Estimation of Environmental Impacts of Regional Economic Integration in East Asia : Implications for Waste and Recycling Policy

Yasuhiko Hotta
Satoshi Kojima

Working Papers

IGES
Institute for Global Environmental Strategies

IGES-WMR Working Paper (2008-001)

Estimation of Environmental Impacts of Regional Economic Integration in East Asia: Implications for Waste and Recycling Policy

by

Yasuhiko Hotta[*] and Satoshi Kojima[†]

November 2008

Abstract

This paper analyses the impact of the future regional economic integration and development on internationalisation of waste and recycling-related issues in East Asia. The analysis focuses upon production and consumption of electronics and electric products and automobiles which are strategically important products in developing Asia in the future. To do so, this paper analysed and interpreted the results of the impact assessment of regional economic integration in East Asia using an environment-extended multi-regional computable general equilibrium model (the REPA model). This paper highlights waste-related impacts, at East Asian regional level, of expected increasing consumption of durable consumer goods due to rapid industrial and economic development, especially issues regarding e-waste and end-of-life vehicle (ELV), which can either be recyclables containing ferrous and non-ferrous metals or hazardous waste depending on governance and technical capacity. The paper confirmed that the environmental impacts are expected to increase in line with the expanded use of resources and the production, consumption and disposal of durable consumer goods, unless Asian developing countries rapidly develop adequate management and treatment capacities for hazardous substances.

Keywords

Waste management, Recycling, E-waste, Economic integration, CGE

[*] Policy analyst/deputy project manger, Waste and Resources Project, IGES. E-mail: hotta@iges.or.jp

[†] Senior environmental economist/project manger, Economic Analysis Team, IGES. E-mail: kojima@iges.or.jp

Table of Contents

1. Introduction

The international movement of recyclables is drawing increasing attention from national governments, international organisations and researchers alike. Through the 1980s and 1990s, many developed countries experienced a hollowing-out of material-intensive industries that shifted to developing countries in Asia. Economic development of Asia has brought increased demand for resources in developing Asia. In fact, from the 1990s to early 2000s, Japan has exported recycled resources abroad. Thus, despite its efforts to establish a comprehensive domestic recycling mechanism, the international movement of recyclables has severely hurt the domestic recycling industries. For example, the export of polyethylene terephthalate (PET) waste damaged the domestic PET recycling industry operations. This means that the impact of globalisation has reached far into the downstream economic activities.

Around the mid 1990s to early 2000s, along with the debate over Basel Convention's Ban Amendment (adopted in 1995 but not yet in effect in June 2008) to prohibit export of hazardous waste for recycling purpose from member countries of Organization for Economic Cooperation and Development (OECD), EU and Lichtenstein to non-OECD countries, several studies discussed the possible economic as well as environmental impacts of banning trade of hazardous recyclables into developing countries (Alter 1997, Cox and Sheales 1996, Elmer 1995, Hoffmann and Wilson 2000, Veena and Hoffmann 2000). However, the focus of these studies tended to be limited in the effect of Basel Convention or its Ban Amendment to local recycling industries.

From the early 2000s, governmental officials, researchers and NGOs in both developed and developing countries, especially those in Asia, started to advocate the concern on transboundary movement of recyclable materials and its economic as well as environmental impacts. These studies extended the scope from waste problems caused by illegal trade in developing countries to issues of Asian regional economy, and analysed international trade of recyclables and its environmental impacts in such wider context. They pointed out that 1) recycling of secondary materials (recyclable materials) is increasing in both developed and developing countries, 2) international trade of secondary materials grows at an even faster rate, and 3) developing countries tend to import a large share of this trade (Van Beukering 2001, p.7 and p.197).

Along this line, around 2004-2007, Japanese research institutes including the National Institute for Environmental Studies (NIES) and the Institute of Developing Economic of Japan External Trade Organization (IDE-JETRO) have pointed out the emerging loop-holes of Japan's comprehensive policy mechanism for recycling caused by (both legal and illegal) international trade of recyclable materials (e.g. Terazono et. al. 2004 and 2008, Kojima 2005, NTT Data Institute of Management Consulting 2006, Re-tem 2006, and E&E Solutions 2006). As the first attempt of the Japanese government to address the needs in further policy-relevant research on impacts of transboundary movement of recyclable materials on its 3R (reduce,

reuse, recycle) policy, the Ministry of the Environment of Japan (MOEJ) established a policy research group under the special framework of study on the 3R Initiative in 2006. However, these previous studies on international trade of recyclables including those by NIES and IDE-JETRO tended to focus on field surveys in developing countries to supplement data of the so-called hidden material/waste stream that does not appear in official statistics. They were mainly interested in the micro-phenomena of environmentally improper recycling, and their analysis did not well reflect the economical dynamics of changes in resource demands and industrial structure between developed and developing countries.

This study, on the other hand, tries to demonstrate the possible application of macro-economic modelling analysis to estimate future impacts of production and consumption of economies over waste and recycling-related issues in Asia. By doing so, the study tries to demonstrate that transboundary movement of recyclables as well as increasing waste problems and improper recycling activities in developing Asia should be better understood in the context of economical dynamics of changes in resource consumption and industrial structure. Although it does not directly show the waste generation and demands in recyclables, the study demonstrates that the combination of modelling analysis and a review of existing literature of waste and recycling issues can still present a fairly concrete picture of the situation in the future and can provide relevant implications to materials management policy in the aspects of both resource and waste.

The analysis of this study focuses on the likely environmental impacts, particularly in terms of waste and recycling issues, of regional economic integration in East Asia. The analysis tries to justify, by conducting both qualitative and quantitative analysis, the recent attention on electronic waste (e-waste) and end-of-life vehicles (ELV), which are internationally important not only as hazardous waste issues but also as issues directly related to changes in industrial structure and resource demands.

This paper is structured as follows: Following this introductory section, Section 2 analyses the dynamics and likely impacts of future international economic integration on waste and recycling-related issues, based on the analysis of Hotta et. al. (2008) that reviewed and synthesised existing policy-relevant surveys and researches, and the results of policy dialogues of waste and recycling-related issues. Section 3 justifies the increasing importance of recyclable resource demands in the increasingly globalising economy, by interpreting the results of macroeconomic modelling analysis of regional economic integration, particularly in terms of demands in non-ferrous metal resources in key industrial sectors in the selected Asian countries from 2001 to 2020 under three different scenarios of the future economic integration. Section 4 briefly presents a series of country specific analysis for Japan, China, Thailand and Viet Nam, which corroborates the main findings of the previous section. Finally, Section 5 concludes this paper with some policy implications of the research results responding to internationalisation of waste and recycling-related issues.

