainly for packaging plastics and films, i.e., single-use plastics. There are also around 8.84 million tonnes of polyethylene terephthalate (PET), which is used for manufacturing plastic bottles (Figure 3). Meanwhile, China imported 33.67 million tonnes of synthetic resins and exported 6.54 million tonnes in 2019, with net imports of 27.13 million tonnes, also showing an increasing trend [45]. The Ban on Waste Import in 2017 has had little impact on the growth trend of synthetic resins due to the rapid development of industries such as electronics, automotive, and real estate in China, leading to the concomitant continual rise in demand.

3.2.2. Trends in Production, Consumption and Trade of Plastic Products

Based on the Ministry of Commerce data (China Recycling Industry Development Report (2013–2021)), time-series changes in the production and consumption of plastic products, recycling, import and export of plastic waste, and the recycling rate were elucidated, as shown in Figure 4. The total domestic production of plastic products surged in the early 2000s, levelled off in the late 2010s, sharply declined in 2018, then rebounded in 2019 to reach a peak of 81.84 million tonnes. Domestic production and consumption have consistently been roughly in balance. In addition, imports of plastic products have remained at only a few percent over the whole period studied, while exports have increased rapidly in recent years.

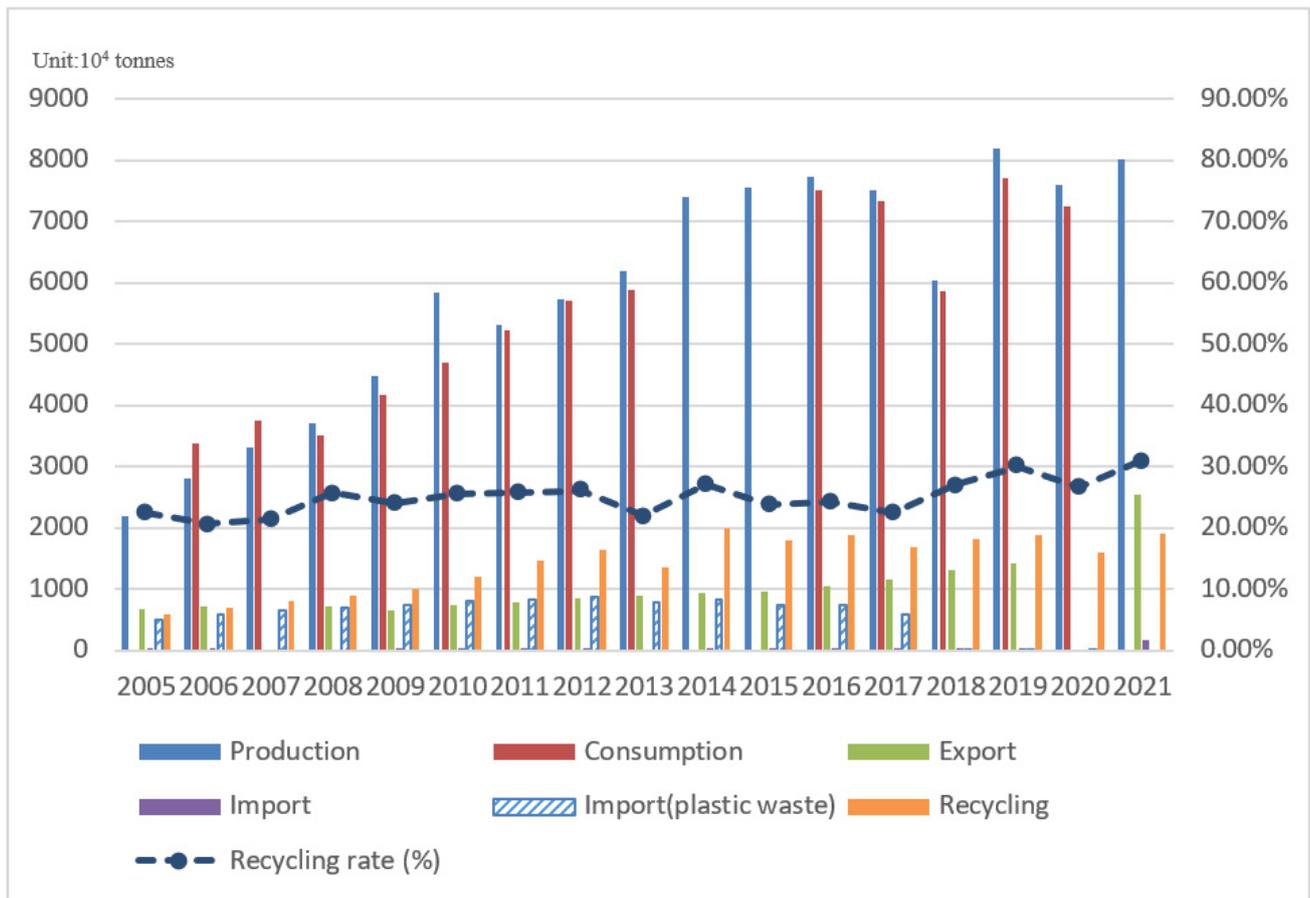


Figure 4. Amounts of production and consumption of plastic products, recycling, export and import of plastic waste, and the recycling rate during 2005–2021.

