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The Chinese import ban and its impact on global plastic waste trade

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Abstract

The rapid growth of the use and disposal of plastic materials has proved to be a challenge for solid waste management systems with impacts on our environment and ocean. While recycling and the circular economy have been touted as potential solutions, upward of half of the plastic waste intended for recycling has been exported to hundreds of countries around the world. China, which has imported a cumulative 45% of plastic waste since 1992, recently implemented a new policy banning the importation of most plastic waste, begging the question of where the plastic waste will go now. We use commodity trade data for mass and value, region, and income level to illustrate that higher-income countries in the Organization for Economic Cooperation have been exporting plastic waste (70% in 2016) to lower-income countries in the East Asia and Pacific for decades. An estimated 111 million metric tons of plastic waste will be displaced with the new Chinese policy by 2030. As 89% of historical exports consist of polymer groups often used in single-use plastic food packaging (polyethylene, polypropylene, and polyethylene terephthalate), bold global ideas and actions for reducing quantities of nonrecyclable materials, redesigning products, and funding domestic plastic waste management are needed.

INTRODUCTION

Plastic has become a major commodity on a global scale and has infiltrated almost every aspect of human life. The historic growth in production has outpaced almost all other manufactured materials from 2 million metric tons (MT) produced in 1950 to 322 million MT produced in 2015 (1, 2). A cumulative total of 8.3 billion MT of plastic has been produced as of 2017 (1). Plastic is a very useful material (moldable, durable, light, and inexpensive), and packaging is the most significant sector (40%) of use (2). Plastic as a material for packaging has had significant advantages, allowing companies to market effectively, design appealing-looking and appealing-feeling packages, prevent loss from store shelves, and transport goods efficiently and economically throughout the world. However, plastic packaging for food, beverage, and tobacco items is often used only once, which has contributed to 61% of global beach litter (3).

While the use of plastic has expanded quickly, little thought has been given to the impact of this growing use on solid waste management systems, which have had to react to the influx of new and variable materials entering the solid waste stream. Plastic packaging and single-use items enter the waste stream immediately after use, contributing to a cumulative total of 6.3 billion MT of plastic waste generated worldwide (1). Management of this large increase and quantity of plastic waste has been challenging, particularly in areas of rapid economic development and population growth. Only 9% of plastic waste has been recycled globally, with the overwhelming majority of global plastic waste being landfilled or ending up contaminating the environment (80%), resulting in an estimated 4 million to 12 million MT of waste plastic entering the oceans annually (1, 4).

Plastics can be challenging to recycle because of the wide variety of uses, additives, and blends that are used in a multitude of products (5), as well as the fact that there are material properties that can limit the number of times that products can be recycled. Commingled and single-stream recycling operations have also contributed to more contamination than ever before in the recycling stream, especially for plastic waste, but the emerging markets in China in the 1990s found that the material could be used profitably, especially when ships could efficiently deliver the material, and that it could be used to manufacture more goods for sale or export. For exporting countries, shipping-processed plastic waste to China and surrounding countries has provided an outlet for managing plastic waste, preventing it from going to landfill or incineration in the source countries (6).

China has increasingly implemented more rigid waste import policies, starting prior to 2010 (7). Then, in 2013, the relationship between plastic waste exporters and China as the primary importer was disrupted when China introduced a temporary restriction on waste imports that required significantly less contamination. This operation was referred to as the “Green Fence” and highlighted the fragility of global dependence on a single importer. The goal of the Green Fence campaign was to increase the quality of the plastic waste that China was receiving while also reducing illegal foreign smuggling and trading (6). While informal (that is, undocumented) flows of plastic waste are known to occur, available data from the European Union (EU) estimate that these instances are a fraction of the waste that which is legally traded and documented. That said, the Green Fence succeeded in its aforementioned goals; however, it did not entirely stop the informal flow of plastic waste, and true quantities are unknown at this time. While the Green Fence campaign was temporary, in 2017, China announced a new import policy permanently banning the import of nonindustrial plastic waste (8).