2. Impacts of Economic Integration on Waste and Recycling Related Issues

2.1 Drivers of internationalisation of waste and recycling issues

Hotta et al. (2008) reviewed the existing studies on international trade in recyclables (Terazono et.al. 2004, Kojima 2005, MOEJ 2005, NTT Data Institute of Management Consulting 2006), and identified three main likely drivers of internationalisation of waste and recycling issues faced by developing and developed countries as follows:

1) Further increase in waste generation due to continuous economic growth in Asia.
2) Increasing international division of labour and globalisation of product lifecycles (resource extraction, production, product distribution, product use, and waste disposal).
3) Increasing waste trade.

Further increase in waste generation due to continuous economic growth

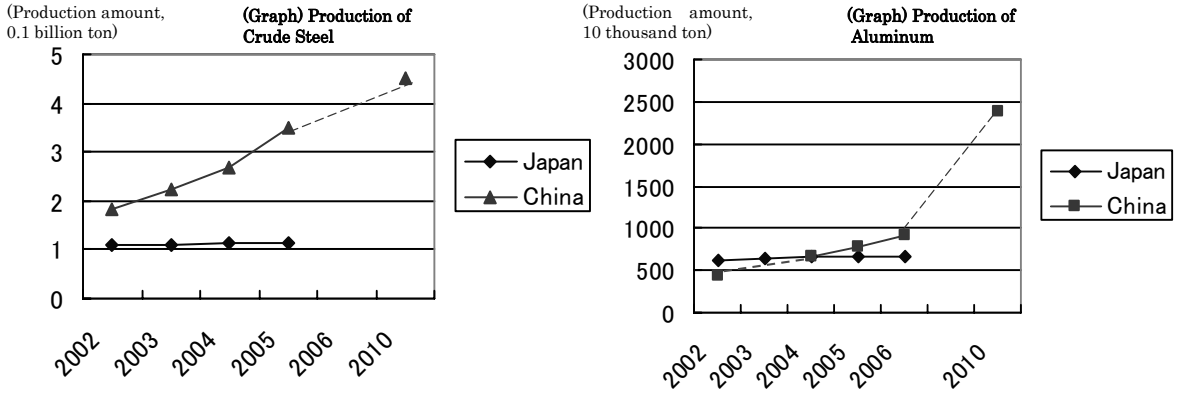
According to the Ministry of Economy, Trade and Industry of Japan (METI), Asia's continuous population growth, economic development, and change in lifestyles through rapid urbanisation will lead to further expansion of production and consumption in durable consumer goods, such as electric home appliances and automobiles, as well as plastic products (METI 2007). This results in rapid increases in resource demands and waste generation (Yoshizawa, Tanaka and Shekdar 2006). Under such pressure, inefficient resource and waste management policies will worsen the current problems of environmental pollution and labour health risks caused by improper treatment and recycling such as open burning and dumping, in particular environmentally unsound metal recovery from e-waste, open burning of plastic parts, or acid treatment.

Increasing international division of labour and globalisation of product lifecycles

Along with increasing resource demands and waste generation, waste and recycling problems are now internationalised through increasing international division of labour and globalisation of product lifecycles (resource extraction, production, product distribution, product use, and waste disposal). The Asian region has been called "the factory of the world." Actually, Asia currently occupies the world's number one share in production of automobiles, chemical textiles, PCs and DVD recorder players (METI 2007). It means that Asia is now in the middle of the globalisation of the upstream economy. METI (2007) also pointed out that the share of East Asia (including Hong Kong, but excluding Japan) in the world private final consumption expenditure expanded from 5.3 per cent in 1980 to 9.9 per cent in 2005. The same report noted the rapid expansion of consumer groups of durable goods in five countries in Asia (China, Thailand, Indonesia, Malaysia, and Philippines) from 2000 to 2005.

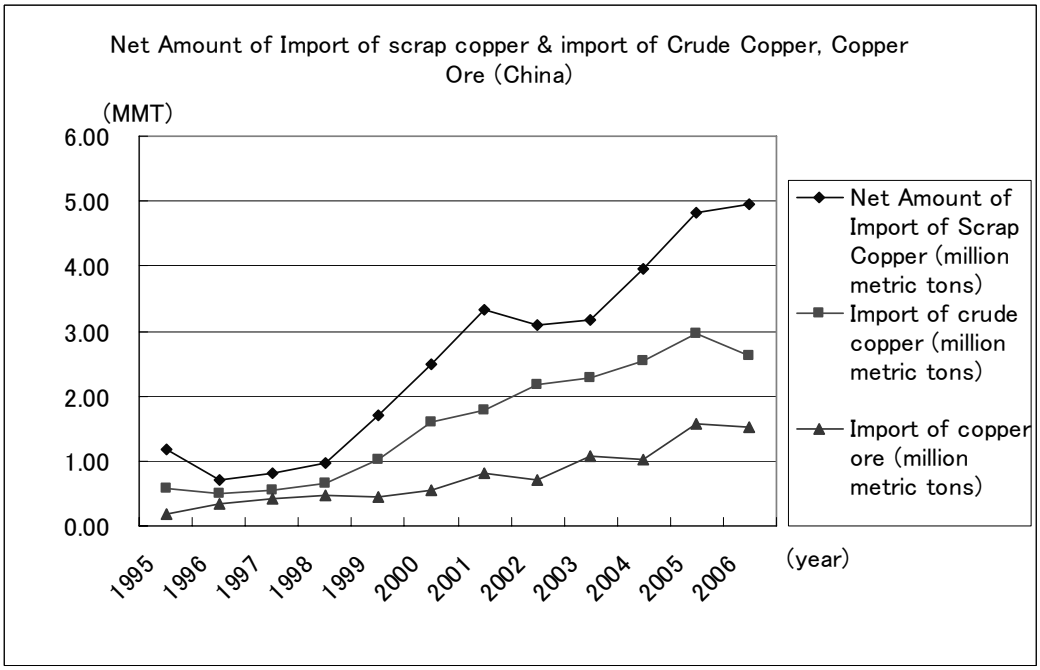
As shown in Figure 1, China's materials industry is developing rapidly while the materials industry in Japan is now in the matured stage. Trade in secondary materials (recyclable

resources) is increasing in the region driven by increasing resource demands in developing Asia due to a swift structural change in the Asian economy in the last 20 years. For example, Figure 2 shows the more rapid expansion of demand for copper scrap than demand for copper ore and crude copper in China.



Note: Production in 2010 of PRC is based on an estimate by Takeda (2006).
Source: Compiled by IGES based on the data in Takeda (2006). For crude steel production and aluminium production in PRC, the figures are based on JOGMEC(Japan Oil, Gas and Metals Corporation)'s database.

Figure 1 Production of crude steel and aluminium in Japan and China



Note: Import of Scrap Copper is based on H.S. Code 7404. Import of Crude Copper is based on H.S. Code 7402.
Source: Compiled by IGES based on; World Trade Atlas Database, Osame, A. (2003, 2005), and Sawada, K. (2006).