In terms of the recycling rate, it is noteworthy that while the total amount of recycled plastics waste has increased over the last 20 years, the recycling rate has consistently remained in the 20–30% range. By type, the amounts of plastic waste recovered in 2021 comprised PET, the highest at 5.5 million tonnes (4 million tonnes of PET bottles, 1.5 million tonnes of others), then packaging films at 3.6 million tonnes, then electric and electronic products at 1.6 million tonnes. Considering the increase in the amount of recycling, it can be evaluated that the recycling capacity is definitely improving. On the other hand, factors that have restrained the increase in China's plastic-waste-recycling rate include an underdeveloped recycling system for plastic waste, low levels of waste collection and classification, and the entry threshold for the recycling industry of plastics [46]. If the source-separation waste management system and resource-recycling system improve through the implementation of relevant laws, the recycling capacity could be increased in the future.

As a result of the plastic import ban in 2017, plastic-waste imports dropped from 7.35 million tonnes in 2016 to 5.83 million tonnes in 2017, to 70 thousand tonnes in 2018 and to zero tonnes in 2019. Meanwhile, the domestic recycling rate of waste plastics reached 30% in 2019 and 31% in 2021, which is believed to have stimulated domestic resource recovery. Concurrently, the production of plastic products dropped by 19.60% to 60.41 million tonnes in 2018, but rebounded strongly by 35.45% in 2019, surpassing 80 million tonnes and reaching another record high.

3.2.3. Trend of Production, Consumption and Trade of Plastic Products

Based on officially published data, a flow of plastic materials in China in 2019 was conducted, as shown in Figure 5.

