United Nations
Centre for Regional Development

Country Chapter

State of the 3Rs in Asia and the Pacific

The People's Republic of China

November 2017

Author:
Dr. Chen LIU
Institute for Global Environmental Strategies (IGES)

Associate Professor Yiying JIN
Professor Yongfeng NIE
Division of Solid Waste Management,
Department of Environmental Science and Engineering, Tsinghua University

Member of Drafting Committee of State of the 3Rs in Asia and the Pacific

Co-ordinated by:
The Secretariat of the Regional 3R Forum in Asia and the Pacific,
United Nations Centre for Regional Development (UNCRD),
Institute for Global Environmental Strategies (IGES)
Financially Supported by:
Ministry of the Environment, Government of Japan

Disclaimer

This country chapter for the People's Republic of China was prepared as an input for the 8th 3R Forum in Asia and the Pacific. The purpose of the report is to assess the status of 3R implementation in Asia and the Pacific and to share knowledge on 3R activities in the region.

ACKNOWLEDGEMENT

This publication is intended to provide expert-based assessment of regional progress of 3R policy implementation in selected countries and regions in Asia and the Pacific, particularly in response to the Hanoi 3R Goals (2013-2023) adopted at the 4th Regional 3R Forum in Asia and the Pacific in Hanoi in March 2013.

The State of the 3Rs in Asia and the Pacific project is a collaborative initiative involving Institute for Global Environmental strategies (IGES) and United Nations Centre for Regional Development (UNCRD), supported by the Ministry of Environment. We acknowledge expert contributions from the Institute for Global Environmental Strategies (IGES), Institute of Developing Economies – Japan External Trade Organization (IDE-JETRO), Kyoto University, Tottori University, University of Tokyo, National Institute for Environmental Studies (NIES) of Japan, Japan Waste Management & 3Rs Research Foundation, ISPONRE of Viet Nam, Green Amity Co., Ltd., Chulalongkorn University, Tsinghua University, University of the Philippines Los Baños (UPLB), North South University, BRAC University, SPREP, Anna University, Royal University of Phnom Penh, CSIR Indian Institute of Petroleum, National Environment Agency of Singapore, University of Malaya (UM), Asia Institute of Technology (AIT) and Institut Teknologi Bandung.

Special acknowledgement for the authors of this Country Chapter, Dr. Chen LIU, Senior Researcher, IGES, Associate Professor Yiying JIN and Professor Yongfeng NIE, Tsinghua University. We also express gratitude for drafting works made by the Institute for Global Environmental Strategies (IGES). This project is financially supported by the Ministry of the Environment of Japan (MOEJ) with intention to support the policy consultations at the Regional 3R Forum in Asia and the Pacific.

United Nations Centre for Regional Development (UNCRD)

Author
Dr. Chen LIU
Institute for Global Environmental Strategies (IGES)

Associate Professor Yiying JIN
Division of Solid Waste Management, Department of Environmental Science and Engineering, Tsinghua University

Professor Yongfeng NIE
Division of Solid Waste Management, Department of Environmental Science and Engineering, Tsinghua University

Editor
Dr. Chen Liu IGES
Dr. Yasuhiko Hotta IGES
Mr. Yoshiaki Totoki IGES

Editorial Support
Ms. Emma Fushimi IGES
Ms. Miki Inoue IGES

Coordinated by:
The Secretariat of the Regional 3R Forum in Asia and the Pacific,
United Nations Centre for Regional Development (UNCRD)
Nagono 1-47-1, Nakamura-ku, Nagoya 450-0001, JAPAN
Tel: (+81-52) 561-9377
Fax: (+81-52) 561-9375
E-mail: 3R@uncrd.or.jp

Institute for Global Environmental Strategies (IGES)
2108-11, Kamiyamaguchi, Hayama, Kanagawa, 240-0115, Japan
Tel: +81-46-855-3700 Fax: +81-46-855-3709
E-mail: iges@iges.or.jp
URL: http://www.iges.or.jp

ABREVIATIONS

3Rs	Reduce, Reuse, Recycle
BOT	Build, Operate, Transfer
DMC	Domestic Material Consumption
EEE	Electrical and Electronic Equipment
EfW	Energy from Waste
ELV	End-of-Life Vehicle
EPR	Extended Producer Responsibility
E-waste	Electronic Waste
HW	Hazardous Waste
ISW	Industrial Solid Waste
ISWM	Integrated Sustainable Waste Management
GHG	Greenhouse gases
MOA	Ministry of Agriculture
MOC	Ministry of Commerce
MOEP	Ministry of Environmental Protection
MOHURD	Ministry of Housing and Urban-rural Development
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NDRC	National Development and Reform Commission
PRC	People's Republic of China
RW	Recyclable Waste
RWM	Recovery and Circulation of Recyclable Waste Materials
WEEE	Waste Electrical and Electronic Equipment

CONTENTS

A: WASTE DEFINITION

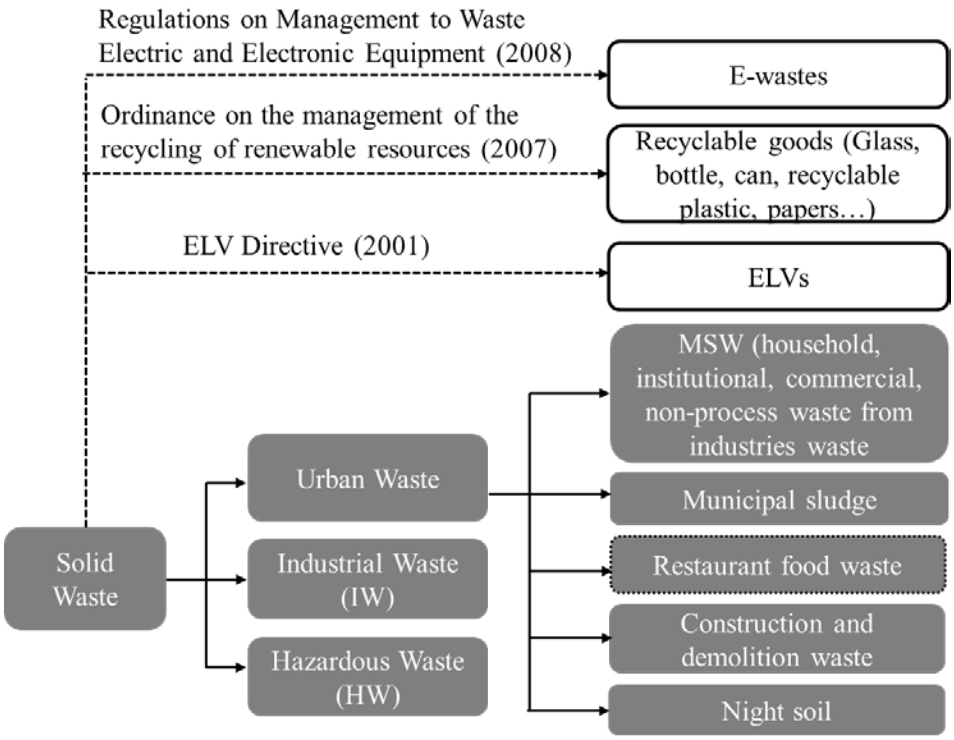
According to the Law of the People’s Republic of China on the Prevention and Control of Environmental Pollution by Solid Wastes (“中华人民共和国固体废物污染环境防治法”) adopted at the 16th Meeting of the Standing Committee of the Eighth National People's Congress on October 30, 1995, and amended at the 13th session of the Standing Committee of the Tenth National People's Congress of the People’s Republic of China on December 29, 2004) and related regulations, “solid waste” refers to articles and substances in solid, semi-solid state or gaseity in containers that are produced in the production, living and other activities and have lost their original use value or are discarded or abandoned despite not having yet lost their use value, and articles and substances that are included in the management of solid waste upon the strength of administrative regulations. “Solid waste” is classified into three types: industrial solid waste (“工业固体废物”, ISW), municipal solid waste (“生活垃圾”, MSW), and hazardous waste (“危险废物”, HW).

ISW means solid waste discharged in industrial production activities. It is usually limited to “process waste” such as process by-products like scrap metal, slag, and mine tailings.

MSW means solid waste discharged from everyday life or from services provided to everyday life as well as the solid waste that is regarded as municipal solid waste under laws and administrative regulations. It usually includes residential, institutional, commercial, street cleaning, and non-process waste from industries. In some cases, construction and demolition waste is also included and can dramatically skew the generation rate, especially in times of high economic growth and related construction activity.

HW means solid waste that is included in the national list of hazardous waste or identified to be dangerous according to the identification criteria and methods of hazardous waste as prescribed by the State. It usually refers to industrial hazardous waste generated as a by-product of the manufacturing process, medical waste, small-scale generation of hazardous waste from households, institutions and commercial establishments, and occasionally small amounts of radioactive waste, e.g. smoke detectors and medical process waste.

According to the Law of the People’s Republic of China on the Prevention and Control of Environmental Pollution by Solid Wastes and related regulations, “solid waste” generally could be classified as Figure A-1. Most of the recyclable waste (such as plastic bottles, cans, paper etc.) and electronic waste (e-waste) is sold on the market or collected by formal/informal agents in the People’s Republic of China, under the management of the Ministry of Commerce (MOC).



Prepared by Author

Figure A-1 Classification of Solid Waste in the People's Republic of China

B: COUNTRY SITUATION

I. Background Information on Waste Management System

1. History

Formal management of solid waste in the People's Republic of China was not implemented until the late 1980s. The first MSW sanitary landfill and the first modernised MSW incineration plant were built around 1990. Since 2000, considerable effort has been put into MSW management, resulting in a sharp increase in the control rate of MSW disposal. At the beginning of the 21st century, the People's Republic of China began to manage medical waste, hazardous waste and agricultural waste. More recently, the management of restaurant food waste, construction waste, sewage sludge have also received attention.

2. Organization

Solid waste management involves many government departments. Thus, the Ministry of Housing and Urban-rural Development (MOHURD) is responsible for MSW collection, transportation, and treatment/disposal, the Ministry of Environmental Protection (MOEP) for industrial waste and hazardous waste management, the Ministry of Commerce (MOC) for recovery and circulation of recyclable waste materials (RWM), the National Development and Reform Commission (NDRC) for the processing and utilization of RWM, and the Ministry of Agriculture (MOA) for the management of agricultural waste.

In practice, the same kind of waste management tends to involve other departments. For example, MSW management and 3R system covers the MSW collection, transportation and treatment system charged by MOHURD, and RWM recycling system charged by MOC and NDRC.

Local Authorities are in charge of providing collection service for MSW, building and operating MSW facilities, treatment and disposal of MSW, and recycling and reuse of RWM.

3. Legislation and Regulation

The legislation framework for waste management and 3Rs is made up of the national law, the regulation promulgated by the State Council, the rule by Ministries, and technology standards. The Environmental Protection Law (enacted on a trial basis in 1979) is adopted in the framework. The Law on Pollution Prevention Caused by Solid Waste (1996) and Circular Economy Promotion Law (2008) provide the primary national legislation of solid waste management and 3Rs. In addition, there are in excess of 20 substantial national regulations and rules issued either by the State Council or through other Ministries, such as Regulation on Administration of Urban Environmental Sanitation and Appearance (1992), Regulation on Administration of Hazardous Chemicals Safety (2002) , Ordinances on Medical Waste Management (2003), and Regulations on Managing Recovery and Treatment of Waste Electrical and Electronic Equipment (2011), Administrative measures on public toilets, Administrative measures on municipal solid waste, Administrative measures on construction waste, and Administrative measures on the franchise of municipal public utilities.

The standards related to HW management include the Standard for controlling MSW for agriculture usage (GB8172-87), Design standard for MSW transferring station (CJJ 47-91), Technology standard for aerobic composting of MSW (CJJ/T52-93), Methods for sampling of MSW and physical analysis (CJ/T3039-95), Technical Standard for Environmental Monitoring of MSW Landfills (CJ/T3037-1995), Standard for MSW Classification and Waste Disposal (CJ/T3033-1996), Standard for municipal environmental sanitation specialized equipment- Waste incineration, gasification, thermal degradation (CJ/T29.1-91), Standard for municipal environmental sanitation facilities (CJJ 27-89), Pollution control standard for MSW landfill (GB16889-1997), Pollution control standard for MSW Incineration (GWKB 3-2000), and Standard for design of MSW sanitary landfill (CJJ 17-2004).

Table B-1 History of Solid Waste Environmental Management in the People's Republic of China

Period	History of Solid Waste Environmental Management
1974	Environment Protection Leading Group of the State Council was established. The People's Republic of China started to carry out disposal of waste water, gases and solid waste.
1989	**Environmental Protection Law** (enacted on a trial basis in 1979)
1991	Entry into force of the Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and Their Disposal
1996	**Law on Pollution Prevention Caused by Solid Waste**
1998	National Hazardous Waste Catalogue (Amended in 2008)
1999	Administrative Measures for Hazardous Waste Transfer Manifests
2001	"Standard for pollution control on hazardous waste storage" (GB18597-2001) "Standard for pollution control on hazardous waste incineration" (GB18484-2001) "Standard for pollution control on the security landfill site for hazardous waste" (GB18598-2001)
2003	**Cleaner Production Promotion Law**
	Hazardous wastes and Medical Wastes Treatment Facility Construction Program
	Ordinances on Medical Waste Management
2004	Administrative measures on hazardous waste operation licenses **Law on Pollution Prevention Caused by Solid Waste (Amended)**
2007	Identification standards for hazardous wastes: · General specifications (GB 5085.7-2007) · Identification for corrosivity (GB5085.1-2007) · Identification for extraction toxicity (GB5085.3-2007) · Identification for reactivity (GB5085.5-2007) · Identification for toxic substance content (GB5085.6-2007)
2008	**Circular Economy Promotion Law**
2011	Regulations on Management to Recovery and Treatment of Waste Electrical and Electronic Equipment
2012	The 12^{th}-five-year Planning on Hazardous Waste Pollution Prevention

Prepared by Author

The regulations and standards related to HW management include Identification Standards for Hazardous Wastes (2007), National Hazardous Waste Catalogue (Amended in 2008), Administrative measures for HW transfer manifests (Amended in 1999), Standard for pollution control on HW storage (GB18597-2001), Standard for pollution control on HW incineration (GB18484-2001), Standard for pollution control on the HW security landfill site (GB18598-2001), Administrative measures on hazardous waste operation licenses (2004), and so on.

The main history of Solid Waste Environmental Management in the People's Republic of China is summarized in Table B-1.

II. Current Status and Challenges (on 3Rs and Waste Management System)

Rapid urbanization along with increasing human activities in metropolitan areas imposes great challenges to urban environmental management. With sustained and rapid economic growth over the past three decades, the People's Republic of China is undergoing massive urbanization. The total population increased from 962.6 million in 1978 to 1328.02 million by the end of 2008. Meanwhile, the urbanization rate over the country increased from 17.4 to 45.7%, and the urban solid waste generation is increasing at an annual rate of 8-10%. In 2008, the collected amount of municipal solid waste (MSW) in more than 600 cities reach 156 million tons.