Figure 2 China's increasing demand in metal: copper and scrap copper

Increasing waste trade

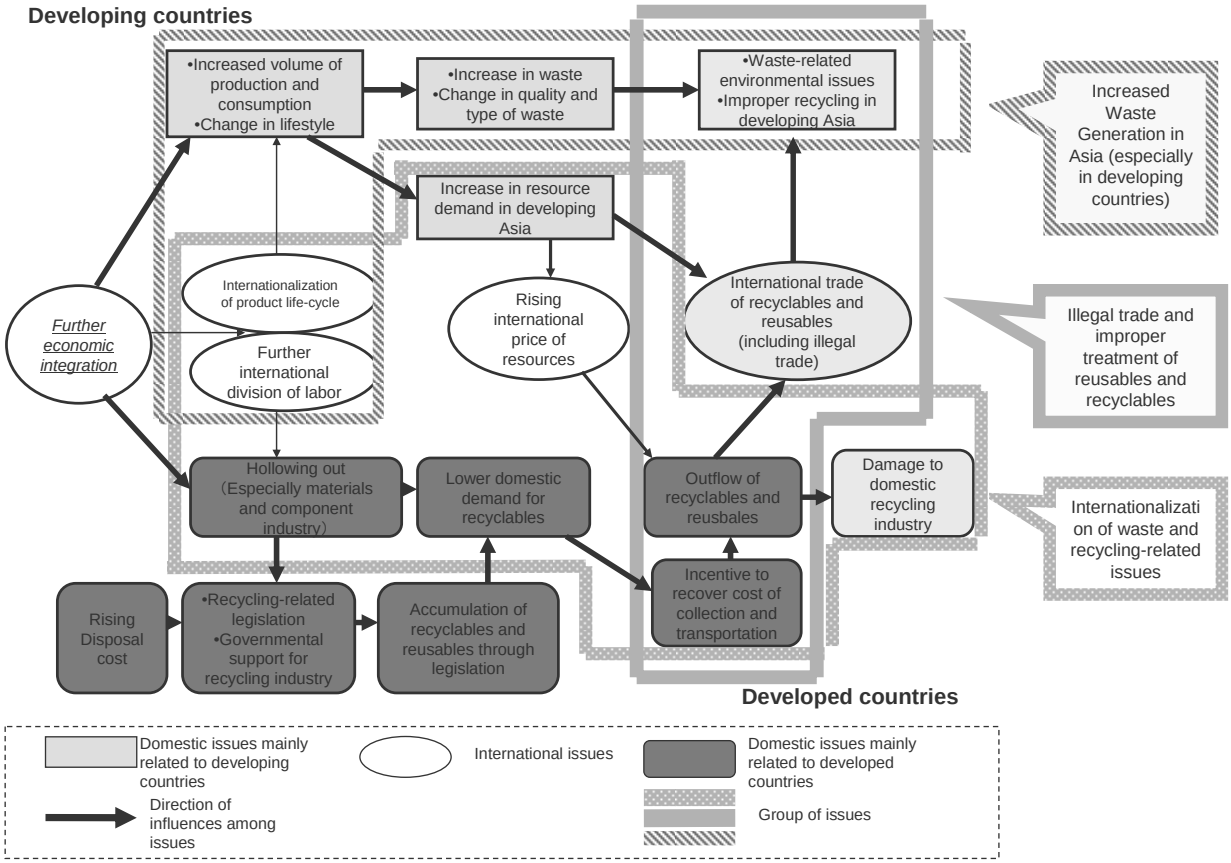
The region faces trade-related problems due to the difficulty in distinguishing between waste, second-hand goods, and recyclables. In addition, some cases of free trade agreements between Japan and South Asian countries have discussed zero tariffs for waste, although this does not mean liberalisation in waste trade,[1] since the Basel Convention defines international procedure for controlling transboundary movement of hazardous wastes, which requires export permission as well as prior notice to and consent of authorities for such movement. Even if developed countries established proper domestic waste management and recycling mechanisms, trade-related problems may cause a political risk of increasing international pressure for the developed countries and multinational corporations.[2]

2.2 Internalisation of waste and recycling related issues

Figure 3 shows the causal chain analysis (CCA) based on the literature review explained in this section, which originally appeared in Hotta et. al. (2008). This CCA illustrates the increasing linkages of waste and recycling issues of developed and developing countries due to increasing international division of labour for production as well as increasing resource demands and consumption in developing countries.

[1] When concerns of promoting waste trade over Japan-Philippines Economic Partnership Agreement and Japan-Thailand Economic Partnership Agreement were politicised, the governments exchanged diplomatic notes confirming to follow the Basel Convention and relevant domestic regulations.

[2] See homepage of Basel Action Network (www.ban.org).



Source: Hotta et. al. (2008, p.38).

Figure 3 Causal Chain Analysis at Regional Level

Asia is now experiencing internationalisation of waste and recycling problems (in other words, globalisation of downstream economy) as seen in the case of e-waste issues or increasing outflow of waste plastics from Japan to China as recyclables. The lifecycle of the product (resource extraction, production, product distribution, product use, and disposal) and location of resource circulation, energy use, or environmental pollution have extended across national borders. Even in a country such as Japan that has well-developed domestic mechanisms for waste management, recycling and pollution prevention, there is an increasing possibility that the development of international trade and distribution of products and materials could expand loopholes for such well-established domestic mechanisms through trade in recyclables or second-hand goods (Hotta et. al. 2008). Therefore, if international trade and market conditions are not taken into account, it is likely that the effectiveness of domestic policies to promote the 3Rs (reduce, reuse and recycling) of end-of-life products will be undermined.

The electric and electronics industries are expected to keep growing due to economic integration in Asia, which will result in expanded demand for nonferrous metals. Recyclable resources, including nonferrous metals, often contain hazardous substances. If the recycling and reuse of such recyclable resources expands, and if the industries' capacity for substance treatment and environmental management in each country remain as insufficient as they are,

environmental and health problems may be further aggravated due to local air, water and ground pollution caused by inadequate recycling.

As the production and consumption of products (the upstream economy) and the generation, reuse and recycling of waste (the downstream economy) are two sides of the same coin, if the division of roles among Asian countries in the upstream economy related to durable consumer goods advances in line with economic integration, the same might happen in the downstream economy as well. The expected economic integration of Asia is likely to enhance these structural changes causing concerns for waste minimisation and the 3Rs to spill over beyond national borders Thus, as similar to industrial policy, waste management and recycling policies that have conventionally focused on urban and national levels shall now consider international aspect of resource and pollution-related challenges.