Here, we quantify the cascading impacts of this new Chinese import ban. We characterize the rapid globalization of management of plastic waste, identifying major import and export trends by region and income level. Twenty-eight years of data (1988–2016) were compiled from the United Nations (UN) Comtrade Database on the imports and exports of the category “plastic waste, parings, and scrap” for four polymer classifications: polyethylene (PE), polyvinyl chloride (PVC), polystyrene (PS), and others (9–12) reported by mass (in kilograms) and trade value (in U.S. dollars). The “other” plastics group includes plastic waste polymers that do not yet have an internati harmonized code used for reporting but encompasses trade of polymers such as polypropy (PP) and polyethylene terephthalate (PET). To quantify the magnitude of the Chinese regula regarding imports of forbidden and constrained waste items, we estimated the quantity of

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waste that would be displaced on the basis of historical cumulative imports of plastic waste into China. Historical cumulative import data were projected forward in a business-as-usual (BAU) scenario using a best-fit trendline analysis, bounded by upper and lower estimates (figs. S1 to S4).

RESULTS

Global annual imports and exports of plastic waste began to rapidly increase in 1993, having grown 723 and 817% in 2016, respectively (Fig. 1). In 2016 alone, about half of all plastic waste intended for recycling (14.1 million MT) was exported by 123 countries, with China taking most of it (7.35 million MT) from 43 different countries (Fig. 2) (*9*–*13*). Since it began reporting in 1992, China has imported 106 million MT of plastic waste, making up 45.1% of all cumulative imports (Table 1). Collectively, China and Hong Kong have imported 72.4% of all plastic waste. However, Hong Kong acts as an entry port into China, with most of the plastic waste imported to Hong Kong (63%) going directly to China as an export in 2016. With the projected BAU Chinese import data, an estimated cumulative 111 million MT of plastic waste will be displaced by 2030 (Fig. 3). The displaced plastic waste is equal to nearly half (47%) of all plastic waste that has been imported globally since reporting began in 1988.

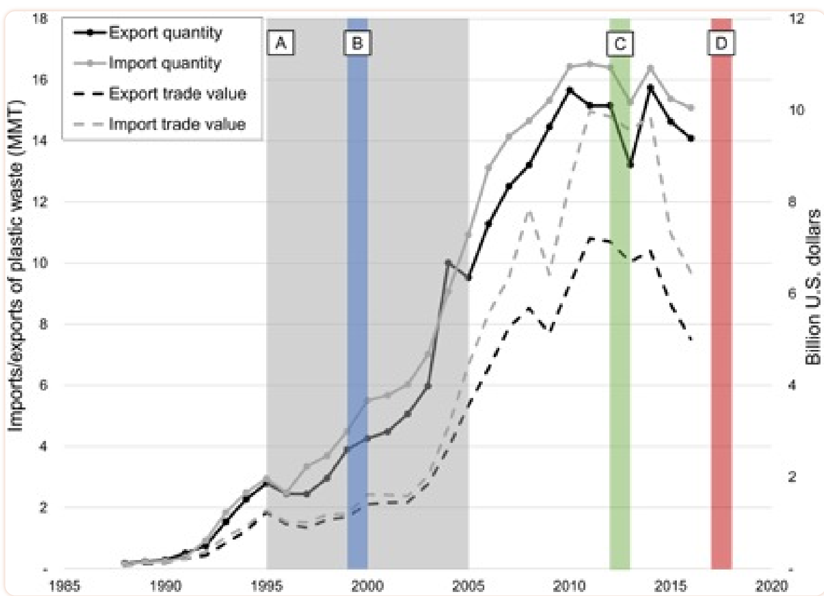

Fig. 1

Trade of plastic waste in mass and trade value (UN Comtrade data).