MSW disposal is a significant environmental challenge that the People's Republic of China is facing in the wake of its unprecedented economic development. There is growing awareness of the threats to the natural environment and human health that are associated with inadequate waste disposal. This is not only because of the amount of MSW produced is far greater than the amount of MSW collected, but also not all of the collected MSW are disposed in controlled disposal sites.

The government of the People's Republic of China tried to respond to this challenge, by moving up the "waste management hierarchy" promoting 3R (waste reduction, reuse and recycle), before other waste disposal methods are pursued. Facing the rapid increase in waste generation, waste disposal has made considerable progress, waste disposal facilities gradually move from urban to rural counties, expanding the scope of services, with a rise in the waste disposal rate.

III. Policy Trends on 3Rs and Waste Management Area

1. Technology policy

"Technical Policy on MSW Management and Pollution Prevention" (2000) emphasizes that landfill is the main disposal technology to date. The policy encourages development of incineration in regions that have developed economies and lack landfill sites. It also promotes the use of composting after separate collection of MSW.

2. Industrialization policy

During the past 10 years, the government of the People's Republic of China continues promoting the marketization and industrialization of MSW treatment and disposal. In 2002, the government introduced MSW fee levying system to promote the development of the waste disposal industry. After that, MOHURD and other ministries promulgated the Regulations of Concession of Municipal Public Service Industry and a series of concession contract template to encourage social capital to invest in MSW disposal industry. The tax incentives are also provided to the WtE industry. WtE plants are exempted from corporate income tax for the first five years of operation and are eligible for an immediate refund of value-added tax. In 2012, MOHURD issued Opinions on Attracting and Regulating Social Capital in Municipal Public Service Industry, introducing policy measures to attract and regulate social capital invest in MSW treatment.

3. Energy policy

The rapid development of waste incineration has benefited from the state's energy policy and purchasing price policies. After the Renewable Energy Act was passed on 28 February 2005, the NDRC issued its ''Regulation of the Price of Electricity from Renewable Energy and Fee Sharing'' on 4 January 2006 and its ''Management Regulation for Electricity from Renewable Energy'' on 5 January 2006. According to these two regulations, the purchasing price of electricity is based on the price in 2005 from a coal-burning power plant with desulphurization plus the subsidised electricity price of RMB0.25/kWh.

IV. Major Treatments and 3R Related Technologies

Prior to 1990, less than 2% of MSW was properly disposed of. Almost all MSW was dumped in a variety of waste dumping sites, most of which were located around city suburbs, with little or no attention given to either site suitability or the provision of any environmental protection measures. Since 2000, considerable effort has been put into MSW management, hundreds of new MSW disposal facilities, including landfill, incineration, and composting plants, have been build up.

There are a variety of waste treatment technologies, including landfill, incineration and other technologies include composting and recycling. There are also a number of new and emerging waste treatment technologies which are able to treat a variety of waste streams.

Landfill has been the primary method of MSW disposal for many decades; it is still the most important means of MSW disposal in many cities. Following the implementation of the "Pollution control standard on MSW landfill" and the "Standard for design of MSW sanitary landfill", the landfill technical level has shown vast improvement in the areas of design, construction, operation, monitoring, and post closure.

Incineration has undergone rapid development over the past 15 years. In 2001, there were 36 MSW incineration (MSWI) plants in operation in the People's Republic of China with the total daily capacity of approximately 6,520 tonnes/d, incinerating 2.9% of all treated MSW. By the end of 2005, there were 67 MSWI plants with a total daily capacity of approximately 33,010 tonnes/d, incinerating about 12.9% of all the treated MSW.

The high content of perishable organic material in the MSW makes composting treatment an important option. There have been many efforts to develop MSW composting. But the application of the technology has faced several difficult challenges: high operation cost; low quality and poor marketing of the MSW compost product has resulted in low sales. Many advanced composting facilities have had difficulty supporting operational costs through the sale of compost products.

By 2008, formal MSW disposal facilities in the People's Republic of China numbered in excess of 500, including but not limited to 406 landfill sites, 13 composting plants, and 72 incineration plants. The total capacity of MSW disposal was 315,283 tons/d, of which 83% was used as landfill, 16% was incinerated and 2% was composted. In total, 102.15 million tons of MSW were disposed of, accounting for 54.2% of the total quantity of MSW collected. The remainder was abandoned at various dumping sites.

In addition, there is a move away from treating waste as a disposal problem towards recognizing waste contains valuable resources that can be recovered. Recovery of value from waste can either be in the form of recovery of resources or recovery of energy.

V. National Plans in Waste Management and 3Rs

No country has ever experienced as large or as rapid an increase in the quantities of the municipal solid waste (MSW) that the People's Republic of China is now facing. The People's Republic of China surpassed the U.S. as the world's largest MSW generator. In 2004 the urban areas of the People's Republic of China generated about 190 million tons of MSW, and by 2030 this amount is projected to be at least 480 million tons (World Bank, 2005). This growing waste stream has significant impact for the society, environment and economic development.

The government of the People's Republic of China has tried to respond to this challenge, by moving up the "waste management hierarchy" promoting 3R (waste reduction, reuse and recycle), before other waste disposal methods are pursued. "Integrated sustainable waste management" (ISWM) is the concept accepted as the principle of MSW management in the People's Republic of China.

In order to improve solid waste management and recycling utilization of waste resources, a series of special plans were developed and implemented over the past ten years, such as

- National Plan on Construction of Disposal Facilities for Hazardous Waste and Medical Waste, issued on 19 December by the State Council
- National Plan on Construction of Municipal Solid Waste Harmless Treatment

Facilities in the 12th Five-Year Period, issued on 19 April, 2012 by the State Council.

- Plan on Hazardous Waste Pollution Prevention and Control in the 12th Five-Year Period , issued on 8 October, 2012 by MOEP, NDRC, Ministry of Industry and Information Technology, and the Ministry of Health.
- Medium and Long-term Planning on establishing Renewable Resources Recovery System (2015-2020), issued on by Ministry of Commerce, NDRC, and other ministries.

VI. Current Potential of Market

During the next Five Year Period, the People's Republic of China will promulgate a series of plans in the field of solid waste management and 3Rs, providing important opportunities for enhancing construction and operation of MSW and HW treatment/disposal facilities, as well as RW recycling in the People's Republic of China.

Furthermore, according to the World Bank (2005), based on current solid waste plans, the People's Republic of China could face an 8-fold increase in its countrywide waste management budget between now and 2020 (rising from 30 Billion RMB in 2004 to 230 billion RMB). The need for increased budgets will be most severe in smaller cities (those under 1 million people).

C: 3R INDICATORS

I. Total MSW Generated and Disposed and MSW Generation Per Capita (by Weight)

1. MSW generation

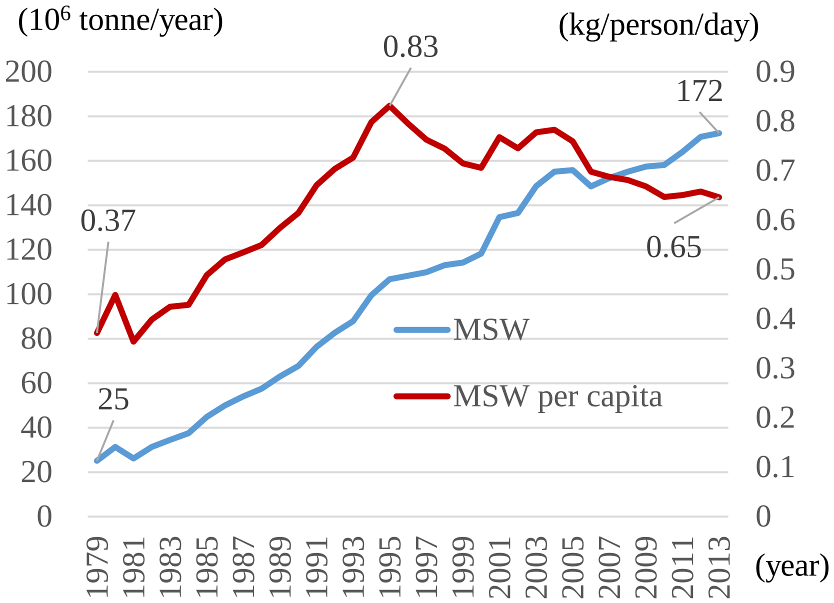
Municipal solid waste is collected and transported by local Sanitary Bureaus in the People's Republic of China. Most available official time-series statistical data about MSW in the People's Republic of China is based on "waste collected" data rather than "waste generated" data.

The quantity of MSW collected and transported increased almost 7 times from about 25 million tons in 1979 to 172 million tons in 2013 (Figure C-1). It is worthwhile to notice that the data shown in Figure C-1 do not include recyclable wastes (such as paper, metal, plastic bottles, restaurant waste) that were diverted by informal agents.

The quantity of MSW collected and transported per capita continually increased between 1979 and 1995, while it gradually decreased between 1996 and 2013 (Figure C-1). The annual increasing rate of the quantity of MSW collected and transported is 9.5%, which was higher than the average annual rate of population increase of 4.1% between 1979 and 1995; while the annual increasing rate of the quantity of MSW collected and transported is 2.8%, which was lower than the average annual rate of population increase of 4.0% between 1996 and 2013. Since the urban population and the total amount of waste generation has been increasing in this period, the decreasing trend of per capita collected and transported MSW might imply that the waste collection ability by local governments has been largely decoupled from the rapid increase of MSW generation since 1996. The reasons could be considered as: (1) the collecting and transporting ability of local government could not keep up with the rapid urban expansion and increase in MSW; and (2) with increasing income and quality of life, MSW has changed in composition rather than increased in total amount. For example, the decreased use of coal for cooking and heating in homes due to the expanding coverage of cooking gas and district heating supply systems. The increase in recyclable wastes such as plastic bottles, cans are not fully reflected in the official statistics as they are collected by informal agents. Some obsolete durable goods, such as cell phones, television sets are sold on the second-hand market and thus are also not included in the official statistics (Chen et al., 2010).

Waste generated data is more useful since it encourages more full-cost accounting of the overall MSW system and program financing. According to the work bank, the per capita waste generation (all waste originating in urban areas from residential, industrial (non-hazardous), commercial and institutional sectors) in urban areas for the three scenarios (low, expected and high) is 1.20 kg/person/day, 1.50 kg/person/day, and 1.80 kg/person/day respectively. The amount of waste generated in urban areas is projected to be at least 480 million tons, which is 2.5-fold higher than in 2004 (190 million tons, 1.23-

fold higher than that of the MSW collected and transported).



Data source: China Statistical Yearbook

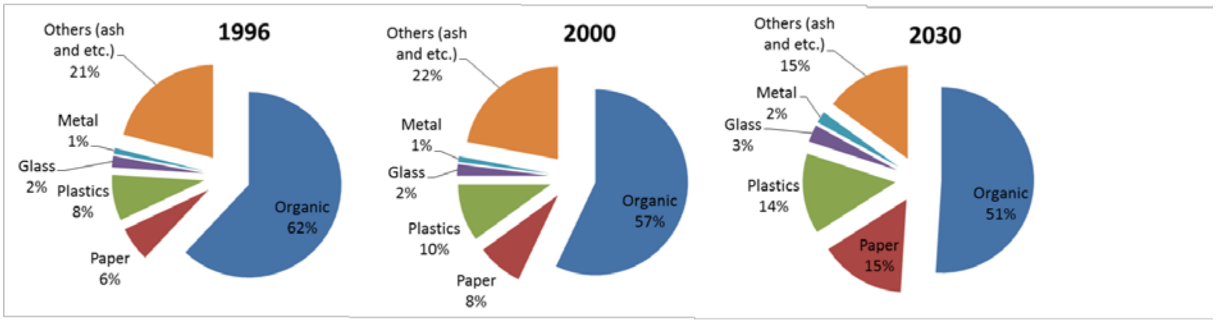
Figure C-1 The quantity and rate of MSW collected and transported in the People's Republic of China between 1979 and 2013

It is also worthwhile to notice that estimated MSW generation in the People's Republic of China in 2004 by the World Bank is 23% more than the amount of waste published in the official statistics. And Wang and Nie (2001) estimated that household recyclable wastes accounted for 8-10% of the total amount of MSW in general.

2. Composition of MSW

The composition of MSW varies among cities, districts, and seasons due to differences in climate, culture, the level of living standards and income as well as consumption and dietary habits, etc. (Huang et al., 2006; Zhang et al., 2010; Chen et al., 2010). The composition of MSW in the People's Republic of China is dominated by a high organic and moisture content, since organic garbage (especially kitchen waste) in MSW occupied the highest proportion at approximately 60%. Subsequently, the trend was reversed and reduced to 50% in 2009 because extra money was used to buy products other than food (Yuan et al., 2006; Huang et al., 2006; Du et al., 2010; Chen et al., 2010).

Figure C-2 presents a comparison of collected MSW (dry-weight) in the People's Republic of China in 1996, 2000 and 2030 (estimated by World Bank). Recyclable waste, especially waste paper and plastics, have increased while the content of organic wastes (food scraps, leaves, grass, wood, and animal matter) and ash have decreased in the MSW stream. Note that most metal, plastic bottles, textiles, glass and wood were separated and sold to private collecting companies, so most recoverable materials had been removed.

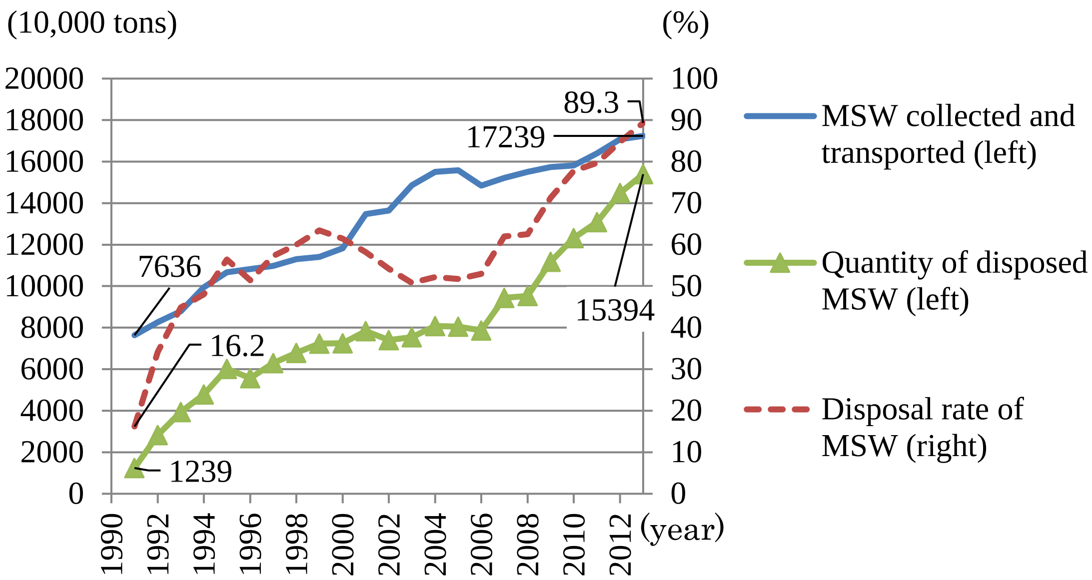


Data source: Wang and Nie, 2001; World Bank, 2005

Figure C-2 Comparison of collected MSW

3. Treatment and disposal of MSW

The treatment and disposal of MSW was started in the 1980s in the People's Republic of China. Before the 1970s, MSW was transported to rural areas as fertilizer because the quantity of MSW was small and its composition was simple. From the 1970s to the mid-1980s, chemical fertilizer became widely used, and MSW could no longer be used as fertilizer. A large quantity of MSW was dumped into ponds, scrubland, riversides and roadsides around the cities. Cities were becoming surrounded by MSW. From the mid-1980s, local governments began to pay attention to the disposal of MSW and disposal facilities began to be built. The first landfill site for MSW was Tianziling MSW Landfill Site in Hangzhou city, Zhejiang province, and the first incineration plant was built in Shenzheng city, Guangdong province (Huang et al., 2006).