3. Justification of the Increasing Importance of Recyclable Resource Demands through Modelling Analysis of Regional Economic Integration

This section analyses the impact of regional economic integration on waste generation and recycling based on the simulation results of household consumption, exports, and the demand for metal resources (both ferrous and nonferrous metals) in the electronics, automobile and construction sectors under regional economic integration scenarios. The simulations were conducted using the Regional Environmental Policy Assessment (REPA) model that was developed by the Institute for Global Environmental Strategies (IGES).[3]

The basic data on waste generation at the national level is not fully available in most developing countries in Asia, and it can be easily presumed that there is a yawning data gap on specific wastes and end-of-life products, which are necessary for the implementation of appropriate policies, such as the amounts of waste electrical and electronic products (e-waste) and end-of-life vehicles, their types and treatment trends (i.e. inventory). This reconfirms the issue of the lack of appropriate information and inventory that was pointed out at the Asia 3R Conference in October 2006, which was hosted by MOEJ and attended by delegates from 19 Asian countries, four G8 member countries, European Commission, and eight participating international organisations. This wide information gap makes the estimation of future generations of specific waste stream or used/secondhand goods at the national or the regional level highly challenging. For example, until 2008, there were no trade data for used/secondhand electronic goods in Japan. For such estimation of data on e-waste trade, Terazono et. al. (2008) tried to estimate the number of used home appliances and PCs exported from Japan to developing Asia by categorising and comparing significant price differences in the unit price of the exported home appliances and PCs. This method to

[3] The environmental data of 6 East Asian countries were collected through collaborative research project of IGES (Japan), the Indonesian Institute of Sciences (Indonesia), the Korean Environment Institute (Republic of Korea), the Hanoi Institute of Technology (Viet Nam), the Policy Research Center for Economy and Environment of the State Environment Protection Authority (China), and the Thailand Environment Institute (Thailand).

categorise the exported products into new ones and used ones is only applied to exports from Japan and not necessary adequate to estimate the future impact of economic integration to resource demands and environmental degradation. This is why this section indirectly analyses the impact of economic integration on the future generation and recycling of e-waste and ELV through simulation results of household consumption of related commodities.

This section also analyses the growth in the demand for metal resources in the construction sector in order to obtain policy implications of likely future increase in demand for recyclable resources in general.

3.1 The model

The REPA model is a multiregional computable general equilibrium (CGE) model developed for conducting impact assessment of implementing environmental policy packages under regional economic integration in East Asia (Kojima 2008). The REPA model is based on the GTAP model that has been widely applied to quantitative analysis of the global economic issues.[4] The standard GTAP model is a static CGE model, but the REPA model introduces dynamics towards 2020 by solving the model for several time steps. For this study, the employed time steps are 2001-2010, 2010-2015, and 2015-2020, which correspond to the employed regional economic integration (REI) scenarios described below. For each time step, macroeconomic drivers such as labour supply and physical capital stock were exogenously shocked to update the datasets.

The employed dataset is a 12-region (i.e. 10 regions/countries for East Asian countries, the rest of OECD and the rest of the world), 33-sector aggregated version of the GTAP Data Base that divides the world economy as of the base year 2001 into 87 regions and 57 sectors.

It must be noted that the REPA model does not reflect resource constraints such as availability of virgin metals, and the simulation results in production and consumption in rapidly developing countries such as China may be overestimated.

3.2 The regional economic integration scenarios

The employed REI scenarios were designed to cover the plausible range of the degree of future REI in East Asia in 2020. The baseline (BL) scenario corresponds to the shallowest integration and the Deep Economic Integration (DEI) scenario does to the deepest integration, respectively, in the plausible range. The Moderate Economic Integration (MEI) scenario is the intermediate scenario between these two extreme scenarios. It must be noted that our scenarios do not aim to predict the future integration. Table 1 summarises the employed

[4] More precisely, the REPA model was developed based on the GTAP-E model, which is an energy substitution extended version of the GTAP model (Burniaux and Truong 2002). For the details of the standard GTAP model, see Hertel (1996).

assumptions of reductions in trade barriers, in terms of both import tariffs and export subsidies, from the base year (2001) levels.

Table 1 Reductions in trade barriers from 2001 levels under each scenario

Scenario	Commodity	Trade partners	by 2010	by 2015	by 2020
DEI	Agricultural commodities	Among ASEAN and each of China, Japan, and Republic of Korea	40%	80%	80%
		Among all ASEAN +3	0%	0%	80%
	Non-agricultural commodities	Among ASEAN and each of China, Japan, and Republic of Korea	50%	100%	100%
		Among all ASEAN +3	0%	0%	100%
MEI	Agricultural commodities	Among ASEAN and each of China, Japan, and Republic of Korea	0%	40%	80%
		Among all ASEAN +3	0%	0%	0%
	Non-agricultural commodities	Among ASEAN and each of China, Japan, and Republic of Korea	0%	50%	100%
		Among all ASEAN +3	0%	0%	0%
BL	Agricultural commodities	Among ASEAN and each of China, Japan, and Republic of Korea	0%	0%	0%
		Among all ASEAN +3	0%	0%	0%
	Non-agricultural commodities	Among ASEAN and each of China, Japan, and Republic of Korea	0%	0%	0%
		Among all ASEAN +3	0%	0%	0%

Note: ASEAN+3 consists of 10 ASEAN countries (Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam) plus China, Japan and Republic of Korea.

3.3 Impacts of regional economic integration on waste generation and recycling

(1) Household consumption of electrical and electronic products and automobiles

As a result of economic integration, the consumption of electrical and electronic products and automobiles is expected to expand greatly in China. However, as Figures 4 and 5 indicate, the REPA model simulations suggest that the impact of economic integration, in terms of difference of the results in 2020 between BL and DEI scenarios, would be minor at about 0.1 to 0.8 per cent. Similarly, the impact of economic integration would not be large in Japan, Republic of Korea and Indonesia, between 0.1 and 4.0 per cent. In Japan, the increase in consumption will not be very large, either.

Compared to other Asian countries, waste-related issues in Japan can be resolved to a certain degree due to the relatively minor increase in the consumption of durable consumer goods.

In contrast, this consumption is expected to rise significantly in Thailand and Viet Nam due to regional economic integration.

The increase in consumption signifies that amount of end-of-life products will also increase. Therefore, it is expected that the domestic generation of e-waste, ELV and related recyclable resources will rise in the future.