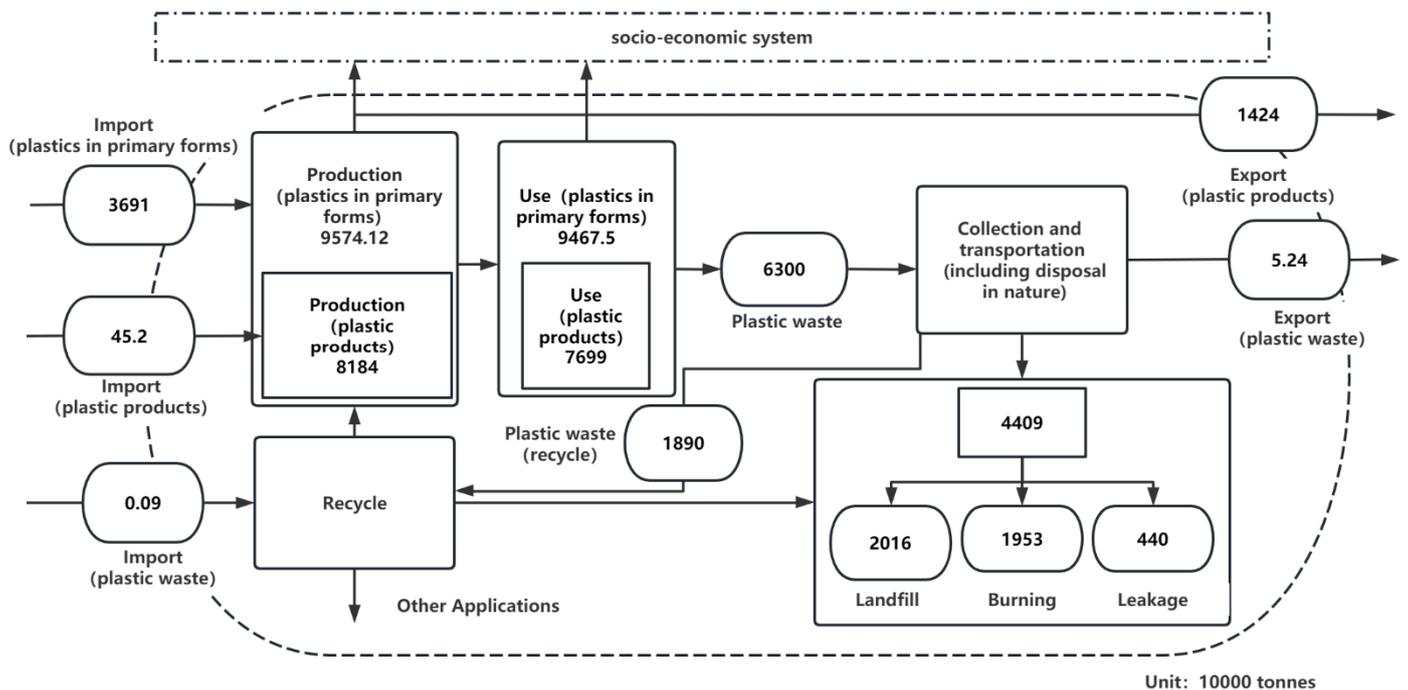


Figure 5. Plastic Material Flow in China, 2019.

The material flow of plastics shows that of the 76.99 million tonnes of plastics products consumed in China in 2019, 63 million tonnes (about 82%) were collected as waste plastics, while the remaining nearly 14 million tonnes (18%) remained within the socio-economic system in the form of increased stocks or in the environment. Of the 63 million tonnes of collected waste plastics, 32% was landfilled, 31% was incinerated, 30% was recycled, and the remaining 7% (or 4.2 million tonnes) was leaked to the environment during collection, transportation, and disposal.

In addition, current statistical data on the amounts of municipal solid waste generated in China only includes quantities that have entered the environmental sanitation collection and transportation system, i.e., the amounts of waste collected and transported, but does not include the unprocessed waste or the waste that has entered the waste-recycling system. Not accounting for such waste plastics from the agriculture sector therefore creates a data blind spot. Over the past decade, living standards in rural areas in China have improved significantly, resulting in a rapid increase in the amounts of rural solid waste generated. Amounts and compositions vary greatly from region to region; in developed regions, rural solid-waste management has gradually been integrated with urban solid-waste management, while in many underdeveloped regions, rural solid waste is still randomly dumped without treatment. On the other hand, waste-collection volumes are rising. Between 2009 and 2018, urban waste collection volume rose from 157 million tonnes to 228 million tonnes, or 45%, while that for the rural waste collection rose from 65 million tonnes to 111 million tonnes, or 69%.

4. Discussion and Policy Recommendations

Regulations on plastic pollution started appearing in the early 1990s, and efforts greatly accelerated upon the introduction of the 13th Five-Year Plan (2016–2020), greatly boosting the ambition for improvements in ecological and environmental quality by 2020. The Plan's legal framework has four key aspects: (1) goals and directions for five-year medium- and long-term economic development of the economy, culture and environment, with policies including for plastic issues; (2) to implement a ban on foreign waste imports; (3) to propose a plastic-recycling and treatment system and relevant policies, including a renewable-resources recycling system/circular economy, and solid-waste management/city infrastruc-

ture; and (4) to introduce related policies to deal with emerging plastics issues such as agricultural film and e-commerce express packaging.

