Plastics Recycling in China
an international life cycle approach

Pieter van Beukering (ed.)

Institute for Environmental Studies

This paper presents an executive summary in English and in Chinese of the report. The report is the result of a collaborative study involving the Institute for Environmental Studies (IVM), the Chinese Academy of International Trade and Economic Co-operation (CAITEC), in Beijing, and the Policy Research Centre for Environment and Economy (PRCEE), in Beijing.

The study was conducted within the program of Collaborative Research in the Economic of Environment and Development (CREED). CREED was established in 1993 as a joint initiative of the International Institute for Environment and Development (IIED), London and the Institute for Environmental Studies (IVM). The full report can be requested from the CREED secretariat which is based at IIED in London. Some of the chapters as well as other CREED outputs can be downloaded from the CREED website at IIED.

IVM Report number W99/05
May 1999

Executive summary (English)

In the coming years and into the 21st century, plastics gain further importance in Chinese national life. Both consumers and industrial users expand their demand for plastics, both in terms of quantity and quality, with an estimated annual growth of 20 percent. The coming decade is a crucial period for the Chinese plastics industry in meeting this demand. At the same time, the rapidly increasing waste burden of plastics has to be minimized. At present, around 50 to 60 percent of waste plastics is left uncollected or is dumped in an uncontrolled manner on land, in rivers or in the sea. This requires intense efforts on the part of the formal and informal waste management sectors as well as the plastics recycling industry. The Chinese recycling sector can reduce the burden of solid waste by creating a market for recovered materials while simultaneously narrowing the gap between the demand and supply of plastic resources.

This research project analyses the role of the plastic recycling industry in creating a more sustainable plastic cycle in China. This role is addressed here both from a qualitative and a model-based angle. The qualitative study, through a field survey and a literature inventory, highlights the following trends and issues on the plastics cycle in China.

- Final demand for plastics is growing rapidly. The domestic primary plastics industry is unable to meet this demand, as a result of which China is highly dependent on imports of plastics. At the same time, waste management in Chinese cities is incapable of dealing effectively with plastics waste. This effect is exacerbated by the fact that less waste plastics are 'formally' recovered because government involvement is less.
- In China, two types of recyclers are distinguished: the ones using domestic waste plastics and the ones using imported waste plastics. The two types have different characteristics. Labour productivity of the importing recycler is higher due to better quality inputs, scale of operation as well as the higher capital intensity of production.
- The recycling rate of plastics (the actual utilisation of waste plastics in plastics production) is declining mainly because recyclers suffer from lack of supply of waste plastics. Import of waste plastics can partially reverse this trend. Yet, critics of trade in waste plastics argue that this type of imports are in reality a disguise for waste dumping by the exporting country. Moreover, cheap imports of waste allegedly crowd out the local recovery system leading to a domestic waste disposal problem.

To further analyze these issues, various scenarios are operated, based on a sectoral cradle-to-grave planning model using the mass balance approach. This model has a dual purpose. The first is to investigate how the Chinese plastics sector can face the acute shortage of plastics in an economically and environmentally sound manner. Options at hand are, on the one hand, to increase domestic production of primary and/or secondary resin, or on the other hand, to expand imports of primary and/or secondary plastics commodities. The second purpose of the model is to shed more light on the trade of waste and to test the claims put forward by the critics. The model integrates financial, environmental transport and trade issues.

The main conclusions of the modeling exercises are:

- The financial and economic costs of the plastic cycle in China can be reduced by increasing the capacity of the domestic recycling industry. Most of the simulated scenarios highlight the limited existing capacity of the recycling industry. This shortage forces the final goods manufacturing sector to use a higher proportion of primary resin in their final goods than what is economically and technically desirable. This has been one of the reasons for the large import of primary resin.
- The additional required recycling capacity should preferably be met by domestic waste plastics. Not only are transport activities avoided but it also reduces the waste burden created by post-consumer plastics. This requires additional attention for the recovery sector of plastics. The recovery rate of waste plastics, which in the last decade plummeted from 20 to 5 percent of the total amount of generated waste plastics, should be reversed as soon as possible. This may require special policies by the Chinese government.
- Despite this advisability, we do not expect the recovery system to be enhanced on the short term. Too many institutional barriers exist to improve the recovery of the increasing waste burden. Therefore, imports of waste plastics should be allowed to meet the gap between demand and supply of waste plastics in China. This will not have a adverse effect on the balance of payment, as the increase in imports of waste plastics will mainly replace relatively expensive imported final goods.

The qualitative and model-based analysis combined enable us to address the question of how to bring about these changes in a society gradually switching from a centrally planned economy to a market economy. Our recommendations are as follows:

How to expand the capacity of the plastics recycling industry?
The role of the government should have an indirect nature by removing obstacles for the industry. It is doubtful whether economic measures are effective because at present most recyclers avoid tax. Also subsidies generally prove to be an ineffective and expensive tool. Alternatively, the government should promote research and development (R&D) focusing on present recycling technologies (i.e. pre-treatment stage), new forms of recycling technologies such as chemical recycling, and the recyclability of end-products.