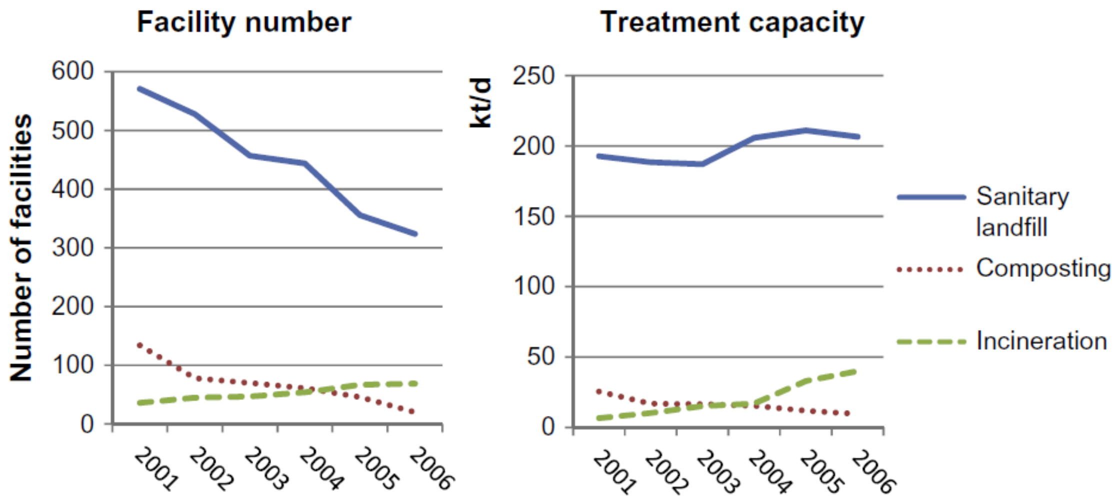
Data source: China Statistical Yearbook

Figure C-3 Variation of quantity of MSW, disposed MSW and the disposal rate

The variation of quantity of MSW, treated and disposed MSW and the treated and disposal rate between 1990 and 2013 is shown in Figure C-3. By 1990, the total treated and disposal rate (the proportion of MSW treated and disposed by sanitary landfill, incineration, composting, and recycling to the total collected and transported MSW) was lower than

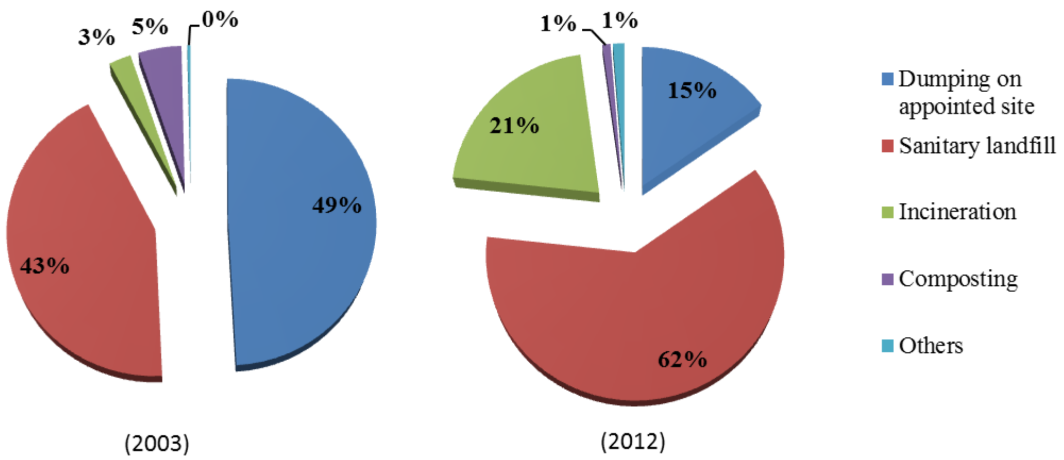
20%. It increased steadily during 1990 to 2006, and increased sharply since 2006. This is done due to the fact that the governments have taken action to promote MSW treatment. For example, the Ministry of Construction published the National Eleventh Five-Year Plan on Urban Environment and Sanitation Plan and asked all provincial governments to prepare their own plans on MSWM (MOC, 2006).

The variation of the amount and capacity of MSW treatment and disposal facilities during 2001 to 2006 is shown is Figure C-4, and the variation of proportion of different disposal methods for MSW between 2003 and 2012 is shown in Figure C-5.



Data source: China Statistical Yearbook

Figure C-4 MSW facilities number and treatment capacity



Data source: China Statistical Yearbook on Environment

Figure C-5 Variation of the proportion of different disposal methods for MSW

In 2003, of the 149 million tons of the collected and transported MSW by local government, 49% was dumped on appointed site, 43% was sanitary landfill, 3% was incinerated, and

5% was composted. In 2012, of the 171 million tons of the collected and transported MSW by local government, 15% was dumped on appointed site, 62% was sanitary landfill, 21% was incinerated, and 1% was composted.

Landfill (including dumping and sanitation landfill) is the main disposal method for MSW in the People’s Republic of China. However, the ratio of sanitation landfill increased, while dumping decreased. Meanwhile, biodegradable composting capacity decreased. The number of composting plants decreased from 70 in 2003, to 7 in 2012. This declining market demand for compost and the need for complete separation at source are considered as the major obstacles to the development of composting.

On the other hand, incineration is widespread and rapidly growing in the People’s Republic of China. The number of incineration plants increased from 47 in 2003 to 138 in 2012. Incineration is a rapidly developing sector as the following four merits (Rech, 2013).

First, both energy and heat can be created by incinerating waste. For local circumstances, this might be particularly useful. Especially in cold areas, both electricity and heat can be produced. The catch phrase for incineration has become energy from waste (EfW), and many local governments want to use the technology.

Second, incinerating MSW can reduce waste in both mass and volume. Numbers differ, but volume is argued to decrease by up to 90% while mass decreases by as much as 70%.

Third, incineration is considered to be a mature industry. It is not a pilot project technology, but has been tested successfully, despite various drawbacks, for a considerable amount of time.

Fourth, incineration does not require complex pre-separation and pre-treatment steps.

It follows, that the government of the People’s Republic of China wants to promote the construction of MSW incineration plants. Therefore, the government offers substantial subsidies in the form of direct feed-in tariff of an extra 0,25RMB per kilowatt/hour for 15 years (NDRC, 2006). In addition, there are build, operate, transfer (BOT) schemes that help lift the burden of investment off municipalities by involving the private sector. The private sector has become the major investor in incineration plants through BOT contracts (Chen et al., 2010). Furthermore, according to the National 12th Five-Year Plan of harmless treatment plant construction of MSW Notification (“十二五”全国城镇生活垃圾无害化处理设施建设规划的通知，国办发〔2012〕23 号), by 2015, the ratio of treatment capability of incineration to all safe treatment capability aims to exceed 35% on average across the whole county, while exceeding 48% in the eastern development region.

However, the following demerits should be taken into full consideration.

First, the average heat value of the People’s Republic of China is 5 MJ/kg, which is lower than the requirement of heat value of 6MJ/kg for incineration. Thus, supplemental fuel is required for incineration. This makes it impossible to gain net energy generation to compensate for high investment (Lin et al., 2007). The composition in some big cities, such as Beijing and Shanghai, is similar to that of western countries. However, in most of the small and medium cities, the composition is different, with an average lower calorific value (LCV) of MSW of only about 4200 kJ/kg (MOC, 2006).

Second, incineration produces highly toxic waste and especially in the People's Republic of China, the large amount of coal ashes from household heating leads to a very high amount of coal sludge after incineration. As the waste is not further processed, but directly landfilled, potentially highly toxic sludge is disposed of including various metals. (Zhang et al., 2010).

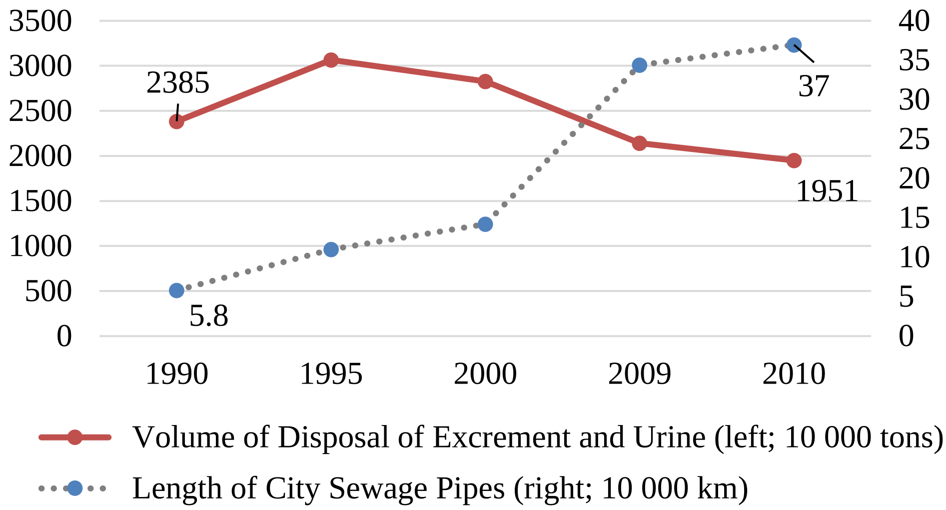
Third, after the problem of toxic residues from incineration, there is an argument made against incineration on the grounds of air pollution. Greenhouse gas emissions from energy from waste may be much higher than from conventional fossil fuels. However, the issue of air pollution has been recognized as a matter of urgency and newer generation incineration plants employ additional filter technology (Zhang et al., 2010).

Fourth, due to land scarcity and public concern, it is increasingly difficult to build more landfills and incineration facilities in cities.

The People's Republic of China has been exploring alternative approaches for solid waste management, including waste separation, composting and recycling. A more integrated approach should be adopted, based on quantitative investigation of the status of the system, system planning and construction in a way that is suited to local conditions, and coordination of all stakeholders by considering their needs and reaching agreements on their roles and responsibilities. It is worthwhile to notice that waste separation at source is one of key points for realizing integrated sustainable waste management by a long-term perspective. Although the waste-separating campaign has been running for 13 years in eight pilot cities including Beijing, Shanghai and Guangzhou, there has not been much progress. There are many challenges left, including a lack of adequate facilities for distinct transport, sorting and recycling; effective regulatory and policy instruments including financial incentive tools for waste minimization and recycling, and public awareness and participation in waste separation at source.

4. Other MSW

The volume of disposal of excrement and urine decreased since 1995 with the development of city sewage systems (Figure C-6). However it implied the sludge waste from wastewater treatment plant might increase.



Data source: China Statistical Yearbook

Figure C-6 Volume of disposal of excrement and urine during 1990 to 2010

Medical waste generated in 261 large and medium-sized cities was 547,500 tons, and disposal capacity was 542,100 tons in 2013. Medical waste disposal rate in most cities has reached 100%.

II. Overall Recycling Rate and Target (%) and Recycling Rate of Individual Components of MSW (Primary Indicator)

1. Household waste collection and recycling system in the People's Republic of China and its changes

In the People's Republic of China, all collection, transportation and disposal of MSW are primarily the responsibility of a central authority.

According to Chung and Poon (2001), the old household collection system included 'ring bell and collection' and 'refuse chutes'. With the former system, each household stores its waste inside until a ringing bell indicates that waste is being collected and residents take the trash out to the curb-side. Waste is normally not separated in this process. The latter system is particularly common in densely populated areas characterized by high-rise apartments. The high-rise apartments feature refuse chutes on each level and residents dispose of garbage by the means of the chutes on each floor. These systems have been taken out of service and have been replaced by a new system since 2000. Residents are advised to place their waste in bags and deposit their garbage in the appointed garbage bins outside the residents' house for collection under the new system, and then the waste is transported by trunk to a local transfer station. This process is usually carried out by a community or business entity in the People's Republic of China. After that, the MSW is stored and transported from the local collection points to points of treatment and disposal, which is undertaken as a municipal responsibility.

Mostly, MSW is collected in a mixed state, but residents can volunteer to participate in the source-separated collection. The recyclable materials from daily use are often collected at the source by scavengers and reusable waste collectors patrolling the residential areas. Residents sell their recyclables to buyers who go door-to-door or sometimes deliver recyclables to the service sites themselves. The buyers in turn sell the materials to a nearby recyclables distribution center where the materials are sorted and sold to factories as raw or processed materials (Zhang et al., 2010).

Furthermore, the above waste collection systems have been deemed insufficient and in the 1990s and 2000s many municipalities in the People's Republic of China introduced source separation schemes with designated bags that are then deposited by residents into specific bins just as it is done in Europe and Japan. However, implementation of the new schemes is not systematic and there is considerable room for improvement (Chen et al., 2010; Zhang et al., 2010).

While source separation of MSW is thus taking place to a limited extend in many municipalities, there was also a considerable rise the phenomenon of scavenging. Scavenging refers to people collecting recyclable goods and selling them to collection sites at a negotiated rate. Scavenging considerably increases the recycling rate in many municipalities in the People's Republic of China. However, the process is not formalized at a municipal level, but organized privately. Scavenging leads to all valuable parts of waste being separated at source, while non-valuable parts of waste are left behind. Municipalities have thus no economic incentive in enhancing recycling through further source separation. Chen et al. estimate the number of private scavengers at approximately 2 million people. It is thus a considerably large informal sector. Latest developments point to various municipalities in the People's Republic of China aiming to formalize the sector by either offering voluntary registration of scavengers with municipal authorities or expulsion. Neither approach has yielded substantial success so far (Chen et al., 2010).