The ban on imports of 24 types of waste in July 2017 was a game-changer in waste-plastics management globally and nationally. From China handling, at peak, around 60% of global waste plastic (170 million tonnes), this dropped to zero in 2019, a decoupling that transformed China's recycling industry toward domestic-resource circulation as a 'push' factor. At the same time, 'pull' factors include: the Law of the People's Republic of China on Solid Waste Pollution Prevention and Control, including separation at source; the Circular Economy Promotion Law; and the 14th Five-Year Plan for the Development of Circular Economy, as both sides of the wheel improve the efficiency of resource use and the circular economy domestically.

Under these umbrella policies, the Chinese government has implemented a series of policies to tackle plastics pollution and outlined those aimed at significant reductions in disposable plastics and improved plastic-waste management. These policies include targets for reducing single-use plastics in sectors such as retail, e-commerce, takeaways, and express parcel delivery, and also call for the introduction of systems for sorting, collecting, transporting, and treating domestic waste, as well as improving plastic-waste collection and transportation efficiency. Other measures include bans on the production and sale of certain single-use plastics, such as foam plastic tableware and plastic swabs, and the prohibition of thin plastic bags and polyethylene agricultural films. China also aims to clean up plastic waste from key water areas, tourist attractions, and rural areas. The current policies also encourage the use of alternative materials and the recycling and disposal of plastic waste, and urge strengthened control over toxic and harmful plastic additives harmful to human health or the environment.

Meanwhile, many local governments and private sectors have undertaken initiatives to address plastic pollution. Beijing launched its Plastic Pollution Control Action Plan for 2020–2025 to reduce disposable plastic products, establish a yearly reporting system for key plastic industries, and create a culture of low plastic usage. Hainan Province comprehensively banned the production, sale, and use of single-use plastic products, including single-use plastic bags and tableware by 2020 and all non-degradable plastic products by 2025. Shanghai implemented a waste separation policy that requires households and companies to sort their trash into four categories and issues fines for defaulters. The private sectors are also involved in recycling post-consumer plastics, such as Suning's "Shared express box" initiative, which replaces traditional paper-based express boxes and plastic packaging.

At the same time, many lessons have been learned over the last three decades. For example, due to the phenomenon of white pollution in the 1990s, China has since banned non-biodegradable fast-food containers on railways and set a deadline to phase out disposable plastic-foam tableware by the end of 2000. Foam-plastic tableware has had a rocky history, as it was initially considered problematic due to harm caused to the ozone layer and the difficulty in recycling and disposal; then, in 2013 it was removed from the industrial structure-adjustment guidance catalog as it met relevant national standards, could be recycled and could save oil resources while reducing raw-material consumption, a decision that was also influenced by global trends in foam-plastic tableware usage. Then, in 2020, the production and sale of disposable foam-plastic tableware were again banned in accordance with the New Restrictions on Plastic.

However, the policy effects of the restrictions were limited, as discussed in Section 3.1.3, mainly due to the facts that: (1) the policy requires plastic bags to be eliminated in terms of their production, sale and use, but in actual implementation more attention is paid to the consumer side and there is no effective control at source; (2) its implementation varied by location and region (it can be more easily executed in medium-sized to large supermarkets and shopping malls in urban areas), and due to the difficulty in regulating the high number of small shops, convenience stores, farmer markets, street vendors, and mobile vendors, particularly in rural areas; and (3) due to the rapid development of emerging industries

such as e-commerce, express delivery, and takeaways, the supervision of plastic-bag use posed challenges. For instance, from 2008 to 2016, the number of plastic bags consumed by China's express delivery industry ballooned over four-fold from 8.2 billion to over 34.7 billion, and in 2018 alone, the number of plastic bags consumed by China's express delivery industry exceeded 24.5 billion [47].