(**A**) Advances in Municipal Recovery Facility (MRF) technology resulting in expansion of commingled recycling, especially single-stream recycling in the United States (1995–2005) (see the Supplementary Materials). (**B**) Surge in globalization, supported by the World Trade Organization and the International Monetary Fund (*29*–*31*). (**C**) Implementation of temporary Chinese import restrictions (Green Fence) (2013). (**D**) Implementation of the n Chinese policy banning the import of nonindustrial plastic waste (2017).

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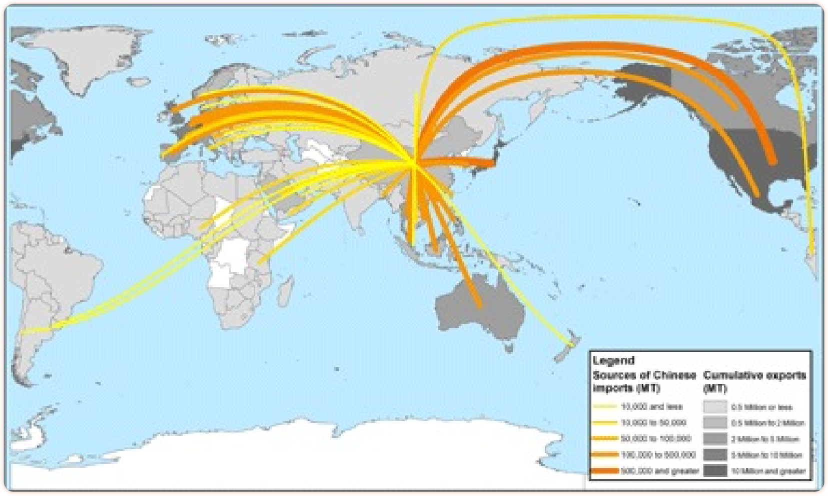

Fig. 2

Sources of plastic waste imports into China in 2016 and cumulative plastic waste export tonnage (in million MT) in 1988–2016.

Countries with no reported exported plastic waste values are white. Cumulative exports represent by country exports of PE, PS, PVC, and other plastic [UN Comtrade data; (9–12)]. Quantities for sources of Chinese imports include PE, PS, PVC, PP, and PET (13).

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Table 1

Cumulative plastic waste export and import by country (1988–2016) (9–12).

MMT, million MT. SAR, Special Adminitrative Region.

Exporters (top 10)

Rank*	Reporter	Economic classification†	Region*	Cumulative trade value (billion USD)‡	Cumulative net weight (MMT)§	% of global exports
1‖	China, Hong Kong SAR	HIC	EAP	16.7	56.1	26.1
2	United States	HIC	NA (OECD)	12.3	26.7	12.4
3	Japan	HIC	EAP (OECD)	9.64	22.2	10.3
4	Germany	HIC	ECA (OECD)	6.95	17.6	8.22
5	Mexico	UMI	LAC (OECD)	4.55	10.5	4.90
6	UK	HIC	ECA (OECD)	3.32	9.26	4.31
7	Netherlands	HIC	ECA (OECD)	3.19	7.71	3.59
8	France	HIC	ECA (OECD)	3.49	7.55	3.52
9	Belgium	HIC	ECA (OECD)	2.55	6.41	2.99
10	Canada	HIC	NA (OECD)	1.93	3.89	1.81
		Total		**64.7**	**168**	**78**

Importers (top 10)

Rank	Country	Economic classification†	Region*	Cumulative trade value (billion USD)‡	Cumulative net weight (MMT)§	% of global imports
1	China	UMI	EAP	57.6	106	45.1
2	China, Hong Kong SAR	HIC	EAP	23.3	64.5	27.3
3¶	United States	HIC	NA (OECD)	5.18	8.49	3.60
4	Netherlands	HIC	ECA (OECD)	2.40	6.43	2.72

*EAP, East Asia and Pacific; ECA, Europe and Central Asia; NA, North America; LAC, Latin American and the Caribbean; SA, South Asia; OECD, Organization for Economic Cooperation.