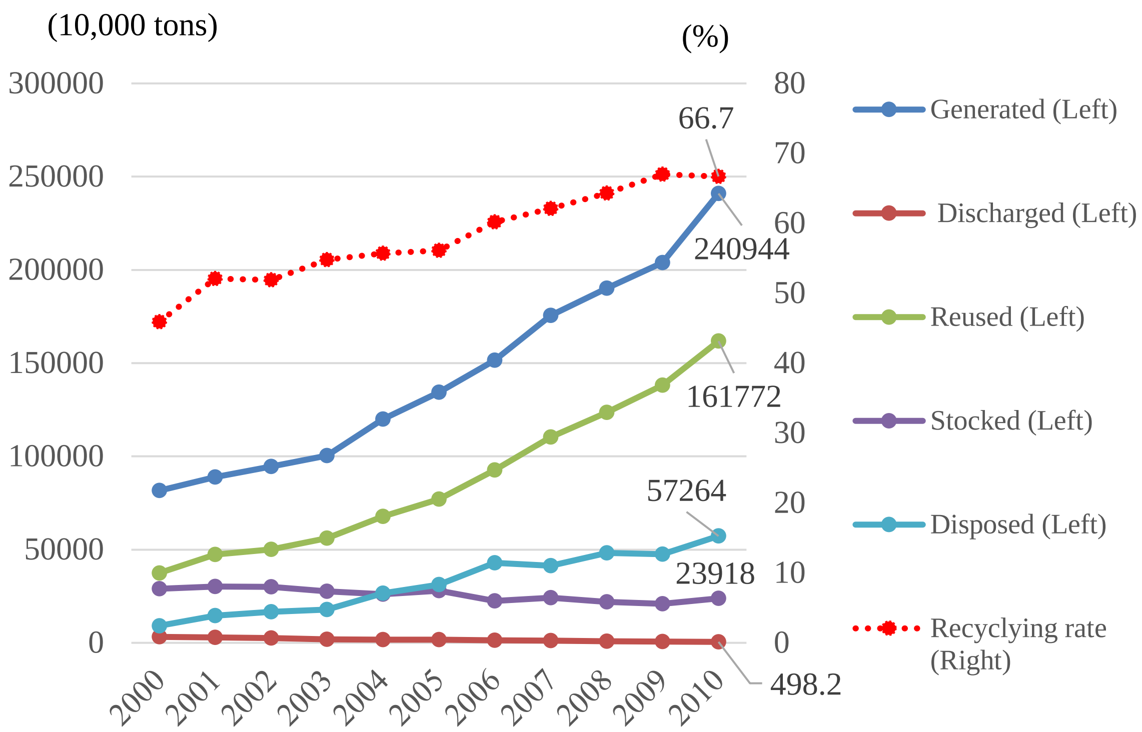
2. Recycling rate of industrial solid waste (ISW)

The recycling rate and target value of ISW is shown in Table C-1, the variation of utilization and recycling rate of ISW during 2000 to 2010 is shown in Figure C-7.

Table C-1 Recycling rate and target value of ISW at national level

Year	Total yield (10^4 ton)	Total comprehensive (recycle) use yield (10^4 ton)	Recycling rate	
			Actual value	Target value
2013	327,702	205,916	63%	72% in 2015 [1]
2012	329,044	202,462	62%	
2011	322,772	195,215	60%	
2010	240,944	161,772	67%	60% in 2010 [2]
2009	203,943	138,186	68%	

Data source: China Statistical Yearbook on Environment



Data source: China Statistical Yearbook on Environment

Figure C-7 Variation of utilization and recycling rate of ISW during 2000 to 2010

3. Related National regulations and target

According to the National 11th Five-Year Plan of Environmental Protection Notification [2007] No. 37, issued by the State Council of the People's Republic of China, the following points were stated:

- Implement harmless disposal projects of MSW
  - Implement construction plans for harmless disposal of MSW and up to 24 Million tons/ day of MSW should be newly increased.
  - The harmless disposal rate of MSW should be no less than 60%.

---

[1] the National 12th Five-Year Plan of Environmental Protection Notification [2011] No. 42
[2] the National 11th Five-Year Plan of Environmental Protection Notification [2007] No. 37

- Carry out the implementation of waste classification and strengthening the environment supervision of disposal facilities.
- Pay high attention to landfill leachate disposal, to implement pollution treatment and ecological restoration for existing garbage disposal plants gradually, and eliminating the pollution hazard.

- Promote the comprehensive utilization of solid waste
  - Focus on the promotion of comprehensive utilization of large industrial solid waste, such as coal gangue, fly ash, metallurgy, industrial chemical waste and gangue.
  - The comprehensive utilization rate of industrial solid waste can reach 60% by 2010. Promote comprehensive utilization of construction waste, straw and animal dung.
  - Build the EPR system, perfect the system of renewable resources recycling, and achieve the harmless comprehensive utilization of E-waste.
  - Enforce stringent regulations on enterprises processing import waste to prevent secondary pollution and crack down illegal imports or exports of waste.

According to the National 12th Five-Year Plan of Environmental Protection Notification [2011] No. 42, issued by the State Council of the People's Republic of China, the following points were stated:

- Make more efforts on the prevention and control of pollution by industrial solid waste.
  - Improve the preferential policy for recycle and disposal of industrial solid waste.
  - Enhance the comprehensive utilization of solid waste and development.
  - Improve prevention and control of pollution by large industrial solid waste, for example, coal gangue, fly ash, industrial by-product gypsum and industrial chemical waste residue.
  - The recycling rate of industry solid waste could achieve 72% by 2015.

- Improve the treatment effect of MSW.
  - Speed up the construction of treatment facilities for MSW.
  - The harmless disposal rate of MSW can reach 80% by 2015, and all countries have the ability to dispose MSW with a harmless way.
  - Perfect the separation and collection system, complete the system of classification collection, airtight transportation and centralized treatment, and strengthen the supervision of operation facilities.
  - Renovate the treatment facilities and sites with simple processing or stack of MSW; Implement ecological rehabilitation and renovation of the closed and old landfill sites.
  - Encourage the following resource utilization methods should be encouraged: anaerobic digestion of waste, incineration for generation of electricity and heat, power generation from landfill gas and resource utilization of kitchen waste.
  - Promote the disposal construction of MSW leachate and incineration fly ash.
  - Implement pilots of co-processing of MSW and sludge with industrial processes.

The government of the People's Republic of China should take a further step to control the solid waste pollution and promote the utilization and harmlessness treatment. Basing on principles of reduction, recycling and harmlessness, the People's Republic of China should also focus on the prevention and control of pollution from solid waste to safeguard people's health, ensure the safety of the environment, develop circular economy and set up a resource-conserving and environment-friendly society.

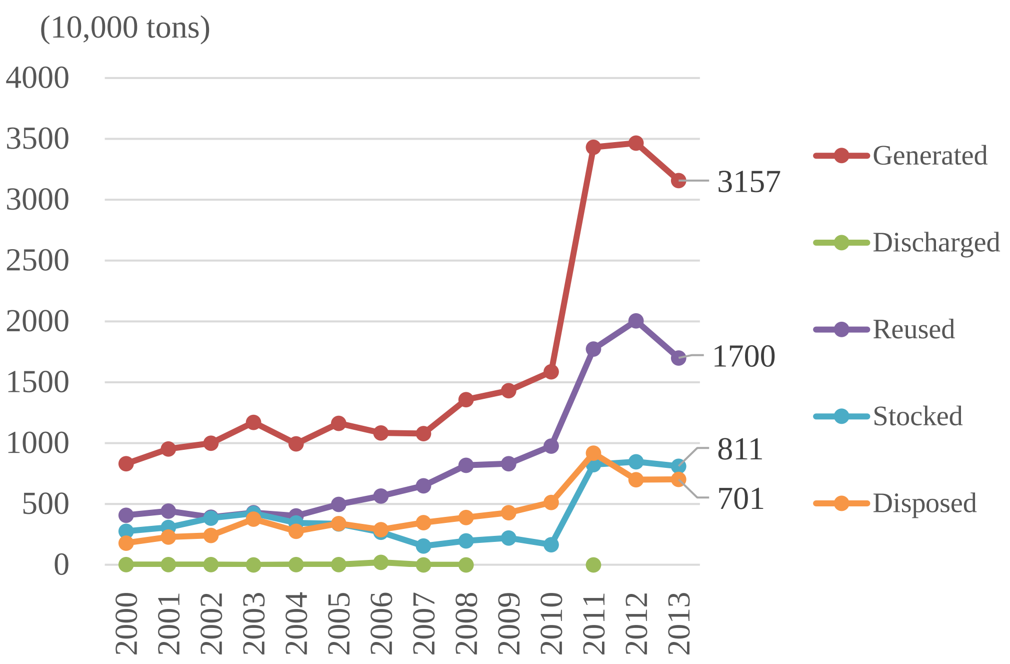
III. Amount of Hazardous Waste (HW) Generated and Disposed in Environmentally Sound Manner (Primary Indicator)

1. Definition of HW

Hazardous waste usually refers to industrial hazardous waste generated as a by-product of the manufacturing process, medical waste, small-scale generation of hazardous waste from households, institutions and commercial establishments, and occasionally small amounts of radioactive waste, e.g. smoke detectors and medical process waste.

2. Generation and disposal of HW

The variation of utilization HW during 2000 to 2012 is shown in Figure C-8.



Data source: China Statistical Yearbook on Environment

Figure C-8 Variation of generation and disposal of HW during 2000 to 2012

3. National regulations and management system of HW

Hazardous waste management system in the People's Republic of China is as follows:

- National Hazardous Waste Catalogue
- 49 categories of hazardous waste & 498 types of waste hazardous chemicals
- A distinguishing mark of hazardous waste is required
- Generators of hazardous waste shall have hazardous waste management plans, and report periodically
- The State practices license control system for the units involved in collection, storage & treatment of hazardous waste
- Hazardous waste collection, storage, recycling & disposal units shall have operation records and periodically report
- Centralized treatment facilities & sites for HW are planned
- Centralized treatment facilities & sites shall draw decommissioning expense in advance
- Preventive measures for accidents & emergency plans are required
- HW transportation is implemented through the use of waste manifest
- Transfer HW via the territory of the PRC is prohibited
- Medical waste is one type of HW and shall comply with the Regulations on Management of Medical Waste

According to the National 11th Five-Year Plan of Environmental Protection, Notification [2007] No. 37, issued by the State Council of RPA, the following points were stated:

- Speed up the implementation of construction plan of hazardous waste and medical waste disposal facilities.
- Improve the charge standards and methods of hazardous waste centralized processing.
- Establish the whole process of environment supervision and management system of collection, transportation and disposal of hazardous waste and medical waste.
- Implement the safe disposal of hazardous waste and medical waste fundamentally and complete the harmless treatment of chromium residue that has been left from the past.

National 12th Five-Year Plan of Environmental Protection, Notification [2011] No. 42, issued by the State Council of the People's Republic of China is the first national plan concerning HW. This plan lists the measurable goals that the People's Republic of China put in place to manage HW from 2011 to 2015 as follows:

- Enhance the prevention and control of hazardous waste pollution.
- Carry out the whole process of hazardous waste management system.
- Determine a list of the key regulatory hazardous waste generation units.
- Strengthen the management of standardization of hazardous waste generation units

and business units in order to prevent illegal transfer of hazardous waste.

- Screen and assess the disposal facilities self-built by companies themselves to promote the development of industrialization, specialization and scale of facilities regarding the use and disposal of hazardous waste.
- Control the landfill of hazardous waste.
- Clamp down on illegal processing facilities of waste lead acid storage battery.
- Standardize the hazardous waste management of laboratory and other hazardous waste from non-industrial source.
- Accelerate the safe disposal speed of chromium residues that have been stockpiling from the past so as to ensure that the newly increased chromium residues can be disposed of harmlessly.
- Strengthen the whole process of construction of medical waste management and harmless disposal facilities and adjust measures to promote the harmless management of medical wastes in countryside, towns and remote areas. The harmless disposal of medical waste in cities at prefecture level and above should be implemented fundamentally by 2015.
- Implement EPR and standardize the recycling activities of waste electric/ electronic products, set up a zone for recycling system of wastes and centralized processing to promoted comprehensive utilization.

IV. Indicators Based on Macro-level Material Flows (Secondary Indicator)

Resource productivity is the quantity of goods or services (outcome) that is obtained through the expenditure per unit resource. This can be expressed in monetary terms as the monetary yield per unit resource.

Resource productivity and resource intensity are key concepts used in sustainability measurement as they attempt to decouple the direct connection between resource use and environmental degradation. Their strength is that they can be used as a metric for both economic and environmental costs. Although these concepts are two sides of the same coin, in practice they involve very different approaches and can be viewed as reflecting, on the one hand, the efficiency of resource production as outcome per unit of resource use (resource productivity) and, on the other hand, the efficiency of resource consumption as resource use per unit outcome (resource intensity). The sustainability objective is to maximize resource productivity while minimizing resource intensity.

The following content on macro-level material flows in the People’s Republic of China is based on the study of Wang et al. (2005), Liu et al. (2011), Wang et al. (2011), and CSIRO and UNEP Asia-Pacific Material Flows online database.

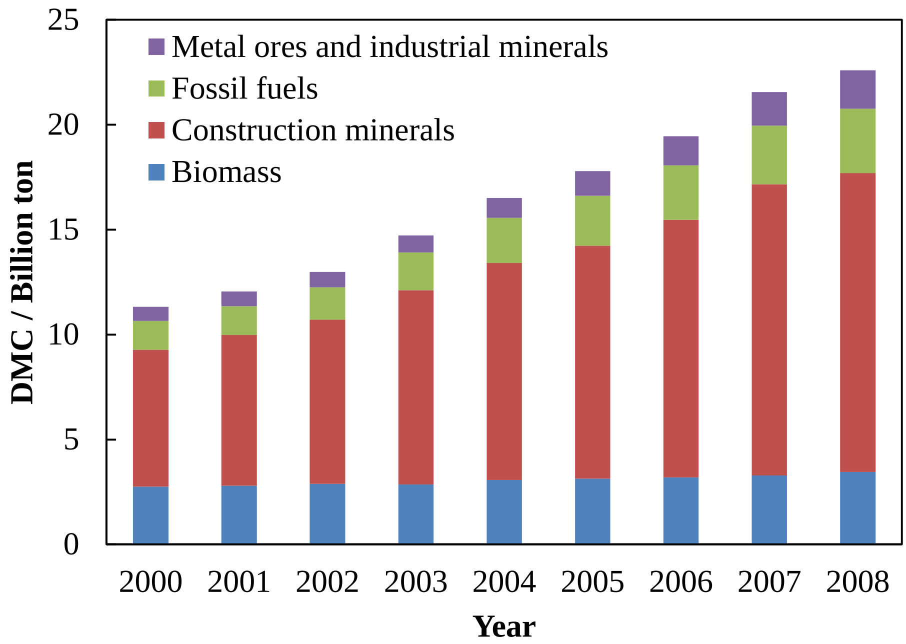
Variations of domestic material consumption in the economy in the People’s Republic of China during 2000-2008 are shown in Table C-2.