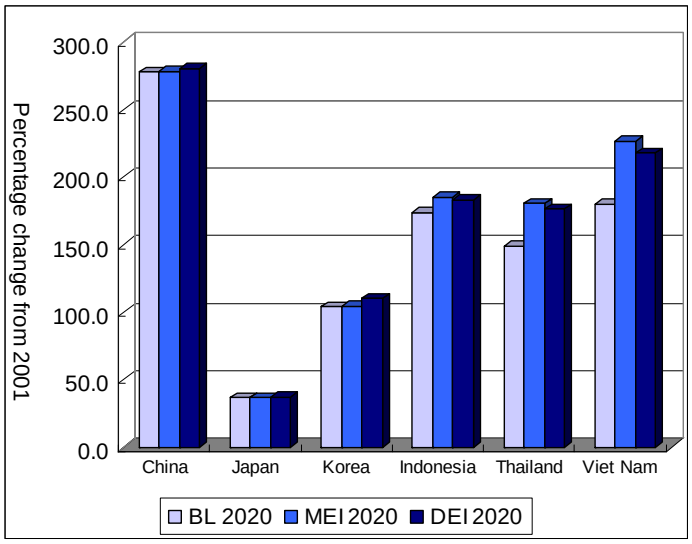


Figure 4 Growth in household consumption of motor vehicles under REI scenarios

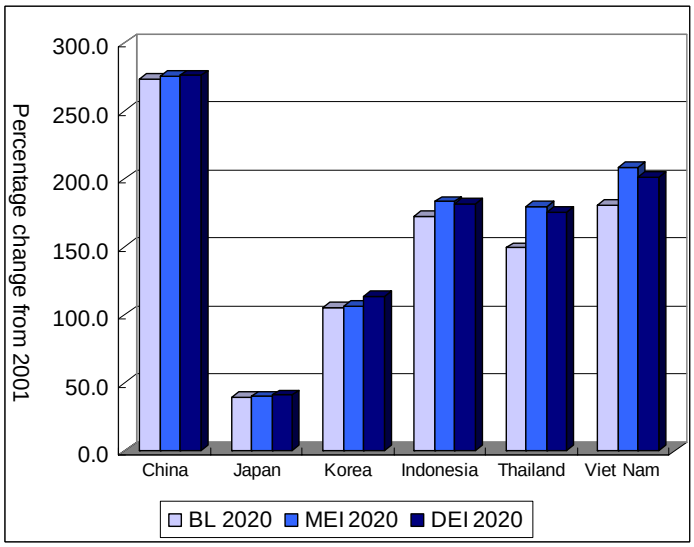


Figure 5 Growth household consumption of electronics under REI scenarios

(2) Demand for imported metal resources in the electrical and electronic industries and the construction industries

To assess the potential impact of economic integration on the demand for recyclable resources, the studies analysed the impact of economic integration on the import demand for metal resources in the electrical and electronics industries and the construction industries.

It is assumed that the demand for metal resources in the electrical and electronic industries includes potential demand for rare metals and other more hard-to-manage and possibly hazardous recyclable resources, for example those in e-waste. It is also assumed that the demand for metal resources in the construction industries represents the potential demand for normal metal scrap, rather than that for recyclable resources contaminated by rare metals and hazardous substances. Furthermore, the demand for nonferrous metals, rather than that for ferrous metals, is assumed to represent the potential import demand for possibly more hazardous recyclable resources.

Based on these assumptions, Figures 6 and 7 show that the increase in demand of imported metal resources would be greater in the electrical and electronics industries, than in the construction industries, except in Japan. The impact of economic integration is considered greater in the electrical and electronics industries, except in Viet Nam and Republic of Korea.

The results of increasing demand in non-ferrous metals suggest that, in the future, there would be an increase in the potential import demand for rare metals and other more hard-to-manage and possibly hazardous recyclable resources.

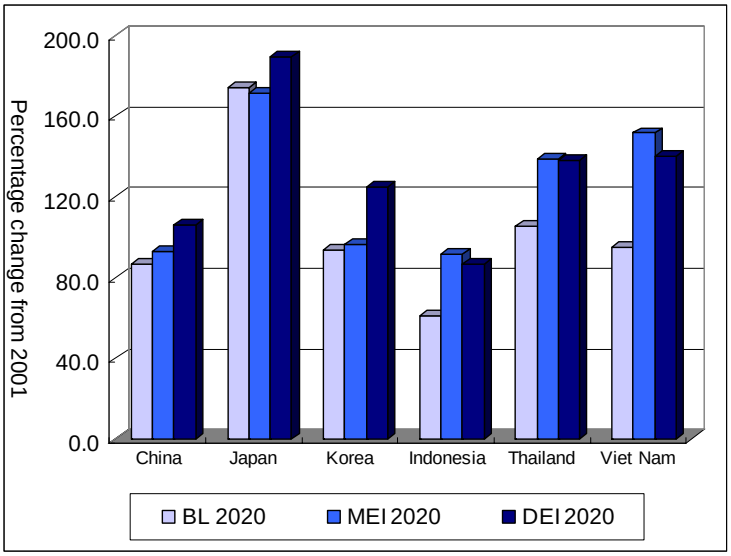


Figure 6 Growth in demand of imported metals in construction sector under REI scenarios

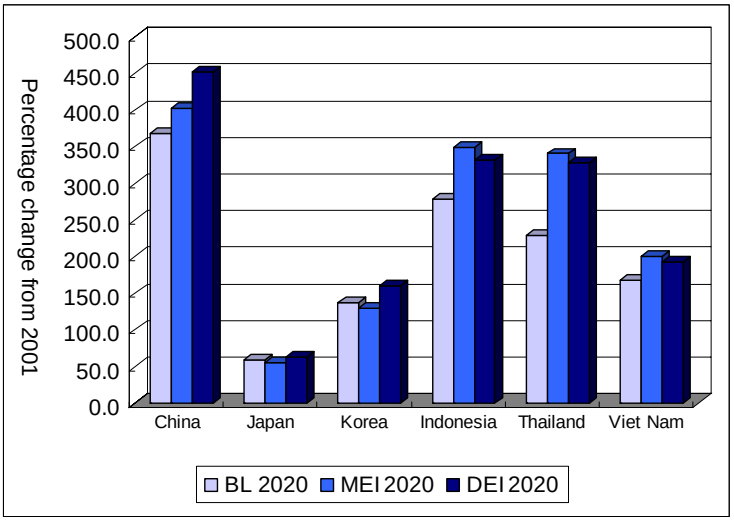


Figure 7 Changes in demand of imported metals in electronics sector under REI scenarios

(3) Demand for domestic metal resources in the electrical and electronics industries and the construction industries

Figures 8 and 9 show an uprising trend in the demand for domestic resources in the electrical and electronics industries and construction industries. These results suggest that the driver for increasing demand for domestic metal resources is generally greater than that for imported metal resources. Naturally, economic integration would affect the demand for imported metal resources larger than that for domestic metal resources.

With regards to the demand for domestic metal resources, it is also expected that any increase would be greater in the electrical and electronics industries than in the construction industries. Therefore, in the future, there would be an increase in the potential domestic demand for rare metals and other more hard-to-manage possibly hazardous recyclable resources.