How to revitalize the waste plastics recovery sector?
It is doubtful whether efforts should be intensified towards rebuilding the formal sector. The operating costs both for collecting and recycling of the informal sector are much lower. However, a serious threat to individual operators is the implementation of large scale waste collection systems which do not allow for separate recovery of the recyclable waste. The government should therefore develop a management system which integrates the operations by the informal sector. Yet, the responsibility for waste not lies solely with the government. Increasingly industries are held responsible for their impacts. A convincing example of extended responsibility in the plastics cycle in China is presented in Beijing where the food packaging producers finance a recovery system.

Obviously, it is economically nor environmentally feasible to recover all waste plastics for purposes of mechanical recycling. It is therefore better to designate a specific type of recycling for a specific types of waste. For example, it can be assumed that the principal form of processing of industrial waste plastics, such as cut-offs, is mechanical recycling. Similarly, feedstock recycling mainly focuses on agricultural film, and energy recovery is applied mainly to household waste such as contaminated food packaging. Such a recycling hierarchy becomes ever more appropriate with the expected diversification of technologies and recovery systems.

How to design a desirable trade policy for waste plastics?

As mentioned earlier, plastic production in China is unable to meet the needs of the domestic market. Besides boosting imports of plastic products, the domestic shortage raises imports of raw materials, such as monomer, polymers and waste plastics. It is expected that this trend continues over the next few years. However, with the establishment of several ethylene projects in the next century, imports of plastic raw materials are expected to slow down. In the process of substituting domestic for imported materials it will be important for Chinese production to meet international levels of efficiency to avoid protective trade measures.

China is among the largest importers of waste plastics in the world. An obvious explanation for this phenomenon is that due to the low wages in combination with the relatively low import costs, plastics recycling is an attractive economic activity to conduct in China. This trend is supported by the booming demand for plastics in China. Still, due to the occurrence of various incidents, the Chinese government mainly recognizes the threat of imports of waste plastics. Policies have been implemented accordingly. Especially with the eye on long term investments, it is important for the recyclers in China to know whether the international market will remain a reliable source of raw materials. The best approach is to further improve the monitoring system of imports of waste plastics to guarantee sufficient supply for the domestic recyclers, while simultaneously protecting China from unwanted imports. Obviously, as recognized in the Basel Convention, a major responsibility also lies with the exporting country. The costs of monitoring and enforcement, ignored in this study, have to be analyzed further to show the real trade-off between more imports of secondary plastics versus alternative scenarios.

In addition to the availability of waste plastics on the international market, the effects of imports of waste plastic on the plastic cycle in China are addressed. We assess the risk that imported secondary materials are substituted for domestic secondary materials. In this case, the domestic recovery sector suffers from increased imports. As a result, increased amounts of solid waste are generated. The modeling exercise, however, demonstrates that under current circumstances, this crowding-out effect does not take place. In fact, it was found that imports actually upgrade the quality of the inputs of the recycling industry and thereby improve the marketability of secondary products. In other words, the recovery sector is not damaged by increased imports of waste plastics. Also the argument that promoting the recycling industry would go at the cost of the primary segment of the industry is found to be invalid. The study shows that, given the large increase in demand for plastics in China, and the relative segregation of the primary and the secondary plastics market, it is unlikely that the primary industry will experience any significant effects from increased recycling.

摘要

今后几年直至进入 21 世纪，塑料在中国人民的生活中将变得愈益重要，消费者和工业用户对塑料的需求无论数量上还是质量上都将有所提高，估计需求量年增 20％。未来 10 年对于中国的塑料工业能否满足需求将是至关重要的阶段。与此同时，必须将迅速增加的废塑料减到最少。目前，约有 50－60％的废塑料未经收集或被随意倾倒在土地、河流或海洋中，这要求正规与非正规的废物处理部门以及塑料再生工业付出努力。中国的再生工业可以通过创造一个回收物资市场来减少固体废物，同时缩小塑料供需之间的差距。

本研究项目从定性和模型两个角度，分析中国再生工业在创造一个更加可持续的塑料生命周期中所起的作用。通过实地调查和文献研究的定性研究凸现出中国塑料生命周期中的以下几个趋势及问题：

●对塑料的最终需求增长迅速。国内原生塑料工业无法满足需求，因此中国高度依赖塑料进口。同时，中国城市的废物处理部门无力有效地解决废塑料问题，而由于政府介入减少致使“正规”回收的废塑料减少，又加剧了这一问题。

●中国的再生塑料厂分为两类，一类用国内废塑料，一类用进口废塑料。两类厂有不同的特点，后者由于投入原料的质量较高、生产规模较大、资本密集程度较高，因而其劳动生产率也较高。

●塑料的再生利用率（废塑料的实际使用量占塑料产量之比）正在下降，主要是由于再生厂受废塑料供应不足的制约。废塑料的进口可以部分地扭转这一趋势，但是废塑料贸易的批评者反对说，废塑料进口实际上是出口国废物倾倒的借口。另外，廉价的进口废塑料据说排挤了国内回收系统，从而导致了国内的废物处理问题。