Table C-2 Domestic material consumption of the economy in the People's Republic of China during 2000-2008

Year	GDP /Billion Yuan-RMB	DMC / Billion Tons					Resource productivity (=GDP/DMC)	Resource Intensity (=DMC /GDP)
		Biomass	Construction minerals	Fossil fuels	Metal ores and industrial minerals	Total amount		
2000	9921.46	2.75	6.53	1.37	0.67	11.32	876.5	0.001141
2001	10965.52	2.79	7.19	1.38	0.7	12.07	908.5	0.001101
2002	12033.27	2.89	7.82	1.54	0.74	12.98	927.1	0.001079
2003	13582.28	2.86	9.26	1.8	0.8	14.73	922.1	0.001085
2004	15987.83	3.07	10.34	2.15	0.95	16.51	968.4	0.001033
2005	18321.74	3.13	11.11	2.38	1.17	17.79	1029.9	0.000971
2006	21192.35	3.19	12.28	2.59	1.39	19.45	1089.6	0.000918
2007	24952.99	3.29	13.88	2.78	1.61	21.56	1157.4	0.000864
2008	31404.54	3.45	14.25	3.07	1.82	22.59	1390.2	0.000719

Data source: CSIRO and UNEP Asia-Pacific Material Flows online database

The DMC of the People's Republic of China is 11.32 to 22.59 billion tons from year 2000 to 2008 (Figure C-9). It has annually increased by 100% in 2008 compared to year 2000, and the average annual growth rate is 52%. The GDP has enhanced to 217%. Especially after 2005, the GDP has shown a sharp rise with an average growth rate of 87%.



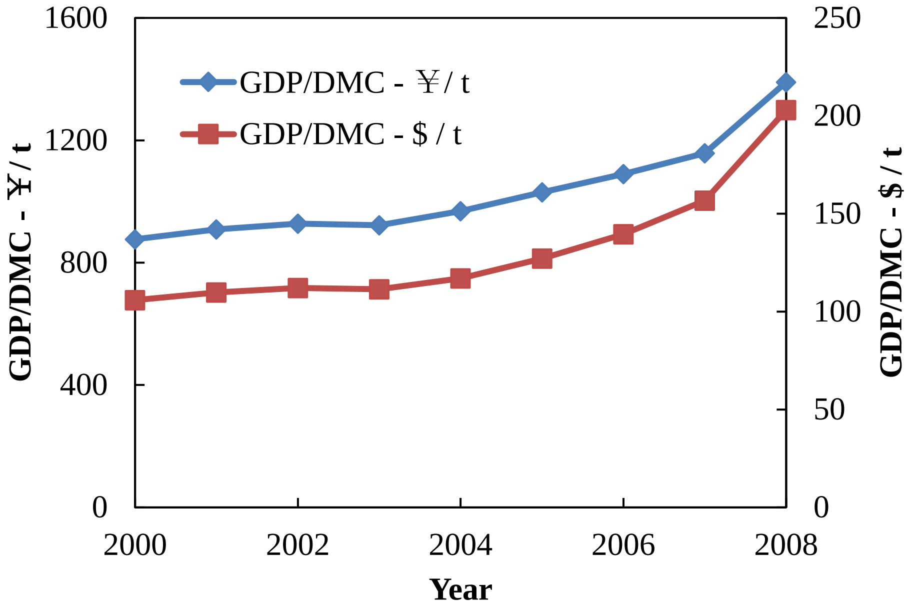
Data source: CSIRO and UNEP Asia-Pacific Material Flows online database

Figure C-9 Variations of DMC components in the People's Republic of China during 2000~2008

As shown in Figure C-9, construction minerals accounted for 57.7-64.4% of the total DMC amount, which showed an increasing trend from 2000 to 2008. Biomass took second place, ranging from 15.3-24.4%, the percentage of which kept decreasing. Percentages of metal ores and industrial minerals were the least in DMC, with a scope of 5.9-8.1%.

The main reason for the high growth of DMC between 2005 and 2008 is due to the growth of construction materials and domestic fuel mining volume. However the fundamental reason for the growth of DMC is the establishment of massive infrastructure and industrial projects, which is led by expanding domestic demand with macro fiscal policy.

Domestic resource efficiency has been enhanced continually from 2000 to 2008 (Figure C-10). This indicates that the DMC was tapering with the People's Republic of China's economy unit output at the time, and moreover the economic development has achieved a certain degree of relative dematerialization. This is consistent with the idea of conserving energy and reducing emissions which is the basis for the solid waste policy and the resource recycling policy (Wang et al., 2011).



Data source: Wang et al. (2005), Liu et al. (2011), Wang et al. (2011), and CSIRO and UNEP Asia-Pacific Material Flows online database

Figure C-10 Domestic material consumption efficiency of the People's Republic of China during 2000 to 2008

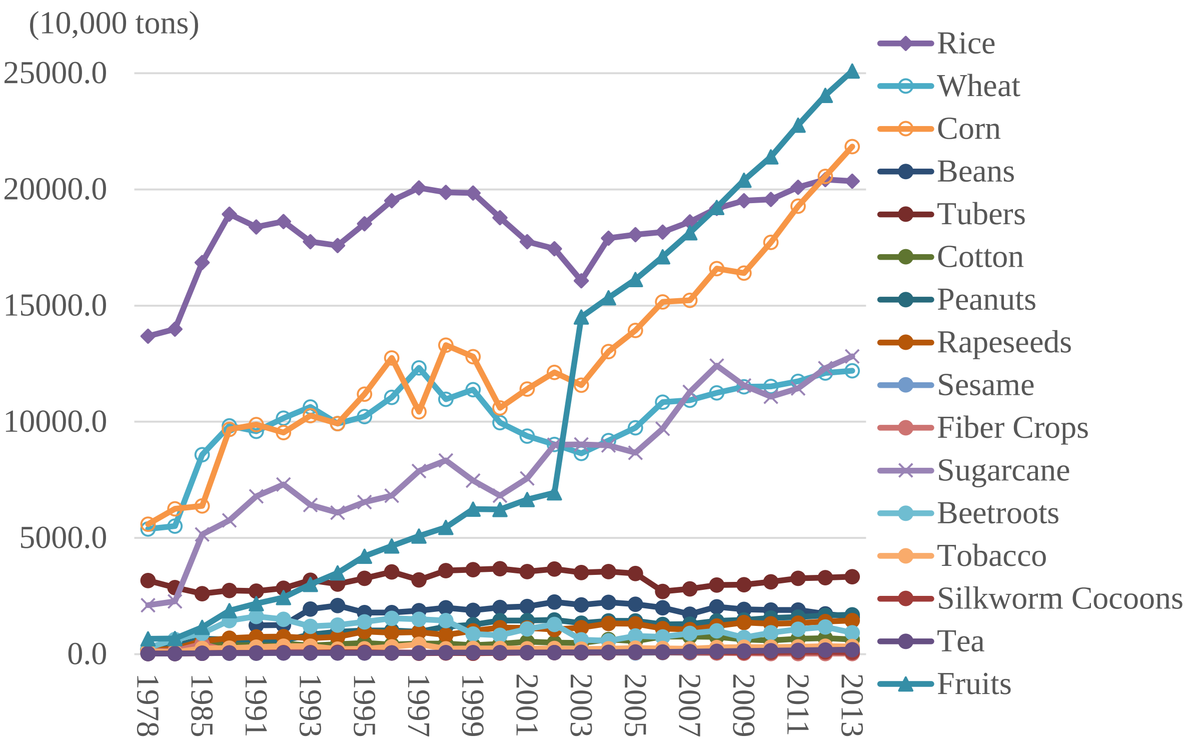
V. Amount of Agricultural Biomass Waste to be Used (Primary Indicator)

The People's Republic of China is an agricultural country with abundant biomass resources such as agricultural residues, animal manure, energy crops and so on. The traditional use of agricultural waste biomass has been direct burning for heating purposes. However, the People's Republic of China is currently adopting much more advanced methods that employ gasification and liquefaction techniques, so that waste biomass is being changed to more environmentally conscious products.

To estimate the potential quantity of agricultural biomass waste, the output of major farm products during 1978 to 2013 (Figure C-11), and the number of livestock during 1961 to 2010 (Figure C-12) by China Statistical Yearbook could be utilized.

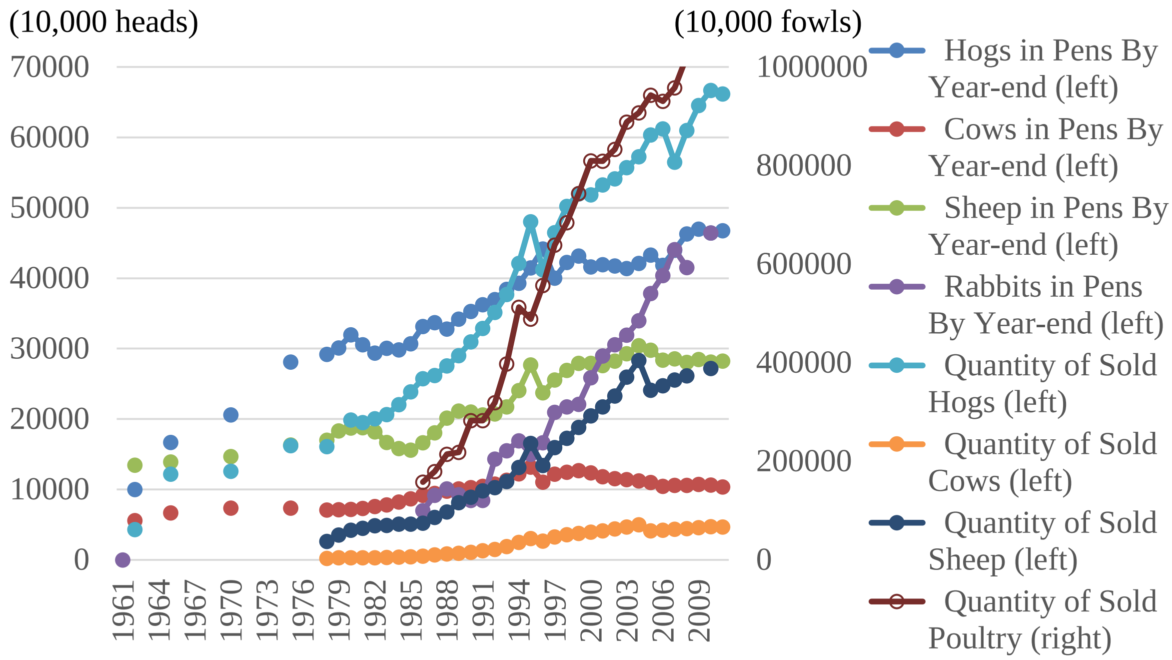
According to the Renewable Law (effective on 1 Jan. 2006), renewable energy will take share of 10% total energy demand in the People's Republic of China by 2010, and 16% by 2020. Furthermore, according to the Medium and Long-term Renewable Energy Development Plan, renewable energy targets by 2020 are as follows:

- Wind: 30GW
- Solar Power PV: 1.8GW
- Solar heater: 300million m^2
- Biomass Power: 30GW
- Biomass Diesel: 2Mt
- Ethanol: 10Mt
- Biogas: 44billion m^3
- Biomass solid fuel:50million ton
- Small Hydro: 75GW
- Hydro: 300GW



Data source: China Statistical Yearbook

Figure C-11 Variation of output of major farm products from 1978 to 2013



Data source: China Statistical Yearbook

Figure C-12 Variation in number of livestock from 1961 to 2010

According to Li et al. (2001), estimate of agricultural, forestry residues, and animal manure generated in the People's Republic of China in 1998 is summarized in Table C-3.

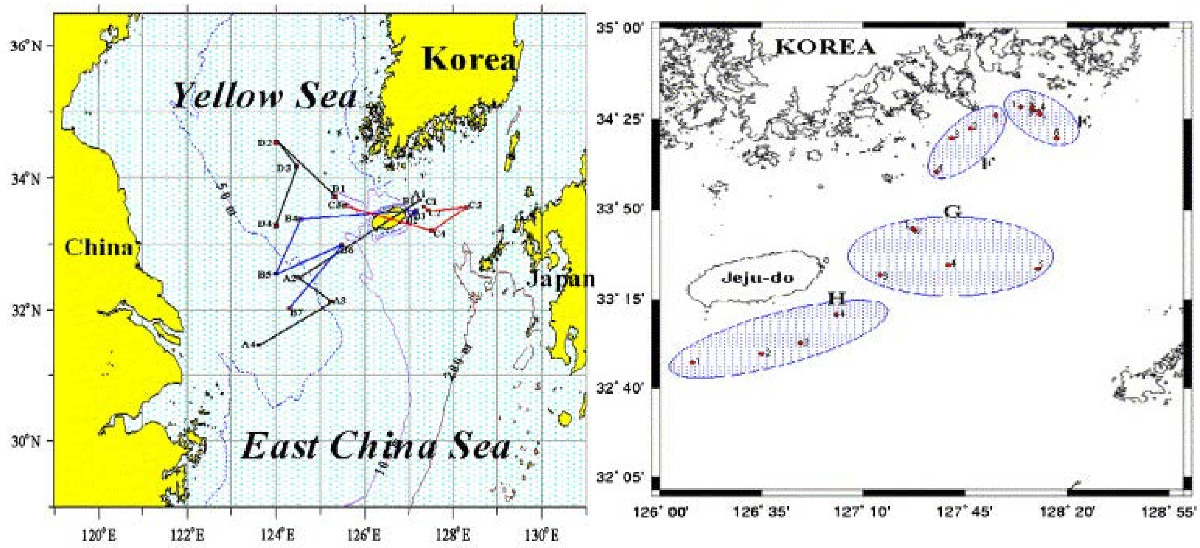
Table C-3 Estimate of agricultural, forestry residues, and animal manure generated in the People's Republic of China in 1998

	Data	UNIT	Year	Reference
Straw	656	10^6 tonne	1998	Li et al. (2001)
Wood residues	111			
Rice husk	42			
Bagasse	21			
Animal manure	917			
Total	1,747			

Data source: Li et al (2006)

VI. Marine & Coastal Plastic Waste Quantity (Primary)

Lee et al (2006) have surveyed and evaluated the types, quantities, and distribution characteristics of litter on the seabed of the South Sea of Korea, including areas around Jeju Island where fishery activities are most active, and in the East China Sea, which is of particular importance with respect to fishery resource management and fishery treaties because of its location between Korea, Japan, and the People's Republic of China. Data from two surveys conducted in different offshore regions were used to identify the distribution characteristics of deposits of litter on the seafloor. The first survey was conducted by the Dong-baek, a training ship from Chonnam National University, Korea, in the summers from 2002 to 2005 in the East China Sea (Figure C-13, areas A–D). The second survey was conducted by the Ka-ya, a training ship from Pukyong National University, Korea, between 1996 and 1997 in the South Sea of Korea, including Jeju Island (Figure C-13, areas E–H). Information on the cruises and trawling stations is provided in Table C-4. The types and quantities of marine litter on the seabed of the South Sea is shown in Table C-5/Table C-6 (Table C-5: areas A–D; Table C-6: areas E–H), and the composition ratio of marine litter to total density on the seabed of the East China Sea is shown in Figure C-14/Figure C-15 (Figure C-14: areas A–D; Figure C-15: areas E–H).