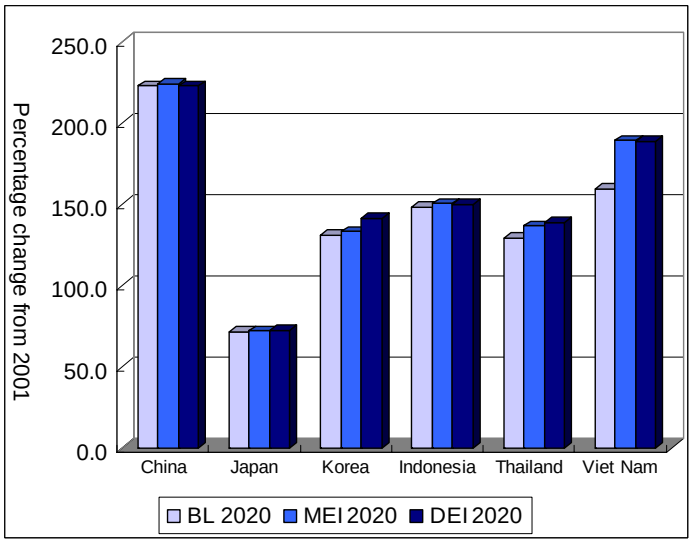


Figure 8 Growth in demand of domestic metals in construction sector under REI scenarios

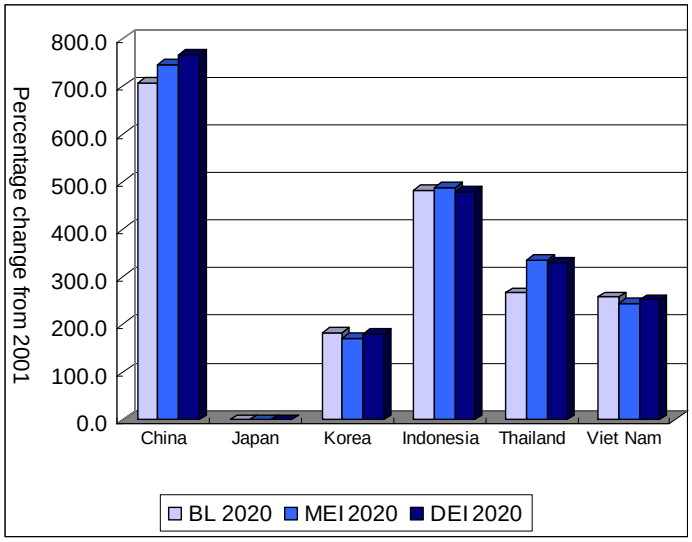


Figure 9 Growth in demand of domestic metals in electronics sector under REI scenarios

4. Country Specific Analysis of Impact of Regional Economic Integration on Waste and Recycling Issues

To provide supplements to the macroeconomic simulation analysis in the previous section, this section briefly presents the country-specific case studies that review the impact of economic integration to waste and recycling policies of four East Asian countries; Japan, China, Thailand, and Viet Nam.[5] Among these four countries, Japan is the most advanced industrialised country in the region with gross domestic product (GDP) per capita of US$ 34,252 in 2006. China (GDP per capita of US$ 2,005 in 2006) is an emerging industrial production center of the world experiencing rapid increase in waste generation and resource demands. Thailand (GDP per capita of US$ 3,251 in 2006) is emerging as a manufacturing economy of the region focusing automobiles and electronic products as strategic products for its economy. Viet Nam (GDP per capita of US$ 73 in 2006) has been rapidly integrating into the regional economy and experiencing rapid economic development since its introduction of market mechanism in the late 1980s.

4.1 Japan

In the 1990s, Japan introduced policy reforms of waste management and recycling for establishing a sound material cycle society. These reforms were in response to the following structural problems:

- A high amount of waste generation every year
- Difficulty in building final disposal sites due to increasing awareness and concerns of citizens

[5] These country specific analyses are based on the three year collaborative research project among Asia-based environmental policy research organisations.

- An increase in the number of cases of illegal dumping due to increasing disposal costs
- Dioxin issues from waste incineration facilities

Japanese experience of developing a sound material cycle society demonstrates that identification of clear and specific social and economic needs is necessary for reform of the social and structural problems of waste. It also exemplifies a step-by-step approach for establishing a comprehensive mechanism for recycling and waste management.

However, Japan's recent experience also reveals that economic integration can undermine the effectiveness of a comprehensive national recycling system. International trade can create loopholes in the domestic recycling system because of price differences of recyclables that reflect differences in valuation of waste and recyclables between countries, inverse onerous cost in Japan, resource needs from outside of Japan, and possible market expansion for second-hand goods, as shown in Table 2.

Table 2　Cost incentives to export of low quality recyclable resources from Japan

Export waste (mixed) plastics to China	Treatment of waste (mixed) plastics in Japan
Sales price in Japan to the dealer exporting to China: 10.3 yen / kg (benefit) - Japanese domestic recycling fee is avoided - Waste plastic will be bought in China: 30 yen/kg (about 20 yen/kg benefit for dealer)	**Domestic recycling fee in Japan for local governments：more than 31 yen / kg or high (cost)** This includes - Cost of waste disposal: more than 25 yen/kg - Transportation fee: 25,000 yen per truck load (4 t)
→ At least 41 yen/ kg of benefit by exporting waste (mixed) plastics to China	

Source: Honda (2005).

This, in turn, can lead to a possible decline or hollowing out of a proper recycling industry in Japan, resulting in an increasing risk of criticism of "waste exports" and political pressure from other countries, despite its efforts to establish comprehensive domestic recycling mechanisms. At the same time, there will be an increasing opportunity for developing countries to develop a proper recycling industry with high technology for recovering rare materials or recyclable resource with high quality, such as the cases of Fuji Xerox and Dowa Eco-Systems, by reducing non-tariff trade barriers (such as complex procedures for international movement of recyclable resources) that make it difficult for companies to integrate recycling systems into their global supply chains.

As Figure 4 in the previous section indicated, the domestic consumption of durable consumer goods in Japan is unlikely to grow substantially along with regional economic integration. Exports are not likely to increase, either. It is possible to consider that the offshore transfer of durable consumer goods production will proceed further except for some products with high added value. The likely direction of environmental policy in Japan may be to disseminate Japanese experience in the appropriate treatment and recycling of end-of-life products, particularly in terms of established systems and technologies, to assist development of systems and capabilities in other Asian countries to cope with waste and recycling issues, and

to take a leadership role in establishing an environmental policy framework for the Asian region that also contributes to closing the loop-hole of Japanese domestic policy.

4.2 China[6]

In the case of China, there are concerns about illegal imports of e-waste that are recycled, often improperly, to help meet increasing demand for resources. This e-waste issue is driven by rapid economic growth in China. Shen et al. (2008) estimated extremely rapid increase in e-waste generation from domestic consumption as shown in Table 3.[7]

Table 3 Prediction of annual obsolescence of e-wastes in China (Mainland)

Year	Amount of Obsolescence by year (10 000 units)				
	Color Television Sets	Household Refrigerators	Household Washing Machines	Air conditioners for Room	Personal Computers
2004	1485.15	446.84	666.74	342.94	375.90
2005	1573.32	444.50	872.73	389.48	1337.21
2006	2041.25	578.01	1048.14	676.43	1376.40
2007	2324.63	727.45	903.76	771.19	3079.10
2008	3088.52	869.56	1022.98	923.68	3177.35
2009	3718.75	924.22	1187.42	1089.14	4782.64
2010	5833.94	966.81	1158.85	1235.02	7190.08
2011	3251.85	973.45	1280.54	3668.45	10796.10
2012	3917.88	1086.99	2530.44	2524.40	16190.75
2013	4041.73	2094.18	1374.37	3875.04	24251.37
2014	4251.48	1242.00	1673.12	2992.61	90491.88
2015	4449.13	1714.78	1519.46	3250.11	80904.88

Source: Shen et al. (2008)

Indeed, policy makers and other stakeholders in China have started to understand that e-waste issues are based on its huge consumption power rather than just about illegal trade of e-waste into China. Although China has developed policies and regulations in response to the challenges of e-waste, the policy and legal systems face great difficulties in the

[6] Country specific analysis for China was conducted in collaboration with a research group from the Policy Research Center for Environment and Economy (PRCEE) of the Ministry of Environmental Protection, China, and Beijing Normal University.