†HIC, high-income country; UMI, upper middle income; LMI, lower middle income; LI, low income; based on 2015 gross national income.

‡Cumulative trade value is the sum of reported values based on annual reports by each country for each trade flow from 1988 to 2016 (UN Comtrade Data).

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§Cumulative net weight is the sum of reported values based on annual reports by each country for each trade flow of four categories: waste PE, waste PVC, waste PS, and waste other plastics from 1988 to 2016 (UN Comtrade Data).

||If considered collectively, then EU-28 countries would rank first on the list of cumulative exports, accounting for 31% of exports.

¶If considered collectively, then the EU-28 would rank third on the list of cumulative imports, accounting for 8.0% of imports

#Other Asia, not elsewhere specified (nes) is 1 of 16 UN areas nes. These areas are used (i) for low value trade or (ii) if the partner designation was unknown to the country or if an error was made in the partner assignment. The reporting country does not send details of the trading partner in these cases, sometimes to protect company information (28).

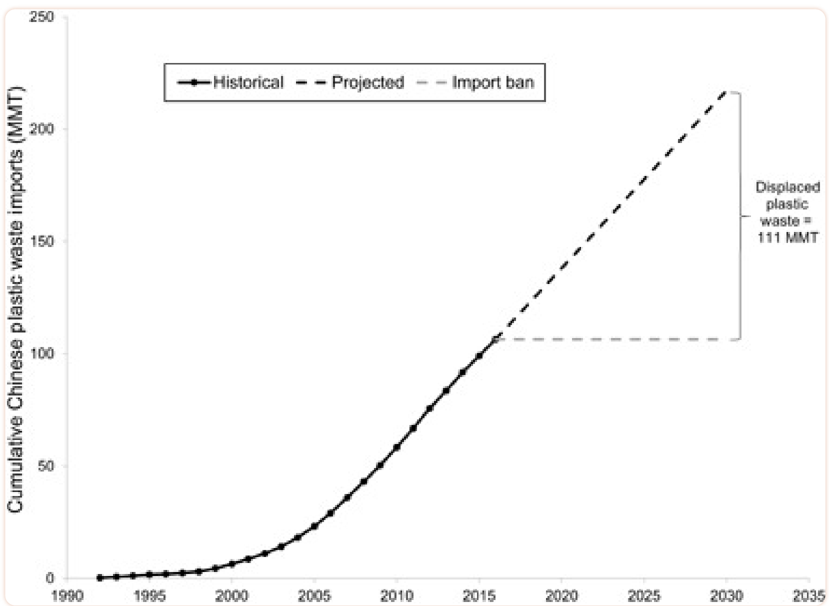

Fig. 3

Estimated mass of global displaced plastic waste due to the new Chinese import ban based on cumulative imports of PE, PS, PVC, and other plastics into China [UN Comtrade data; (9–12)].

The BAU (business as usual) projection of Chinese imports was created by using a linear regression of the last 10 years of imports. The Chinese ban on importation of plastic waste is based on a 100% implementation of the regulation (see the Supplementary Materials for details).

High Income (HIC) countries have overwhelmingly been the primary exporters of plastic w since 1988, contributing to 87% of all exports and valued at $71 billion USD (Table 1 and ta S1). Imports of plastic waste are almost evenly split between HIC and Upper Middle Income

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countries, which collectively account for 96% of all imports and are valued at $106 billion USD (Table 1 and table S1). All of the top 10 countries exporting plastic waste are HIC, except for Mexico (UMI) ranking fifth. Seven of the top 10 countries importing plastic waste are HIC as well, except for China (first), India (ninth), and other Asia not elsewhere specified (see note # in Table 1). If taken collectively, then the EU-28 would be the top exporter.