为进一步分析这些问题，在分部门“从摇篮到坟墓”计划模型的基础上，我们运行了多种模拟方案。该模型有两个目的，第一个是研究中国塑料工业如何在经济学上和环境友好的角度上面对塑料的严重短缺。目前的选择是，一方面，增加国内原生树脂或再生树脂的生产，另一方面，扩大原生或再生塑料的进口。模型的第二个目的是更多地关注废塑料贸易，检验批评家们提出的看法。模型综合了财政、环境运输和贸易几个方面的问题。

模型运行的主要结论如下：

●可以通过提高国内再生工业的生产能力而减少中国塑料生命周期的财务成本和经济成本。大多数模拟方案凸现了再生工业现有生产能力的不足，这一短缺迫使最终产品制造业在生产最终产品时，使用原生树脂的比例高于经济上和技术上所要求的比例，这是大量进口原生树脂的原因之一。

●用国内废塑料满足再生能力的增加是更可取的办法，这不仅能避免运输活动，而且减少了塑料消费后造成的废物问题。这要求更多地关注塑料回收部门。废塑料的回收率在过去十年间从占废塑料总量的 20%跌落至 5%，这一趋势必须尽快扭转，这要求中国政府采取特殊的政策。

●尽管有这些可取的办法，我们并不指望回收系统能在短期内获得改善，要改进日益增加的废物的回收工作，还存在着太多的障碍。因此，应允许进口废塑料以弥补中国废塑料供需之间的差距。这对收支平衡并无副作用，因为废塑料进口的增加将替代相对昂贵的最终用品的进口。

综合定性的和基于模型的分析，使我们得以解决在从计划经济向市场经济转变的社会中，如何能引起这些转变的问题。基于以上研究结果，我们建议如下：

如何扩大塑料再生工业的生产能力？

政府的作用应是间接的，通过消除产业发展的障碍来实现。由于目前大多数再生厂逃税，经济手段是否有效令人怀疑。同样地，补贴一般来说也是一种无效的、昂贵的政策工具。政府应促进研究和开发，重点在现有再生技术（即预处理阶段）、化学再生法等新的再生技术形式、以及最终制品的可再生性。

如何激活废塑料回收部门？

人们对是否应加大力度重建正规回收渠道有疑问。非正规渠道的回收和再生成本都大大低于正规渠道，然而，一个严重威胁个体经营者的是大规模废物回收制度的实施，该制度并未考虑到可再生废物的分离回收。因此，政府应制定一个结合非正规渠道的废物管理体制。但是，废物处理的责任不应单由废物管理部门承担，日

显然，将废塑料全部回收用于机械再生在经济上和环境上都是不可能的，因此，更好的办法是对特定品种的废塑料采用特定的再生方法。例如，假定工业废塑料（下脚料等）的主要加工形式是机械再生，进料再生法主要用于农膜，而能源回收法主要用于家庭废物，如污染的食品包装等。这样的等级制对技术和回收系统的多样化更为适宜。

如何制定适合的废塑料贸易政策？

如前所述，中国的塑料产量不能满足国内的市场需求。除了增加塑料制品的进口外，国内的短缺还增加了原材料的进口，如单体、聚合物及废塑料。估计今后几年这一趋势仍将继续。但是，随着下个世纪几大乙烯工程的建成，塑料原材料的进口可望减少。在进口替代过程中，重要的是使中国的生产效率达到国际水平，而避免使用保护性的贸易措施。

中国是世界上最大的废塑料进口国，对于这一现象的显而易见的解释是，由于低工资及较低的进口成本，塑料再生在中国是一项颇具吸引力的经济活动，中国对塑料的旺盛需求又支持了这一趋向。由于一些事件的发生，中国政府仍然主要看到废塑料进口的危害，并已实行相应的政策。尤其当着眼于长期投资，对中国的再生厂来说，重要的是要了解国际市场是否能保持稳定的原料供应。更好的方法是进一步改善废塑料进口的监控体制以保证国内再生厂有足够的供应，同时排除有害物的进口（显然，正如巴塞尔公约中公认的，主要的责任在出口国）。

除了国际市场上废塑料的供应，我们还注意到进口废塑料对中国塑料生命周期的影响。我们评估了进口再生塑料替代国内再生塑料的风险。在这种情况下，国内回收部门将受到进口增加的冲击，结果是，产生的固体废物将增加。不过，模型运行显示，在目前情况下，这种挤出效应并未发生。实际上，我们发现，进口废塑料提高了再生工业投入原料的质量，因而增加了再生制品的销路，换言之，回收部门并未因进口废塑料的增加而遭受损失。同时，促进再生工业的发展将牺牲原生塑料工业的说法也被证明是站不住脚的。研究显示，如果中国塑料需求大幅度增长，并且原生塑料与再生塑料市场相对分离，原生工业不会因再生工业的发展而受到显著影响。