The effects of plastics policies aimed at addressing plastic pollution prior to 2016 aimed at reducing plastic at the source were quite limited, which can be confirmed through time-series changes in the production and consumption, as well as the recycling rate of plastic products, as shown in Figure 4. As can be seen, the amounts of plastic production and consumption did not drop, while the amounts of plastic recycled did not rise. Since 2016, however, the growth trend of the production and consumption of plastic products has moderated, and at the same time the recycling rate rose, surpassing 30% for the first time in 2021.

Plastic pollution also has direct and critical impacts on climate change, biodiversity, as well as the UN's sustainable development goals (SDGs). According to the Action Plan for Carbon Dioxide Peaking Before 2030 (2030年前碳达峰行动方案), controlling and tackling plastic pollution are key to achieving carbon neutrality in China. The realization of an "ecological civilization" is also a high priority for China, which focuses on balancing biodiversity conservation and socio-economic development. Moreover, these efforts are likely to boost motivation for various domestic stakeholders to adopt measures to reduce plastic production, consumption, and mismanaged waste, contributing to achievement of the SDGs, specifically targets 12.4, 12.5, and 14.1 [48].

On the other hand, plastic products are an important basis for China's petrochemical and light industry. While conventional plastic products are mainly used in agriculture, construction and daily living, the plastic industry is gradually expanding into high-end fields such as the automotive, pharmaceutical, and other industries. It is predicted that with the development of China's social economy and the continuous improvement of living standards, the demand for plastic products will continue to grow. The 14th Five-Year Development Guidance on Technological Progress in Plastics Processing Industry underscores the necessity of adhering to the 'functional, lightweight, precision, ecological, intelligent' direction of technological progress, to institutional innovation, to the principles of 'market-oriented' and 'government-led', as well as adhering to high leadership standards and ecological development. Further, the use of plastics extends across all aspects of living; thus, how to promote an inclusive and sustainable recovery from COVID-19, and a green and just transition, by incorporating biodiversity, climate change and plastic pollution concerns into all policies represents not only a big challenge, but a big opportunity.

In order to further tackle plastic pollution, some key suggestions with important policy implications are provided below:

1. Enhance coherence and integration between policies toward multi-tasks

For example, the Action Plan for Carbon Dioxide Peaking Before 2030 highlights the urgency of carbon reduction in the petrochemical and chemical industries, both of which are closely linked to plastics production, and the 14th Five-Year Development Guidance on Technological Progress in Plastics Processing Industry also mentions the need to support the development of China's plastics recycling industry. This is important because most of China's waste plastics, especially low-value packaging materials, are currently mixed with household waste and end up in landfills or are incinerated (Figure 5). However, at present, there is little evidence that other policies are being developed to address these challenges. For example, the latest Five-Year Plan (i.e., the 14th Five-Year Plan Plastic Pollution Control Action Plan) proposes reducing landfill plastic waste while boosting incineration capabilities nationwide to 800,000 tons per day by 2025 yet carrying this out would nearly triple the carbon footprint, as every kilogram of plastic burned emits 2.9 kg of CO₂. Therefore, in order to achieve its ambitious carbon neutrality targets, China must address the issues related to this approach: the disposal of end-of-life plastics through incinerators;

2. Establish a comprehensive management system that combines both vertical and horizontal approaches/governance

To effectively manage plastic waste, it is essential to establish a comprehensive management system that combines both vertical and horizontal approaches, i.e., the central government, local governments, businesses, and consumers (vertical), and the design, production, distribution, consumption, and recycling of plastic products among peers (horizontal). However, the New Restrictions on Plastic and relevant policies do not clearly define the responsibilities among the government, businesses, and consumers in the vertical approach, nor do they propose green design standards for plastic products in the horizontal approach, thus these deficiencies impede the policy's effectiveness. To address these issues, it is recommended to promote the Extended Producer Responsibility (EPR) system, which would assign environmental responsibilities to business. Additionally, it is essential to establish specific requirements, guidelines, and standards for ecologically designed plastic products in the horizontal approach to enhance preventive policies at the early stage of plastic life-cycles;