[7] Comparing to the estimates by Shen et al. (2008), the REPA model results in the previous section seem to be very conservative. In general, CGE models have difficulties in reflecting drastic structural changes and tend to produce conservative results.

implementation stage,[8] especially in securing an adequate material flow of recyclable resources into proper recycling facilities.

By expecting huge increase in domestic consumption of electronics and electric products, it is reasonable to propose the introduction of product environmental policies in China. Also, if product exports from China expand rapidly in the future, it is possible that other countries will increase pressure on China with regard to the environmentally conscious design of products, environmental consciousness in the production stage, and extended producer responsibility domestically.

4.3 Thailand[9]

It is expected that economic integration will contribute to the rapid growth of the automobile industry in Thailand, since the automobile sector generates 16 per cent of GDP, 8 per cent of employment, and is ranked 15th in worldwide automobile production. Thailand Environment Institute (Sangmahamad 2008) identified the existence of green labelling for automobiles, the start of voluntary environmental management by car producers, and an increasing number of recycled automobile parts businesses as promising aspects for Thailand's potential for introducing an extended producer responsibility (EPR) based recycling scheme for ELV. On the other hand, their weak points are the lack of a formal recycling management system for ELV and processing of automobile parts relying on rather small-size junk shops. Considering these strengths and weakness, Sangmahamad (2008) proposed the following three measures for facilitating proper recycling and waste management systems for ELV:

- Design and production stage: promotion of Eco-car production and commercialization,
- Production and post-consumption stage: promotion of industrial symbiosis as Japanese manufacturers promoted "zero waste factories" in Japan in 1990s, and
- Supply chain management: promotion of the implementation of Greening the Supply Chain and EPR.

Considering the substantial increase in exports in the manufacturing industry as a result of economic integration according to our simulation results presented in the previous section, the policy proposals of Sangmahamad (2008) in enhancing the added value of export products is reasonable. Domestically, economic integration is expected to result in an increase in industrial waste from the manufacturing industry and the domestic consumption of durable consumer goods in Thailand. Therefore, it is also reasonable to propose the promotion of industrial symbiosis as Japanese manufacturers promoted "zero waste factories" in Japan in

[8] See also the argument of Wang (2007) for his analysis on applicability of EPR principle to China's e-waste management by comparing with EU.

[9] Country specific analysis for Thailand was conducted in collaboration with a research group from the Thailand Environment Institute (TEI).

1990s to promote the reuse and recycling of industrial waste, and for the introduction of product environmental policies.

4.4 Viet Nam[10]

The case study of Viet Nam shows that the country faces increasing pressures from e-waste generation. Production of household electronic appliances has increased annually 16 per cent on average. On the other hand, e-waste is mainly handled by local Urban Environment Companies (URENCOs). At the same time, a large amount of e-waste is collected by waste purchasing units and recycled at craft villages. The recycling industry is only established in craft villages as small family business or private enterprises, and it mainly recycles paper, plastic, ferrous metals, aluminium, and lead with backward technology and rudimentary equipment. Further increases in production and consumption of household electronic appliances in Viet Nam, combined with current improper treatment of e-waste, will likely lead to further increases in discharge of hazardous substances from e-waste.

As for the impact of regional economic integration, Viet Nam anticipates an increase in e-waste generation mainly driven by higher incomes and cheaper imported goods that will lead to an increase in household consumption of electronic appliances. It is also expected to lead to an increase in industrial waste generation. With the advantage of its cheap and abundant labour force, Viet Nam is becoming a part of international production networks of electronic products in conjunction with regional economic integration. Vietnamese legislation has permitted importing recyclable waste without proper institutional capacity and mechanism for regional cooperation, which makes it very difficult for Viet Nam to distinguish hazardous waste, second-hand goods, and recyclable waste.

The same conclusion for Thailand applies to Viet Nam. Our simulation results in the previous section show that economic integration will have considerable influence on production and consumption. While Thailand has started to develop policies concerning the management of durable consumer goods, Viet Nam has to achieve overall improvements in general waste and recycling policy systems, as well as data enhancement. Small industrial accumulations (craft villages) have already started inadequate recycling. Considering the expected expansion in the demand for recyclable resources, it is desirable to develop an adequate environmental management capacity in the recycling industry.

5. Conclusion: Towards Regional Policy Response

This paper suggests that the demand for metals and other recyclable resources as well as waste generation will expand in Asian developing countries due to continued economic growth boosted by regional economic integration.

[10] Country specific analysis for Viet Nam was conducted in collaboration with a research group from the Institute for Environmental Science and Technology (INEST) at Hanoi University of Technology.

In particular, increased demand for rare metals and other possibly hazardous nonferrous metal resources is expected in Asian developing countries due to the growth in the electrical and electronics industries. This will increase potential imported and domestic demand for more hard-to-manage and possibly hazardous recyclable resources, such as those contained in e-waste and ELV. The environmental impacts from hazardous wastes are expected to grow along with the expanded use of resources and the production, consumption and disposal of durable consumer goods, unless Asian developing countries rapidly develop adequate management and treatment capacities for hazardous substances including imported recyclable resources and for the use of by-products.

Considering the domestic expansion in the consumption of durable consumer goods and the demand for resources, using an embargo or other trade sanctions may be insufficient to control negative environmental impacts from the trade of possibly hazardous recyclable resources, even if the focus is placed on recyclable resources. The country-specific studies revealed the continued lack of capacity in handling potentially hazardous materials and waste in developing Asia. Taking account of the rapidly expanding consumption and disposal of durable consumer goods, in line with the expanding domestic resources demand, it will be necessary to place a higher priority on policies to establish domestic mechanisms for the appropriate collection, treatment, reuse and recycling of e-waste and ELV containing metal resources, and the importance of regional cooperative scheme to support such capacity development of proper recycling and management of materials will be increased.

Acknowledgement

This paper presents part of the work under a commissioned research project by the Ministry of the Environment, Japan (the Research on Innovative and Strategic Policy Options Second Phase), but this paper does not necessarily represent the views of the Ministry of the Environment, Japan or those of the Institute for Global Environmental Strategies. The usual disclaimer applies.