Regionally, EAP (East Asia and Pacific) countries are characterized as the leading exporters of plastic waste; however, this is because of the large flow of exports from Hong Kong to China (fig. S5). Excluding Hong Kong, ECA (Europe and Central Asia) countries lead in exporting (for example, Germany, UK, and Netherlands), contributing to 32% ($27.6 billion USD) of all exports, followed by NA countries (United States and Canada) contributing to 14% ($14.3 billion USD) of exports (see footnote ‖ in Table 1 and table S2). EAP countries have dominated the import of plastic waste, having imported 75% ($83.3 billion USD) of plastic waste imports since 1988 (table S2). Collectively, the nation members of the OECD have contributed to 64% ($57.4 billion USD) of all exports, suggesting that the trade of plastic waste may largely be occurring between OECD and EAP countries (see note 2 in table S2). Furthermore, 33 of 35 OECD countries are considered HIC, 90% of the top 10 exporting countries are members of the OECD, and 23 of 36 EAP countries are low- or middle-income countries. These findings are consistent with historical trends of waste management practices in which low- and middle-income countries often import waste material for recycling (*14*). Consequently, wealthier nations, with more robust waste management infrastructure, are sending plastic waste to countries that are still developing economically with less-developed waste management infrastructure. Relatively high domestic management costs in exporting countries versus the cheaper processing fees in China have driven the trends illustrated here (for example, it is often cheaper to transport recycled materials by ship to China than it is to transport domestically by truck or rail) (*15*). In addition, exporting countries have preserved solid waste management capacity by sending waste to China where there are progressive environmental policies related to circular economy (for example, Environmental Protection Law, Circular Economy Promotion Law, etc.) (*16*); however, implementation of these policies has lagged, largely because of the top-down approach that has been taken, which lacks social and environmental indicators supporting market-based policy and public participation (*16*, *17*).

Of the four polymer groups, the “other plastics” group is the most commonly traded plastic waste comprising a cumulative 131 million MT imported ($61.5 billion USD) and 123 million MT exported ($50.4 billion USD) traded between 1988 and 2016, followed by PE, which has had 67 million MT exported ($25.5 billion USD) and 71 million MT imported ($33.2 billion USD) since 1988 (fig. S6). Within this time period, China has imported primarily other plastics and PE (fig. S7). Excluding Hong Kong, the United States is the leading exporter of PVC and other plastics. Germany is the leading exporter of PE, and Japan is the leading exporter of PS. Each of these countries remains in the list of top five cumulative exporters for all four polymer groups. China is the leading importer of three of four polymer groups (table S3), with Hong Kong leading China in importing PS.

DISCUSSION

China is still developing solid waste management infrastructure, and an estimated 1.3 million to 3.5 million MT of plastic is estimated to enter the oceans annually from its coastline (4). Using population data, waste generation rates, and percent plastic in the waste stream, we estimated the contribution of imports to the domestic waste stream in China. On the basis of the data from 2010 to 2016, the import of plastic waste to China contributes 10 to 13% additional mass to the domestic plastic waste that is already generated within the country and is difficult to manage. In 2016, the imports (7.35 million MT) contributed another 10.8% of waste to the 60.9 million MT of plastic waste estimated to be generated in China (table S4).

The UN Comtrade data alone cannot accurately portray what is happening to plastic waste worldwide and does not trace the movement of waste between countries, which is a limitation of this research. For example, while we did obtain industry data showing that the United States imports plastic waste from Mexico, we do not know whether that waste is then processed domestically or exported to Hong Kong or China. The fact that plastic waste transfer between countries can be convoluted provides impetus for closely monitoring plastic waste to accurately track and better manage it. In addition, two of the most commonly used polymers, PET and PP, lack specific data because trade codes for these waste materials are not yet harmonized.

In 2013, the Chinese Green Fence campaign resulted in a reduction of plastic waste accepted at the Chinese border, with some shipments being turned away and sent back to the source countries. As a result, plastic recycling industries experienced a globally cascading effect since little infrastructure exists elsewhere to manage the rejected waste. A $446 million USD and $298 million USD reduction in export and import trade values, respectively, occurred from 2012 to 2013 (Fig. 1). While the value of plastic waste trade did not recover to levels seen before the Green Fence, it remained significant in 2016, and the Green Fence was only a small sample of the potential impact of the recent policy banning waste imports. Furthermore, since it restricts legal trade, the new import ban policy could increase the informal and illegal flow of plastic waste.