Data source: Lee et al (2006)

Figure C-13 Trawling sites for marine litter on the seabed of the study area (above, the East China Sea; below, the South Sea of Korea)

Table C-4 Observation information of trawling sites

Sites	Latitude	Longitude	Sampling date	Sites	Latitude	Longitude	Sampling date
A1	33°54′	127°29′	7 Jul, 2002	E1	34°30′	128°07′	24 Aug, 1997
A2	32°42′	124°49′	8 Jul, 2002	E2	34°31′	128°07′	1 Oct, 1997
A3	32°14′	125°22′	8 Jul, 2002	E3	34°30′	128°08′	22 Jan, 1997
A4	31°45′	123°60′	9 Jul, 2002	E4	34°21′	128°09′	27 Aug, 1996
B1	33°50′	127°15′	26 Jun, 2003	E5	34°28′	128°09′	24 Aug, 1997
B2	33°44′	127°10′	26 Jun, 2003	E6	34°19′	128°14′	28 Jan, 1997
B3	33°49′	127°14′	26 Jun, 2003	F1	34°27′	127°56′	24 Jan, 1997
B4	33°29′	124°52′	28 Jun, 2003	F2	34°20′	127°48′	24 Jan, 1997
B5	32°60′	124°00′	26 Jun, 2009	F3	34°12′	127°39′	23 Oct, 1996
B6	33°00′	125°46′	29 Jun, 2003	F4	34°02′	127°32′	29 Apr, 2004
B7	32°02′	124°32′	30 Jun, 2003	G1	33°42′	127°24′	28 Apr, 2004
C1	33°43′	127°24′	24 Jun, 2004	G2	33°41′	127°25′	28 Apr, 2004
C2	33°39′	127°37′	24 Jun, 2004	G3	33°20′	127°16′	30 Sep, 1997
C3	33°46′	128°18′	25 Jun, 2004	G4	33°28′	127°35′	28 Apr, 2004
C4	33°21′	127°50′	25 Jun, 2004	G5	33°27′	127°06′	4 Jul, 1997
C5	33°37′	125°48′	26 Jun, 2004	H1	32°50′	126°16′	20 Jul, 1997
D1	33°50′	125°30′	26 Jun, 2005	H2	32°54′	126°37′	21 Jul, 1997
D2	34°50′	124°00′	27 Jun, 2005	H3	32°58′	126°45′	21 Jul, 1997
D3	34°20′	124°45′	28 Jun, 2005	H4	33°08′	126°55′	21 Jul, 1997
D4	33°20′	124°00′	29 Jun, 2005				

Data source: Lee et al (2006)

Table C-5 Types and quantities of marine litter on the seabed of the South Sea

(unit: kg/km-2)

Line A trawling sites				Line B trawling sites							Line C trawling sites					Line D trawling sites			
1	2	3	4	1	2	3	4	5	6	7	1	2	3	4	5	1	2	3	4
0.4	–	–	1.3	0.4	–	–	4.6	–	7.6	0.4	–	2.7	–	1.3	4.4	0.3	1.1	0.6	–

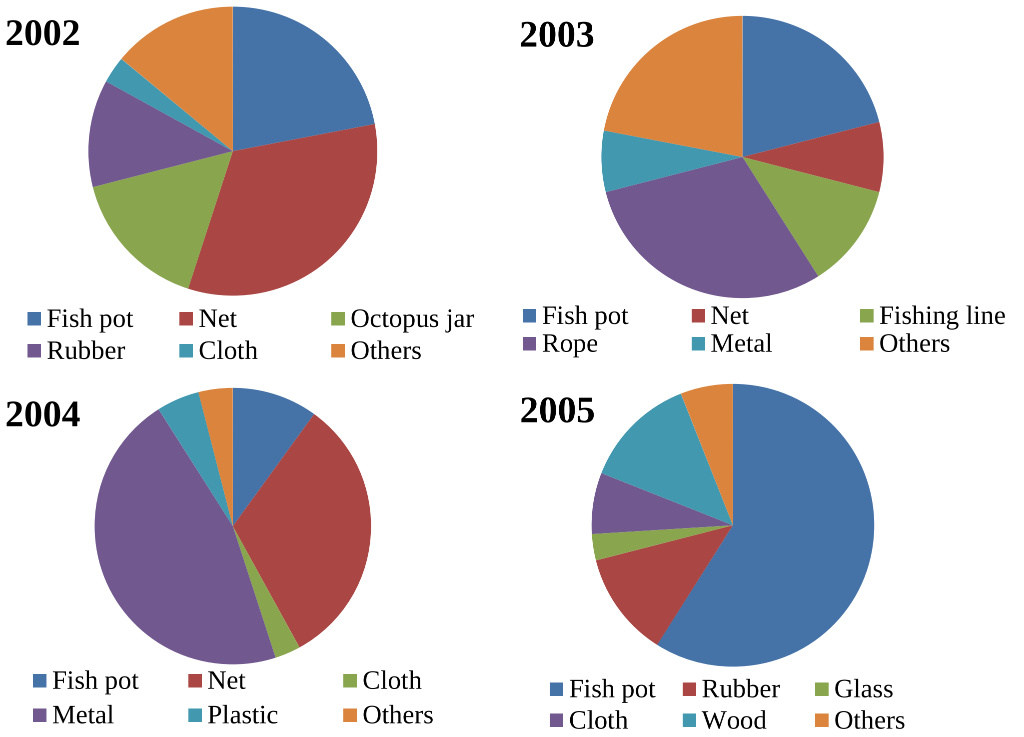
Data source: Lee et al (2006)

Table C-6 Types and quantities of marine litter on the sea bed of the South Sea

(unit: kg/km-2)

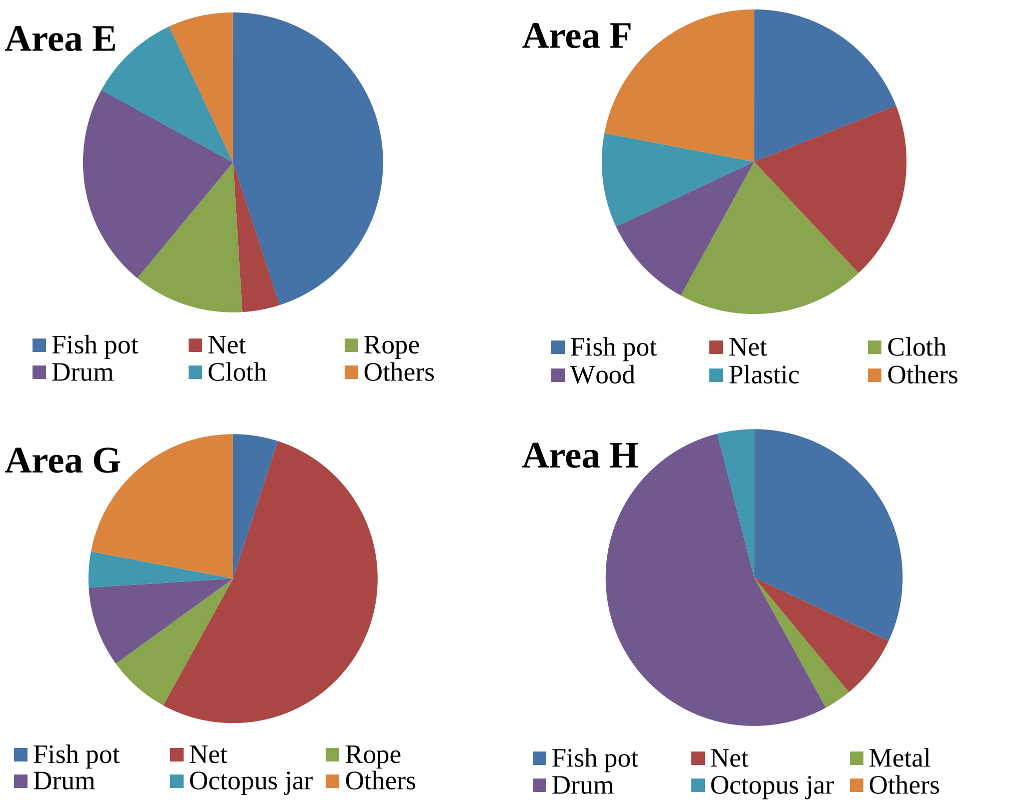
Area E trawling sites						Area F trawling sites				Area G trawling sites					Area H trawling sites			
1	2	3	4	5	6	1	2	3	4	1	2	3	4	5	1	2	3	4
1.3	–	0.5	0.3	0.9	–	0.8	0.5	11.5	15.4	–	–	–	–	5.6	–	–	–	–

Data source: Lee et al (2006)



Data source: Lee et al (2006)

Figure C-14 Composition ratio of marine litter to total density on the seabed of the East China Sea



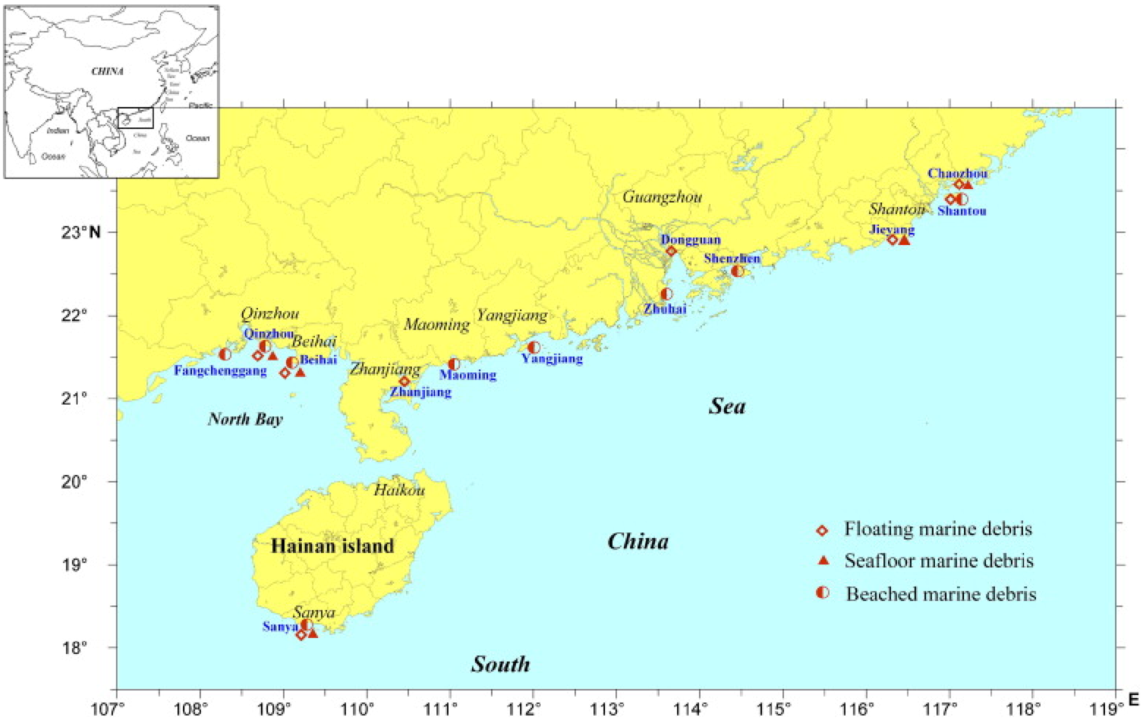
Data source: Lee et al (2006)

Figure C-15 Composition ratio of marine litter to total density on the seabed of the South Sea of Korea

In addition, the northern South China Sea is a sensitive ecosystem lying amid a densely populated and highly industrialized region, with intense coastal and shipping activities. Zhou et al. (2011) have studied floating, seafloor, and beached marine debris in coastal seawaters or beaches around the northern South China Sea to assess the distribution, types, and amounts of anthropogenic and natural (marine and terrestrial) debris, and provide a baseline for future comparisons. The locations of marine debris surveys are shown in Table C-7 and Figure C-16.

Table C-7 Location and methods of the marine debris surveys in near-shore areas around the northern South China Sea

The types of marine debris		Location
Floating marine debris (FMD)	Small or medium size (SMSFMD)	Eight stations: Chaozhou, Shantou, Jieyang, Dongguang, Zhanjiang, Beihai, Qinzhou and Sanya
	Large size or outsize (LOSFMD)	
Seafloor marine debris (SMD)		Chaozhou, Jieyang, Beihai and Qinzhou
		Sanya
Beached marine debris (BMD)		Nine stations: Shantou, Shenzhen, Zhuhai, Yangjiang, Maoming, Beihai, Fangchenggang, Qinzhou and Sanya



Data source: Lee et al (2006)

Figure C-16 The location of investigated floating marine debris, seafloor marine debris and beached marine debris in coastal seawaters or beaches around the northern South China Sea between 2009 and 2010

All floating marine debris was sampled in eight study areas and the results are shown in Table C-8.