3. Establish a tracking system for plastics along the supply chain

Data on the plastic supply chain are inadequate; no official data have been released on the amounts of plastic-waste generation by sector or plastic waste entering the environment through different channels. Meanwhile, the current policy focus is directed more on the monitoring of direct plastic litter and environmental impacts; however, upstream (product and material-related) monitoring and downstream monitoring (waterways, waste, and marine and coastal environment) lack sufficient integration;

4. Establish a quality certification system for recycled products to improve the quality of recycled products as well as raise public awareness

The definition of 'Reclaim' needs to be clarified. The evaluation index of recyclability of plastic products is inconsistent and unclear: the key purpose of recycling and reusing waste plastics from domestic waste is to achieve secondary use of resources; therefore, the quality of recycled plastic products is of key concern to consumers. How to discern recycling product types therefore remains a challenge;

5. Develop behaviour-based solutions targeting consumers' daily lives and social practices to prevent or reduce plastic waste generation

New behaviour, awareness and knowledge need to be instilled, via situational prompts, such as appropriate infrastructure or access to alternatives, as well as ways of educating consumers and creating enabling conditions to tackle plastic pollution. Reaching a critical mass of society-wide action would accelerate the shift in norms and mindsets and spur action;

6. Promote a platform for stakeholder collaboration and community-based interventions

Establishing a platform for collaboration among multiple stakeholders could link individual practices together for scaled implementation through co-planning and co-implementation. High-potential approaches for raising awareness and responsibility, motivating reuse, and changing behaviors are community-based recycling and organised clean-ups. Combinations of top-down and bottom-up approaches are necessary as a long-term solution;

7. Create appropriate policies for the post-COVID-19 era

Due to lockdowns and other restrictions, the three-year-long pandemic has changed the ways in which people live and hindered the implementation of numerous environmental-protection activities in cities that have implemented waste separation, such as Shanghai. Citizens were generally unable to discard waste in the usual ways. For cities that do not yet separate waste, reductions in manpower have delayed its implementation.

It is therefore crucial to consider appropriate policies for environmentally friendly single-use plastics to transition to the post-pandemic era as soon as possible.

5. Conclusions

This paper provided a preliminary overview of China's plastic policies and their effects over recent decades, as well as policy recommendations to enhance the country's ability to tackle plastic pollution domestically and internationally. However, there are limitations to this study. The New Plastic Restriction policy was only implemented relatively recently, and its policy effectiveness is still yet to be determined, thus further analysis is required. Additionally, this study only conducted a macro-level analysis, and deeper research into the actual level of implementation of the policy by consumers at the micro-level is required. Furthermore, this study acknowledges that other factors, such as regional enforcement differences, alternative material availability, and the role of the private sector in promoting sustainable practices may affect the effectiveness of China's plastic policies. Additionally, this study did not explore the potential unintended consequences of plastic policies, such as the emergence of new forms of waste resulting from plastic substitutes. Future research should address these limitations to provide a more comprehensive understanding of the complex challenges posed by plastic pollution in China.

Moreover, it is important to note that the issue of plastic pollution in China is not isolated and cannot be solved by China alone. Indeed, given its global nature, international cooperation and coordination are needed in order to tackle it effectively, and in this regard, China has already taken steps to engage in international discussions on plastic pollution, such as by joining the Global Ocean Alliance and participating in the United Nations Environment Assembly. However, more efforts are needed to establish international agreements and cooperation frameworks to address the issue on a global scale.

In conclusion, China's plastic pollution problem is a complex issue that requires a multi-dimensional approach combining policy, technology, and international cooperation. While this study provides a preliminary overview of China's plastic policies and their effects, further research is needed to fully understand the problem and develop effective solutions.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su15119087/s1>, Table S1: Relevant policies.

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