Suggestions from the recycling industry demonstrate that, if no adjustments are made in solid waste management, and plastic waste management in particular, then much of the waste originally diverted from landfills by consumers paying for a recycling service will ultimately be landfilled (6). Furthermore, it is possible that EAP countries surrounding China could also receive the displaced plastic waste; however, many of these countries lack the infrastructure to manage their own plastic waste, let alone a rapid increase in plastic waste supplied by other countries. While there are some country-level assessments that exist (for example, World Bank, OECD, etc.), there is no global standard for the classification of countries that have sufficient infrastructure to manage imported plastic waste.

Both the displaced plastic waste and future increases in plastic recycling must be addressed immediately. Initially, the countries exporting the most plastic waste can use this as an opportunity to develop and expand internal markets. If domestic recycling of plastic waste is not possible, then this constraint reinforces the motivation to reduce use and redesign plastic packaging and p ucts so that they retain their value and are more recyclable in domestic markets. In additio import and export of plastic waste are another justification for a global agreement relating use and management of plastic materials called for previously (18, 19). Of relevance to this sion is the fact that the international Basel Convention, which governs the export of hazardous and other waste, already exists. For example, if plastic waste were characterized as a “waste requiring special consideration” (Y46) under the Basel Convention, then export could potentially be regulated. Basel also provides a framework for knowledge sharing and promoting the proper management of waste, including harmonization of technical standards and practices, which could help build capacity to properly manage plastic waste around the world. One legal concept that could be applied to the management of plastic waste is strict liability, holding both waste producers and exporters accountable for making sure that the material they ship is properly managed by any receiving entity. Lastly, each country wishing to continue to import significant quantities of plastic waste could consider an import tax specifically to fund the development of solid waste management infrastructure within that country.

With plastic production and use continuing to rise, and companies and countries both committing to circular economies and increasing plastic recycling rates, the quantity of plastic waste needing a “home” will continue to increase for the foreseeable future. Where will the plastic waste go now? Without bold new ideas and management strategies, current recycling rates will no longer be met, and ambitious goals and timelines for future recycling growth will be insurmountable.

MATERIALS AND METHODS

Historical trade of plastic waste

The UN Comtrade Database provides the most comprehensive international trade data regarding imports and exports of many commodities. Trade data were organized on the basis of the Harmonized Commodity Description and Coding Systems (HS), which was implemented by the UN in 1988. This system provides an international nomenclature structure for international trade commodities. Countries and regions can report data regarding traded items based on the given code. Reported trade flows include net weight (in kilograms) of exports, imports, reexports, and reimports. In addition, trade values associated with annual trade of plastic waste were provided by the UN database in U.S. dollars. Annual values were based on reported tonnage and corresponding trade values between 1 January and 31 December each year. Within the UN Comtrade data is information regarding the global trade of plastic waste including waste, parings, and scraps of PE (3915.10), PS (3915.20), PVC (3915.30), and other plastics (3915.90) (*9*–*12*). Other plastics include trade data for plastic waste polymers that do not have an individual HS trading code such as PP and PET.

Any commodity, including plastic waste, can be reimported and reexported for a variety of reasons. According to the UN, reexported material may be “defective, the importer might have defaulted on payments or canceled the order, the authorities might have imposed an import barrier, or demand or prices in the country of origin might have made it worthwhile to bring the good back” (*20*). Both the reimport and reexport values were incorporated into the overall trade quantities reported in this study and contributed only 0.02 and 9.3% of all global imports and ex[illegible] since 1988.