Table C-8 The abundance and composition of SMSFMD and LOSFMD in eight coastal seawaters around the northern South China Sea during 2009 and 2010

Study area	Type	Year	Plastic	Styro-foam	Wood	Paper	Metal	Rubber	Fabric/fiber	Glass	Others	Total	Area (m^2)	Density (items/km^2)	
Dacheng Bay,Chaozhou	SMSFMD	2009	4			3						7	416.5	16.807	16.193
		2010	3	2		2				1		8	513.5	15.579	
	LOSFMD	2009	4	1	2							7	83300	0.0840	0.0812
		2010	4	1	3							8	102000	0.0784	
Shantou[1]	SMSFMD	2009		1								1	925	1.081	0.901
		2010	1	1								2	2775	0.721	
	LOSFMD	2009		1								1	185000	0.0054	0.0036
		2010	1									1	555000	0.0018	
Shenquan port,Jieyang	SMSFMD	2009	5			1		1				7	500	14.000	14.099
		2010	3	2		3						8	563.5	14.197	
	LOSFMD	2009	6	2	2			1		1		12	41700	0.2878	0.1831
		2010	4	1	3							8	102000	0.0784	
Weiyuan island,Humen town,Dongguang	SMSFMD	2009	7	4		1		1		2		15	1295	11.583	0.9871
		2010	14	3								17	2083.5	8.159	
	LOSFMD	2009	2	1	1				1	1		6	259000	0.0232	00260
		2010	4	6	1					1		12	416700	0.0288	
Xiashan district,Zhanjiang	SMSFMD	2009		5							1	6	1505	3.987	8.473
		2010	1	1	12						4	18	1389	12.959	
	LOSFMD	2009	3	3		2						8	691400	0.0116	0.0148
		2010	1	6		2	1					10	555600	0.0180	
Qiaogang port,Beihai	SMSFMD	2010	2							1		3	10950	0.274	
	LOSFMD	2010	2	1								3	365000	0.0082	
The moon bay, Sanniang bay, Qinzhou	SMSFMD	2010	2							1		3	10950	0.274	
	LOSFMD	2010	2						1			3	365000	0.0082	
Sanya[2]	SMSFMD	2009	1									1	120	8.333	9.166
		2010	1								1	2	200	10.000	
	LOSFMD	2009	5	1								6	30000	0.2000	0.1334
		2010	1						1			2	30000	0.0667	

Small or medium size floating marine debris (SMSFMD)

Study area	Type	Year	Plastic	Styro-foam	Wood	Paper	Metal	Rubber	Fabric/fiber	Glass	Others	Total	Area (m^2)	Density ($items/km^2$)	
Density ($items/km^2$)		2009	3.570	2.100	0.000	1.050		0.420		0.420	0.210	7.771	4761.5	7.771	4.922
		2010	0.918	0.306	0.408	0.170				0.102	0.170	2.073	29374.5	2.073	
Percent (%)		2009	45.9%	27.0%	0.0%	13.5%		5.4%	0.0%	5.4%	2.7%				
		2010	44.3%	14.8%	19.7%	8.2%			0.0%	4.9%	8.2%				
		Mean	44.9%	19.4%	12.2%	10.2%		2.0%	0.0%	5.1%	6.1%				
Large size or outsize floating marine debris (LOSFMD)															
Density ($items/km^2$)		2009	0.0155	0.0070	0.0039	0.0015		0.0008	0.0008	0.0015			1290400	0.0310	0.0250
		2010	0.0076	0.006	0.0028	0.0008	0.0004		0.0008	0.0004			2491300	0.0189	
Percent (%)		2009	50.0%	22.5%	12.5%	5.0%		2.5%	2.5%	5.0%					
		2010	40.4%	31.9%	14.9%	4.3%	2.1%		4.3%	2.1%					
		Mean	44.8%	27.6%	13.8%	4.6%	1.1%	1.1%	3.4%	3.4%					
Floating marine debris (FMD)															
Density ($items/km^2$)		2009	3.5855	2.107	0.0039	1.0515		0.4208	0.0008	0.4215	0.2100			7.802	4.947
		2010	0.9256	0.312	0.4108	0.1708	0.0004		0.0008	0.1024	0.1700			2.092	
Percent (%)		2009	48.1%	24.7%	6.5%	9.1%		3.9%	1.3%	5.2%	1.3%				
		2010	42.6%	22.2%	17.6%	6.5%	0.9%		1.9%	3.7%	4.6%				
		Mean	44.9%	23.2%	13.0%	7.6%	0.5%	1.6%	1.6%						

Data source: Lee et al (2006)

In a related policy, the UNCED Agenda 21, formulated at the United Nations Conference on Environment and Development in 1992, called for establishment of a comprehensive coastal management scheme in managing a nation's coastal affairs (UNCED, 1992). Over the last few decades, the government of the People’s Republic of China has made a significant effort in developing a better management scheme in coastal areas.

The People’s Republic of China has improved its legislation concerning maritime matters. A series of laws and regulations at national and local levels have been formulated. Jurisdictional, zoning boundaries and allocating use rights for coastal and coastal resources have been essentially established. The laws and regulations show the People’s Republic of China's endeavors to protect its coastal environment. There are a huge number of regulations and procedures, issued by the State Oceanic Administration (SOA) and the State Environmental Protection Bureau (EPB), to direct or organize human activities in coastal areas.

The SOA is responsible for supervising activities in marine environment, and organizing the investigation, monitoring, surveillance and evaluation of the marine environment. It has a primary role in protecting against marine pollution and damage caused by marine construction projects, such as offshore oil exploration and exploitation, and by waste dumping at seas. The state Environmental Protection Bureau (EPB) is responsible for directing, coordinating and supervising marine environmental protection work throughout the nation. It possesses the authority to enforce the law relating to marine environmental protection against land-based pollutants and pollution from coastal construction projects. The Ministry of Transport is responsible for overseeing, investigating and dealing with vessel-source pollution, and keeping the waters under surveillance in the port areas. Laws and regulations related to the coastal areas in the People’s Republic of China are summarized in Table C-9.

Table C-9 Laws and regulations related to the coastal areas in the People’s Republic of China

Name of laws/regulations	Date of promulgation (d/m/y)
Law on the marine environmental protection	23-08-1982
Regulations concerning environmental protection in offshore oil exploration and exploitation	29-12-1983
Regulations concerning the prevention of pollution of sea areas by vessels	29-12-1983
Regulations concerning the dumping of wastes at sea	06-03-1985
Law on Fishery Resources (Amended on 21-10-2000)	20-01-1986
Law on Mineral Resources (Amended on 29-08-1996)	19-03-1986
Law on Land Resources Management (Amended on 29-08-1998)	25-06-1986
Regulations concerning prevention of environmental pollution by ship-breaking	18-05-1988
Law on Environmental Protection	26-12-1989
Regulations concerning prevention of pollution damage to the marine environment by coastal construction projects	25-05-1990
Regulations concerning prevention of pollution damage to the marine environment by land-based pollutants	25-05-1990
Measures for implementation of the regulations concerning the dumping of wastes at sea	25-09-1992

Name of laws/regulations	Date of promulgation (d/m/y)
Implementing regulations on the protection of aquatic wild animals	05-10-1993
Law on the Territorial Sea and the Contiguous Zone	25-02-1992
Measures for implementation of the regulations concerning environmental protection in offshore oil exploration and exploitation	20-09-1992
Regulations of natural protected reserves	09-10-1994
Measures of management of marine natural reserves	29-05-1995
Regulations for the protection of wild plants	30-09-1996
Provisions governing the management of coastal forest belts under special state protection	09-12-1996
Provisions on the procedure for investigation and handling of accidents of pollution in fishing areas	26-03-1997
Measures on the protection of natural reserves of aquatic fauna and flora	17-10-1997
Law on the Exclusive Economic Zone (EEZ) and the continental shelf	26-06-1998
Measures of management on utilization of sea areas	27-10-2001
Marine functional zonation scheme	22-10-2002
Law on Environmental Impacts Assessment	28-10-2002
Law on prevention of marine pollution and damage from marine construction projects	19-09-2006

Prepared by Author

The Law on Environmental Impacts Assessment was passed at the Thirtieth Session of the Standing Committee of the Ninth National People's Congress of the People's Republic of China on 28 October 2002, and came into force on 1 September 2003. The promulgation of the law aimed to protect the environment (including coastal and marine environment) from pollution due to planning and construction. The Law on prevention of marine pollution and damage from marine construction projects was promulgated on 19 September 2006, and took effect on 1 November 2006. It covers the legal monitoring and managing marine construction projects and their impacts, such as building artificial islands, bridges, and pipelines in the coastal areas.

VII. Amount of E-waste Generation, Disposal and Recycling. Existence of Policies and Guidelines for E-waste Management (Primary)

1. Definition of E-waste

According to the "Administrative Measures for the Prevention and Control of Environmental Pollution by Electronic Waste", e-waste includes:

- discarded electronic & electrical products or electronic & electrical equipment, discarded parts and components thereof, as well as articles and substances that are subject to the management of electronic waste as prescribed by authorities;
- obsolete products or equipment generated in industrial production
- obsolete semi-finished products and residues, obsolete products generated as a result of repairs

  - renovation and reproduction of products or equipment
  - products or equipment discarded in daily life or in activities of providing services for daily life
  - products or equipment that are prohibited to be produced or imported by any law or regulation.

2. Main policies and guidelines for E-waste management

- "Administration Regulation for the Collection and Treatment of Waste Electric and Electronic Products" issued by the State Council, was enacted in August 2008, and effective as of January 1, 2011. This regulation is expected to change the landscape for the informal waste handling sector, and will pursue the interest of formal and large scale operators.
  - Catalogues of waste electrical and electronic equipment
  - WEEE is collected by multi-channels for centralized treatment
  - Treatment facilities of WEEE should be licensed
  - The State establishes funds for WEEE treatment, which could be used as WEEE treatment subsidy
  - Treatment of WEEE should be planned by related provincial authorities
  - Provincial governments could set up WEEE centralized treatment sites
- In 2009, the National Development and Reform Commission of the People's Republic of China announced the National Old-for-new Home Appliance Replacement Scheme (HARS). In this scheme, five common household electronic and electrical appliances are covered, including TVs, refrigerators, washing machines, air conditioners and personal computers. The coverage and levies of each products are set as follows:
  - Deposit standard: TV (13 yuan), PC (10 yuan), Refrigerator (12 yuan), Washing machine (7 yuan), air conditioner (7 yuan)
  - Subsidy standard: TV (85 yuan), PC (85 yuan), Refrigerator (80 yuan), Washing machine (35 yuan), air conditioner (35 yuan)
- The Appliance Trade-in Policy, from June 2009 to the end of 2011 states the following points:
  - 10% subsidy in old-for-new consumption
  - All replaced home appliances shall be returned to designated collectors
  - Every province shall designate dismantling and recycling facilities to treat the collected waste home appliances

3. Current situation and E-waste Generation

According to the "White Paper on Current Situation and Trend of WEEE Recycling Industry in China" by the China Household Electric Appliance Research Institute, there were 1125 enterprises, including manufactures, retailers, traditional recyclers and processors, authorized by the National Household Appliance Trade-in Policy up to December 31, 2011. It stated that 30% of the manufactures took part in the recovery positively, while only 5% of the processors recover WEEE. Promoted by the National Household Appliance Trade-in Policy, there is WEEE recycling system operating with large-scale and diverse pathways.

As of December 2011, there were 105 processing enterprises authorized by the National Household Appliance Trade-in Policy, 84 enterprises listed in the WEEE dismantling and disposal enterprises dictionary, and 53 enterprises that received the certification of WEEE processing (by May 20, 2012). Without double counting, there were 140 WEEE recyclers and processors in the People's Republic of China.

In 2011, the WEEE items processed were mainly televisions (84%). Other items were washing machines (7.7%), refrigerators (4%), computers (desktop and laptop) 3.7% and air conditioners (less than 0.5%).

This proved that the National Household Appliance Trade-in Policy accelerated the development of processing enterprises, and while many processing enterprises achieved large scale processing, the actual operating rate is still quite low, compared with the planned handling capacity (Table C-10).

Table C-10 The amount of E-waste generation and E-waste disposal and recycling

	Data	UNIT	Year	Reference
Estimated amount of E-Waste Generation	5,154	10^4 unit	2009	White Paper on Current Situation and Trend of WEEE Recycling Industry in China
	5,854		2010	
	6,671		2011	
	7,585		2012	
	10,980		2013	
Amount of E-Waste Disposal and Recycling	296	10^4 unit	2009	
	1,917		2010	
	5,633		2011	
	2,584		2012	
	4,173		2013	

Data source: White Paper on Current Situation and Trend of WEEE Recycling Industry in China

VIII. Existence of Policies, Guidelines, and Regulations Based on the Principle of Extended Producer Responsibility (EPR)

The existence of policies, guidelines, and regulations based on the principle of EPR in the People's Republic of China is summarized in Table C-11.

Table C-11 Existence of policies, guidelines, and regulations based on the principle of EPR

Year	Name of the policy	Content
1989	Recycling method of scrap cement bag	It is the first law embodying the concept of EPR in the People's Republic of China. Cement factory must recycle the used cement bag, and also define a standard deposit and recycle.
1995	Law of Prevention and Control of Environmental Pollution caused by Solid Waste	The regulation about EPR was published to provide guidance and enlightenment. It is the first time to stipulate a principle of EPR. This indicates national government's encouragement and support for recycling of solid waste in the People's Republic of China. It also requires the product producers, users and sellers to reuse and recycle containers and packaging materials according to relevant regulations.
1997	Provisions of limiting mercury content in battery	To limit the production of various kinds of batteries with high mercury content.

Year	Name of the policy	Content
1999	Interim measures for recycling and utilization management of packaging resources	Expanded the concept of EPR from the area of used cement paper bags to all packaging.
2003	Law of Cleaner Production Promotion	It established the basic structure of EPR in the People's Republic of China. A certain amount of responsibility regulations on ecological design, environmental information disclosure and waste disposal, recycling and utilization has been set.
2007	Measures for the Pollution Control of Electronic Information Products	According to the current situation in the People's Republic of China, it stipulates the electronic and automotive sectors, which have huge environment effects and also a further stipulation for the source prevention responsibility on electronic information products, motor producer, product environmental information disclosure responsibility and disposal responsibility on the final recycling procedure.
2006	Recycling technology policy of automotive product	
2008	Measures for the prevention and control of environmental pollution from E-waste	
2008	Law of Circular Economy Promotion	It indicates the initial establishment of EPR in the People's Republic of China. The first time to elaborate the EPR clearly in law, and makes it a basic management regulation. This law clearly established the producer's responsibility on source prevention; recycle and treatment. In addition it also indicates the consumer has responsibility on returning waste products and formulating relevant waste list to ensure producers to take the extended responsibility.
2011	Management regulations on recycling of waste household appliances and Electronic Products	E-waste recycling and related activities can apply to 《content of E-waste disposal》 The procedure will take the responsibility of the funding on recycle project. The government has the responsibility to use the fund to disassemble E-waste and to extract the reusable materials for raw materials and fuel from E-waste. At the same time the regulation also encourage producers to recycle the waste electrical and electronic products.

Prepared by Author

IX. GHG Emissions from Waste Sector

According to UNFCCC, the reporting scope of the China's National Greenhouse Gas Inventory 2005 covers five major sectors, i.e. energy activities, industrial processes, agricultural activities, land use change and forestry, and waste treatment, involving six greenhouse gases including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbon (HFC), perfluorocarbon (PFC) and sulphur hexafluoride (SF_6). The People's Republic of China's total GHG emissions in 2005 are summarized in Table C-12, and the carbon dioxide, methane and nitrous oxide inventory in 2005 is shown in Table C-13.

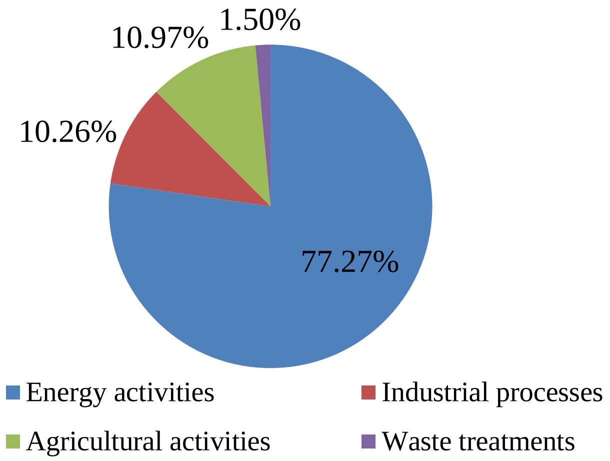
Table C-12 The People's Republic of China's Total GHG Emissions in 2005

(Unit: 10^4 t CO_2 eq)

Items	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Total GHG emission	597,557	93,282	39,370	14,890	570	1,040	746,709
Energy activities	540,431	32,403	4,030				576,864
Industrial processes	56,860		3,410	14,890	570	1,040	76,770
Agricultural activities		52,857	29,140				81,997
Waste treatment	266	8,022	8,022				11,078
Land use change and forestry	-42,153	66	7				-42,080
Total net GHG emission (including land use change and forestry)	555, 404	93, 348	39, 377	14, 890	570	1,040	704,629

Data source: UNFCC[3]

From sectoral perspective, excluding land use change and forestry, the People's Republic of China's GHG emissions from energy activities, industrial processes, agricultural activities and waste treatments were 5.769 Gt (10^9 tonnes) CO_2 eq, 768 Mt (10^6 tonnes) CO_2 eq, 820 Mt CO_2 eq and 111 Mt CO_2 eq respectively in 2005, accounting for 77.27%, 10.26%, 10.97% and 1.50% of the total emissions accordingly (Figure C-17).