References

Alter, H. 1997. Industrial recycling and the Basel Convention, *Resources, Conservation and Recycling* 19:29-53.

Burniaux, Jean-Marc, and Truong Truong. 2002. *GTAP-E: An Energy-Environmental Version of the GTAP Model*, GTAP Technical Paper No.16. West Lafayette, IN: Purdue University.

Cox, A., and T Sheales. 1996. Basel Convention - Economic issues in the ban on. shipments of hazardous waste. *Australian Commodities* 3 (3):384-397.

E&E Solutions. 2006. *Sho-gaikoku no Shigen Junkan Seisaku ni kansuru Kiso Chosa (Basic Survey on Resource Circulation Policy in Foreign Countries)*. Tokyo: METI.

Elmer, J W. 1996. The Basel Convention: effect on the Asian secondary lead industry. *Journal of Power Sources* 59 (Number 1): pp. 1-7(7).

Hertel, Thomas W. 1996. *Global Trade Analysis: Modeling and Application*s. New York, NY: Cambridge University Press.

Honda, D. 2005. Frontier of International Reycling: Possibility of International Cycle Business. In *IGES-KFACE seminar "International Relations from Waste Perspective"October 15, 2005*. Yokohama, Japan.

Hoffmann, U., and B. Wilson. 2000. Requirements for, and benefits of, environmentally sound and economically viable management of battery recycling in the Philippines in the wake of Basel Convention trade restrictions. *Journal of Power Sources* 88:115-123.

Hotta, Yasuhiko, Mark Elder, Hideyuki Mori, and Makiko Tanaka. 2008. Policy Considerations For Establishing An Environmentally-Sound Regional Material Flow In East Asia. *The Journal of Environment & Development*.

Kojima, Michikazu. 2005. *International Trade of Recyclable Resources in Asia*. Chiba, Japan: Institute of Developing Economies, Japan External Trade Organization

Kojima, Satoshi. 2008. *REPA Model for Impact Assessment of Environmental Policies under Regional Economic Integration in East Asia*, IGES-EA Working Paper 2008-001. Hayama: IGES.

METI. 2007. *White Paper on International Economy and Trade, Japan, 2007*. Tokyo: METI.

MOEJ. 2005. *Current Situation of International Movement of Recyclable Resources*, The 3rd Special Committee concerning Construction of International SMS and Environmental Conservation, Waste and Recycle Committee, Central Environmental Council. Tokyo, MOEJ.

NTT Data Institute of Management Consulting. 2006. Chiiki Recycle Sangyo wo Ikashita Junkan Shigen no Tracability ni kansuru Kentou Houkokusho (Report on Tracability of Recyclable Resources by Utilizing Regional Recycling Industries). In *METI Commissioned Research in FY 2005*. Tokyo: METI.

Osame, A. 2003. Reflection of China's Non-Ferrous Industry in 2002, Influence of SARS and Future Perspective of Copper Supply and Demand. *Kinzoku Shigen Jouhou (Metal Resource Report)* Vol.33 (No.4).

——. 2005. Reflection of China's Non-Ferrous Industry in 2003. *Kinzoku Shigen Jouhou (Metal Resource Report)* Vol.34 (No.5).

Re-Tem. 2006. Tracability wo kakuho shita Shigen Junkan Network no Kouchiku ni kansuru Chosa Houkoku-Sho (Survey Report on Establishment of Resource Circulation Network ensured by Tracability). In *METI Commissioned Researh in FY 2005*. Tokyo: METI.

Sangmahamad, P. 2008. Thailand: National Study on automobile waste sector. In *The Final Workshop of the RISPO II*. Yokohama.

Sawada, K. 2006. *Trend of Copper Consumption in China and Copper Industry in Mongol and Kazakhstan*. Tokyo: JOGMEC.

Shen, X., X. Mao, and T. Wei. 2008. *Regional Economic Integration and E-Waste Management in China*. In The Final Workshop of the RISPO II. Yokohama.

Takeda, K. 2006. *Risk Management in Chinese Business*. In Workshop of Asia Business Research Area, Graduate School for Creative Cities, Osaka City University. Osaka: Osaka City University.

Terazono, A., S. Sakai, Y. Moriguchi, I. Bulent, K.Suzuki, Y. Yamamoto, and K. Hanaki. 2004. *Asia Chiiki ni okeru Shigen Junkan Haiki no Kouzou Kaiseki (Analysis of Structure of Resource Circulation and Waste Disposal in Asian Region), Heisei 15-nendo Haikibutsu Shori nado Kakagaku Kenkyu Kenkyu Houkoku-sho* (Research Report of Waste Management Scientific Research Grant in Aid in FY 2003. Tokyo: MOEJ.

Terazono, A., A. Yoshida, R. Murakami, S. Murakami, and T. Shinkuma. 2008. Asia Chiiki ni okeru Haidenkidenshikiki to Haiplastic no Shigen Junkan System no Kaiseki (Analysis of Resource Cycle System of WEEE and Waste Plastics in Asian Region). In *Heisei 19-nendo Haikibutsu Shori nado Kakagaku Kenkyu Kenkyu Houkoku-sho (Research Report of Waste Management Scientific Research Grant in Aid in FY 2007)*. Tokyo: MOEJ.

Van Beukering, P. J. H. 2001. *Recycling, International Trade and the Environment: An Emperical Analysis*. Dordrecht: Kluwer Academic Publishers.

Veena and Hoffmann eds. 2000. *Achieving Objectives Of Multilateral Environmental Agreements: a package of tra de measures and positive measures,*. Edited by UNCTAD.

Wang, Xuejun. 2007. *China's Social and Economic Needs for Circular Economy and EPR mechanisms*. In IGES UNESCAP Workshop on EPR and International Material Flow. Manila, Philippines: IGES, .

Yoshizawa, S., M. Tanaka, and A.V. Shekdar. 2006. *A research on an estimate on future trend of world waste generation*. In The 4th Special Committee concerning Construction of International SMS and Environmental Conservation, Waste and Recycle Committee, Central Environmental Council. Tokyo, MOEJ.

Waste and Resources Project

Mission and Background - Towards a sustainable use of materials

Rapid economic and population growth is causing serious problems related to resource consumption and waste management in Asia. The goal of the project is to establish environmentally-sound material flows and to realise sustainable production and consumption in the Asia-Pacific region by conducting strategic policy research on both upstream (production, consumption and distribution) and downstream (waste and recycling) issues of resource use. Special attention is given to international recycling and linkages between resource management, product and recycling policy and chemicals management policy. Capacity development and policy dialogues on global, regional, national and local levels will also be included in the project

For further information & Contact

IGES

Institute for Global Environmental Strategies
Waste and Resources Project
TEL: +81-46-855-3840
FAX: +81-46-855-3809
Email: wmr-info@iges.or.jp