Since the implementation of the HS, trade information for plastic waste as commodities was reported by 191 countries from 1988 to 2016. Of the four plastic waste categories, 175 countries reported exports greater than 0 MT, and 190 have reported imports greater than 0 MT. Because of geopolitical changes in national boundaries and names, trade data were combined for some reporting countries and territories. For example, data from 1988 to 1990 were reported by the "Former Federal Republic of Germany." Data from 1991 to 2016 were reported by "Germany." These two data sets were combined and reported as Germany. In addition, data from each of the 28 nations participating in the EU were combined for comparison of Europe's trading of plastic waste (see footnote ¶ in Table 1). It should be noted that variation in how reporting is done, valuation between the commodity source and destination country, and timing of reporting can affect the consistency and reliability of the data.

The available data for PE, PS, PVC, and other plastics from 1988 to 2016 were used to determine historical and regional trends of international trade of plastic waste in terms of net weight and trade value. We analyzed trade patterns over time by country, income level and region, and individual polymer. Data were compiled and sorted for all reporting countries for each of the four plastic waste polymers. In addition, World Bank regional assignments and income levels were applied to every reporting country for all trade flows, plastic waste polymer categories, and years in which data were available. Economic classifications were based on 2015 gross national income estimations reported by the World Bank (*21*). Regional classifications were assigned on the basis of the current World Bank assignment groups (*22*, *23*). Cumulative values of traded recycled waste from 1988 to 2016 were used to create historical rankings of reporting countries, income status, world regions, and polymers (Table 1 and tables S1 to S3).

Finally, cumulative values were used to show geographic trends by country in ArcGIS 10.4 (Fig. 2 and figs. S8 to S12). Quantitative symbolization based on cumulative net weight of traded recycled polymers was used to provide geographic understanding of trade of plastic waste. Radial flow maps were generated using the Data Management XY to Line tool for the 2016 exports of PE, PS, and PVC from the top five historical exporters excluding Hong Kong (United States, Japan, Germany, Mexico, and UK) (figs. S8 to S12) (*24*–*26*). Sources of Chinese imports of plastic waste in 2016 were visualized by radial flow maps, weighted, and shaded on the basis of reported net weight (Fig. 1) (*13*).

Displaced plastic waste

To estimate the quantity of plastic waste displaced by the new Chinese regulations, we examined historical trends for the import of plastic waste into China. The projection assumed that no imports of plastic waste were made after the implementation of the regulations as of 31 December 2017 as per the Chinese Ministry of Environmental Protection announcement. Overall, the new regulations ban the following categories of items: (i) forbidden items (n = 125), (ii) constrained items (n = 32), and (iii) allowed items (n = 18) (*8*). Forbidden wastes are no longer allowed to be imported into China, and constrained waste is only accepted if it meets specific material sta
Eight types of plastic waste from consumer goods are now banned including plastic waste p

mers of PE, PS, PVC, PET, and others (for example, PP), as well as bales of PET plastic bottles, aluminum plastic film, and compact disk/digital video disks. Industrial plastic waste that meets Chinese control standard GB 16487.12 is still conditionally accepted (27).

The displaced plastic was represented by the difference between the projected BAU cumulative Chinese imports in 2030 and the 100% implementation of the ban in 2030. Three different regression fits were made using (i) a linear fit of all the data (1988–2016) that resulted in fig. S1 and a coefficient of determination (R^2) of 0.89, (ii) a second-order polynomial fit of all the data (1988–2016) that resulted in fig. S2 and an R^2 of 1.0, and (iii) a linear fit of the linear part of the curve, in the last 10 years (2006–2016), which resulted in fig. S3 and an R^2 of 1.0. The highest and lowest of these projections were used to bound our estimate of displaced plastic. The "best" estimate is in between the linear regression of all the data (projected at 63.3 million MT) and the second-order polynomial (projected at 195 million MT). Thus, the 10-year linear regression estimate of 111 million MT became the best estimate (fig. S4). Although the announcement of the new regulations suggested complete restrictions on the imports of recycled waste, analyses of 50 and 75% restriction scenarios were provided. The quantity of displaced plastic waste was calculated for the year, immediately following the restrictions (2018), and every 5 years from 2020 to 2030 (table S5).