Data source: UNFCC

Figure C-17 Composition of the People's Republic of China's GHG emissions sectors in 2005 (excluding Land Use Change and Forestry)

In 2005, the People's Republic of China's total CO_2 emissions were 5.976 Gt, of which the emissions from energy activities were 5.404 Gt, accounting for 90.4%; and the emissions from industrial processes were 569 Mt, accounting for 9.5%. The CO_2 removed through land use change and forestry came to 422 Mt and the People's Republic of China's net CO_2 emissions were 5.554 Gt. In 2005, the People's Republic of China's total methane emissions were 44.454 Mt, of which

[3] http://unfccc.int/resource/docs/natc/chnnc2e.pdf

the emissions from agricultural activities were 25.169 Mt, accounting for 56.62%, the emissions from energy activities were 15.429 Mt, accounting for 34.71%, and the emissions from waste treatments were 3.824 Mt, accounting for 8.60%. In 2005, the People's Republic of China's total nitrous oxide emissions were about 1271 Kt (10^3 tonnes), of which the emissions from agricultural activities were 938 Kt, accounting for 73.79%, the emissions from energy activities were 134 Kt, the emissions from industrial processes were 106 Kt, and the emissions from waste treatments were 93 Kt. In 2005, the People's Republic of China's total fluorinated gas emissions from the industrial processes came to about 165 Mt CO_2 eq.

Table C-13 The People's Republic of China's carbon dioxide, methane and nitrous oxide inventory 2005

(Unit: 10^4 t)

GHG source and sink categories	CO_2	CH_4	N_2O
Total national emissions (net emissions)	555,404	4,445	127
1. Energy activities	540,431	1,543	13
A. Fuel combustion	540,431	229	13
(1) Fuel production, processing and conversion	240,828		3
(2) Manufacturing industries and construction	211,403		
(3) Transport	41,574	13	4
(4) Business	13,680		
(5) Residents	26,273		
(6) Agriculture	6,673		
(7) Biomass combustion (for energy uses)		216	6
B. Fugitive emissions from fuels		1,314	6
(1) Oil and natural gas systems		22	
(2) Coal mining		1,292	
2. Industrial processes	56,860		11
A. Cement	41,167		
B. Lime	8,562		
C. Iron and steel	4,695		
D. Calcium carbide	1,032		
E. Limestone and dolomite	1,040		
F. Adipic acid			6
G. Nitric acid			5
3. Agricultural activities		2,517	
A. Enteric fermentation		1,438	
B. Manure management		286	27
C. Rice cultivation		793	
D. Agricultural lands			67
4. Land-use change and forestry	-42,153	3.1	0.02
A. Change in forest and other woody biomass stocks	-44,634		
B. Forest conversion	2,481	3.1	0.02
5. Waste treatment	266	382	9
A. Solid waste disposal		220	
B. Wastewater treatment		162	9

GHG source and sink categories	CO_2	CH_4	N_2O
C. Waste incineration	266		
Memo items			
International aviation	995		
International navigation	1,122		

Data source: UNFCC

In the People's Republic of China, rapid economic growth and urbanization have led to increasing solid waste generation and GHG emissions from the waste sector. Solid waste disposal not only has a major impact on the quality of life and environment for the people, but constitutes a significant source of GHG emissions, generating large quantities of methane, carbon dioxide and nitrous oxide.

Currently, most of the solid waste generated in the People's Republic of China is disposed of in three ways — landfill, incineration and composting. According to the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Inventories, there are four sources of waste-generated GHG emissions: solid waste disposal sites, biological treatment of solid waste, incineration and open burning of waste, and wastewater treatment and discharge. Among them, solid waste disposal sites are the biggest source of GHG emissions. At landfill sites, methane is one of the six GHGs observed by the Kyoto Protocol and has a strong greenhouse effect, even greater than that of carbon dioxide. Temperature increases resulting from methane is potentially 21 times that of carbon dioxide. According to IPCC estimates, methane generated from solid waste landfills accounts for 3 to 4% of global greenhouse gas emissions each year. In addition, other greenhouse gas emissions are generated from solid waste landfills, including carbon dioxide, non-methane volatile organic compounds and small amounts of nitrous oxide, oxynitride and carbon monoxide.

Specifically, CO2 emissions from incineration of fossilized material-originated wastes in 2005 were 2.658 Mt, and emissions from organic waste incinerations were 3.927 Mt (excluded in the total). The CH4 emissions from waste treatments in 2005 were 3.824 Mt, of which the CH4 emissions from solid waste disposals were 2.204 Mt, accounting for 57.62%; and the CH4 emissions from wastewater treatments were 1.621 Mt. For the first time, the N2O emissions from industrial and municipal wastewater treatments were estimated in the People's Republic of China's 2005 GHG inventory, and were around 93 Kt (Table C-14).

Table C-14 The People's Republic of China's GHG emissions from waste treatments in 2005

(Unit: 10^4 t)

GHGs	CO_2		CH_4	N_2O
Solid waste disposals (landfill)	-		220.4	-
Industrial wastewater treatment	-		122	9.3
Wastewater treatments	-		40	
Waste incinerations	Origin	Emissions	-	-
	Fossilized	265.8		
	Organic*	392.7		
Total emissions		265.8	382.4	9.3
Total(CO_2 eq)				11,181

* the value for item with an asterisk was not accounted in the total emissions amount. *Data source: UNFCC*

In recent years, the government of the People's Republic of China has reinforced development and supervision of the waste-disposal sector. The People's Republic of China has continuously improved urban waste-disposal standards, formulated regulations and intensified technical development and applications. Advanced waste incineration technologies have been widely deployed, and their localization has been increased to effectively lower the costs of production, and to facilitate their industrialization. Such measures as charging for household waste treatment, and contract-based service and responsibility system established for the environmental sanitation sector, and adoption of enterprise management by public units have contributed to the structural reform of waste treatment system. Incentive policies have been formulated to promote landfill gas recovery, encouraging enterprises to build and use a landfill gas collection and utilization system.

D: EXPERT'S ASSESSMENT ON 3R POLICY IMPLEMENTATION

I. Identified Issues Related to Waste Management and 3Rs

Facing the rapid increase in waste generation, solid waste management and 3Rs has made considerable progress, waste disposal facilities gradually move from urban to rural counties, expanding the scope of services, with a rise in the waste disposal rate. However, there are still challenging problems to be solved.

(1) Lack of a definite strategy for MSW disposal remains a major problem. It is not enough to build more waste disposal facilities or to introduce more stringent standards.
(2) There is a shortage of effective management of MSW from generation, collection, transportation, and treatment to final disposal, without specific legal documents on management and standards on separation and recycling.
(3) Lack of effective supervision and insufficient financial support for construction and operation of MSW treatment facilities resulted in low levels of operation and the creation of secondary pollution at some urban waste facilities.
(4) Shortage of Environmentally Sound Disposal Facilities is still the main challenging problem although large numbers of incineration plants and landfills have been built over the last decade. In the larger cities, almost all landfills are overloaded, most face closure in the near future, and site selection for new facility has become increasingly difficult in the last two years. It is predicted that lack of capacity for waste disposal facilities will soon become a distinctive feature of the larger cities, particularly megacities.

II. Policy Options to Promote Waste Management and 3Rs

(1) Improve efficiency by strengthening the co-operation of related management sector.
It is necessary to strengthen the whole management system for MSW and RW to improve working mechanisms, through establishing the joint working meetings and/or a long-term management cooperation communication platform among the related government departments.
(2) Improve the legal standards and enforcement capacity
A sound legal framework and appropriate policies will encourage reduction, recycling, and environmental disposal of urban waste. It is necessary to step up efforts to improve the regulatory framework for modern urban waste management.
(3) Improving collection of MSW and RW
Due to the difficulties associated with MSW disposal from the high percentage of kitchen waste in the household waste, it is very important to take measures to remove as much kitchen waste as possible from household waste. The source separation method, based on the separate collection of "wet waste" and "dry waste", should be adopted.
For restaurant food waste, waste electrical and electronic products, there needs to be a professional business recycling system.

(4) Strengthen the financial guarantee and improve the technology level of facility construction
Large improvements in MSW waste management may be possible if the right policies are implemented and the right financial incentives are offered. Policies on urban waste disposal may prove more important than technical regulations. Development in disposal technologies and the industry requires effective policymaking, including technology, industrial, energy and investment policies.

Most of the existing recycling facilities for waste electrical and electronic products are small workshops or businesses with backward technology. It is necessary to build large-scale treatment facilities, or a recycling and processing zone for waste electrical and electronic products.

(5) Strengthening the supervision of MSW disposal facilities operations.
Although the construction requirements of many of the People's Republic of China's newly-built landfill and incineration plants meet the national standard, with some having already reached the level of developed countries, the fact remains that at the operation and management levels, most landfills are still unsatisfactorily low. There is a great need to strengthen both the supervision and inspection of MSW disposal facilities. Landfill level assessment has already improved the operation and management level of landfills in the People's Republic of China significantly.

(6) Strengthen public participation
It is necessary to establish a public participation mechanism in the decision-making of MSW facility projects, and a mass supervision and reporting system for the illegal acts in all aspects of urban waste management. The public should be encouraged to participate in green consumption, source reduction, and separation collection of urban waste, through propaganda and education.

REFERENCES

Chen, Z.D., Geng, Y., and Fujita T. (2010) An overview of municipal solid waste management in China. Waste Management 30, 716-724.

Chung, S.S. and Poon, C.S. (2001) A comparison of waste-reduction practices and new environmental paradigm of rural and urban Chinese citizens. Journal of Environmental Management 62, 3-19.

CSIRO and UNEP Asia-Pacific Material Flows online database. Retrieved January 08, 2015, from URL: http://www.cse.csiro.au/forms/form-mf-start.aspx

Li, J.J., Zhuang, X., DeLaquil, P., Larson, E.D. (2001) Biomass energy in China and its potential. Energy for Sustainable Development V (4), 66-80.

National Bureau of Statistics of China (2014) China Statistical Yearbook 2014 (in Chinese), Chinese Statistics Press, Beijing.

National Bureau of Statistics of China (2014) China Statistical Yearbook on Environment 2013 (in Chinese), Chinese Statistics Press, Beijing.

NDRC (2006) Tentative Management Rules on Price and Fee Sharing for Electricity Generation from Renewable Energy (in Chinese). Retrieved January 08, 2015, from URL: http://www.gov.cn/ztzl/2006-01/20/content_165910.htm

Huang, Q.F., Wang, Q., Dong, L., Xi, B.D., and Zhou, B.Y. (2006) The current situation of solid waste management in China. Journal of Material Cycle and Waste Management 8, 63-69.

Lee, D.I., Cho, H.S., Jeong, S.B. (2006) Distribution characteristics of marine litter on the sea bed of the East China Sea and the South Sea of Korea. Estuarine, Coastal and Shelf Science 70(1), 187-194.

Lin, J.Q., Lin N., Qiao, L.M., Zheng, J., and Tsao, C.C. (2007) Municipal Solid Waste Management in China. Retrieved January 08, 2015, from URL: http://www.personal.ceu.hu/students/06/Lin_Jiaqiao/Assignments/Municipal%2520Solid%2520Waste%2520Management%2520in%2520China.doc+&cd=2&hl=en&ct=clnk&gl=jp

Liu, W., Ju, M.T., Chu, C.L., Shao, C.F., Tian, W.X. (2011) Materials and energy flow analysis and empirical study in regional environmental-economic system. Journal of natural resources 26(8), 1435-1445.

MOC (2006) National Urban Environment and Sanitary Plan in the Eleventh Five-Year Period (in Chinese). Retrieved January 08, 2015, from URL: http://www.bjmac.gov.cn/pub/guanwei/F/F10/F10_3_7/200712/t20071213_7635.html

Rech, M. (2013) EU-China Cooperation on Municipal Solid Waste Management. Retrieved January 08, 2015, from URL: http://euchinacrn.org/wp-content/uploads/2013/03/3-4_Max-RECH.pdf

Solenthaler, B and Bunge, R. (2004) Waste Incineration in China. Retrieved January 08, 2015, from URL: http://www.umtec.ch/dokumente/dokumente/downloads/publikationen/Waste_Incineration_China_Chinese.pdf

United Nations Conference on Environment and Development (1992) Protection of the oceans, all kinds of seas, including enclosed and semi-enclosed seas, and coastal areas and protection, rational use and development of their living resources Agenda 21, Chapter 17.

UNFCCC. Retrieved January 08, 2015, from URL:http://unfccc.int/2860.php
Wang, H.M., Yue, Q., Lu, Z.W. (2011) Decoupling analysis of China's resource consumption and economic growth over the Period 1998-2008. Resource Science. 2011, 33(9): 1757-1767.
Wang, H.T. and Nie, Y.F. (2001) Remedial strategies for municipal solid waste management in China. Journal of the Air and Waste Management Association 51 (2), 264-272.
Wang, Q., Liu, J.Z., Gu, X.W., Ding, Y. (2005) Domestic Material Consumption of Chinese Economic System. Resource Science 27(5), 2-7.
World Bank (2005) Waste Management in China: Issues and Recommendations, May 2005, Urban Development Working Papers, East Asia Infrastructure Department, Working Paper No. 9. Retrieved January 08, 2015, from URL: http://siteresources.worldbank.org/INTEAPREGTOPURBDEV/Resources/China-Waste-Management1.pdf
World Economic Outlook Database, Retrieved November 10, 2014, from URL: http://www.imf.org/external/pubs/ft/weo/2008/02/weodata/index.aspx
White Paper on WEEE Recycling Industry in China (2013), Retrieved November 10, 2014, from URL: http://www.cheari.org/recycling
http://www.imf.org/external/pubs/ft/weo/2008/02/weodata/index.aspx
Zhang, D.Q., Tan Soon Keat, Gersberg, M. Richard (2010) Municipal solid waste management in China: Status, problems and challenges. Journal of Environmental Management 91, 1623-1633.
Zhou, P., Huang, C., Fang, H., and et al. (2011) The abundance, composition and sources of marine debris in coastal seawaters or beaches around the northern South China Sea (in Chinese). Marine pollution bulletin, 62(9), 1998-2007.