Impact of imported plastic waste in China

The imported plastic waste into China has an impact on their existing waste stream. To examine this impact, the population of China for years 2010 to 2016 was obtained from the World Bank. Values for Chinese waste generation rates and percent plastic in the waste stream were obtained from Jambeck *et al*. (4). Waste generation rates were multiplied by the population and converted to years and MT to calculate the plastic waste generation (in MT) per year. We then summed the plastic waste generation values and imported plastic waste values to determine the total waste to be managed within China per year. Finally, the impact was estimated by the percentage of plastic waste that was imported each year divided by the total waste to be managed.

Supplementary Material

http://advances.sciencemag.org/cgi/content/full/4/6/eaat0131/DC1:

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was conducted at the UGA without specific project funding. A.L.B. was funded by a UGA Teaching Assistantship. **Author contributions:** A.L.B. led the data collection and calculations and contributed to the research design, model development, interpretation of results, and writing of the manuscript. S.W. contributed to the research, calculations, and writing of the manuscript. J.R.J. led the research design and contributed to the data collection, model development, interpretation of results, and writing of the manuscript. **Competing interests:** The authors declare that they have no competing interests. **Data and materials availability:** All data needed to evaluate the conclusions in the paper are present in the paper and/or the Supplementary Materials. Additional data related to this paper may be requested from the authors.

SUPPLEMENTARY MATERIALS

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Supplementary material for this article is available at
http://advances.sciencemag.org/cgi/content/full/4/6/eaat0131/DC1

Supplementary Text

fig. S1. Linear fit of all historical cumulative Chinese imports of plastic waste (R^2 = 0.89) (9–12).

fig. S2. Polynomial fit for historical cumulative Chinese imports of plastic waste (R^2 = 1.0) (9–12).

fig. S3. Linear fit for the last 10 years of cumulative Chinese imports of plastic waste (R^2 = 1.0) (9–12).

fig. S4. Best-fit regression analysis for future plastic waste imports (9–12).

fig. S5. Top five importers to China in 2016 and top five export destinations for the top five historical exporters (13, 24–26).

fig. S6. Comparison of cumulative import and export quantities of plastic waste (MT) from 1988 to 2016 for each plastic waste polymer.

fig. S7. Annual Chinese imports of each plastic waste polymer from 1992 to 2016.

fig. S8. Destination countries of U.S. exports of plastic waste in 2016 and cumulative plastic waste export tonnage (in million MT) in 1988–2016.

fig. S9. Destination countries of Japanese exports of plastic waste in 2016 and cumulative plastic waste export tonnage (in million MT) in 1988–2016.

fig. S10. Destination countries of German exports of plastic waste in 2016 and cumulative plastic waste export tonnage (in million MT) in 1988–2016.

fig. S11. Destination countries of Mexican exports of plastic waste in 2016 and cumulative plastic waste export tonnage (in million MT) in 1988–2016.

fig. S12. Destination countries of UK exports of plastic waste in 2016 and cumulative plastic waste export tonnage (in million MT) in 1988–2016.

table S1. Ranking of World Bank economic groups based on cumulative exports and imports plastic waste (in MT) from 1988 to 2016 (9–12).

table S2. Ranking of World Bank regional groups based on cumulative exports and imports of plastic waste (MT) from 1988 to 2016 (9–12).

table S3. Ranking of countries based on cumulative exports and imports of each plastic waste polymer classif tion from 1988 to 2016 (9–12).

table S4. Estimated percentage of imported plastic waste to be managed in China from 2010 to 2016 (4, 9–12, 14).

table S5. Projected displaced plastic waste based on 100, 75, and 50% restriction scenarios for Chinese imports of plastic waste after the implementation of the new Chinese import ban policy.

table S6. Ranking of top countries that exported plastic waste to China in 2016 (MT) (13).

database S1. Trade Data Compilation Framework (Excel file).

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