# FY2009 Progress of the Research on environmental, economic, and social impacts of resource circulation systems in Asia

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**The 2nd Workshop of "Asia Resource Circulation Policy Research"**
**15-16 March 2010, Hotel Villa Fontaine Shiodome, Tokyo**

IGES Institute for Global Environmental Strategies

## Outline of the presentation

- **Overview of the research project**
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- **Progress in FY2009**
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  - Case study on domestic resource circulation policies
  - Regional case study on E-waste
  - Integrated policy impact assessment model (IPAM)
- **Next steps**

## Research objectives

- This research aims to provide useful information to formulate effective resource circulation policy options which will mitigate resource constraints within environmental and social constraints:
  - Resource constraints: vulnerability of economy against resource scarcity and consequent resource price fluctuation
  - Environmental constraints: shortage of waste disposal sites, environmental problems due to emissions of pollutants including GHGs from life cycle of products
  - Social constraints: provide means of livelihood to the poor engaging informal recycling activities while addressing environmental and health problems of informal recycling in developing countries



## Expected contribution to policy making

- For the national level:
  - Policy options addressing decline of domestic resource circulation system due to uncontrolled recyclables exports to developing countries.
  - Policy options to address environmental problems due to inappropriate recycling activities in the recipient countries of uncontrolled recyclables trades.
  - Policy options to mitigate environmental resource scarcity, e.g. GHG emissions and shortage of waste disposal sites.
- For the regional level (particularly ASEAN+3 or ASEAN+6):
  - Policy options to utilise potential of regional policy cooperation e.g. a combination of technology transfer in recycling and financial assistance in resource circulation infra development.

## Some methodological issues

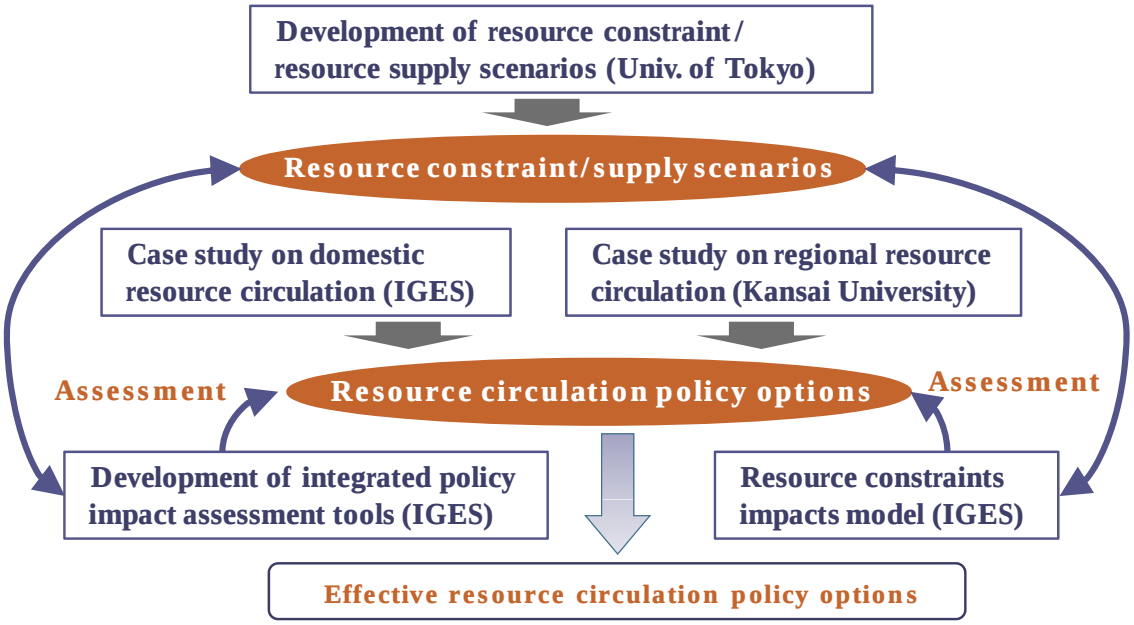
- Global material flows are relatively well studied, but the resource scarcity issues are rarely reflected.
  - Our material flow/stock analysis tries to address this issue.
  - We also try to utilise thoeretical models on resource constraints (such as Pyndick 1978 and Farzin 1995 on dynamic path of resource scarcity rent).
- The current I-O based resource-environment-economy models do not reflect potential substitution due to relative price changes among input.
  - Combine multiregional CGE with resource use models etc.
- Public infrastructure investment is important resource circulation/3R policies, but most multi-regional CGE model cannot properly address this issue due to lack of forward-looking dynamics.
  - Develop dynamic multi-regional CGE model as a core of integrated policy impact assessment model.



## Progress in FY2009

**(FY2009 is the first fiscal year of this project, and this project commenced in October 2009)**

## Research structure



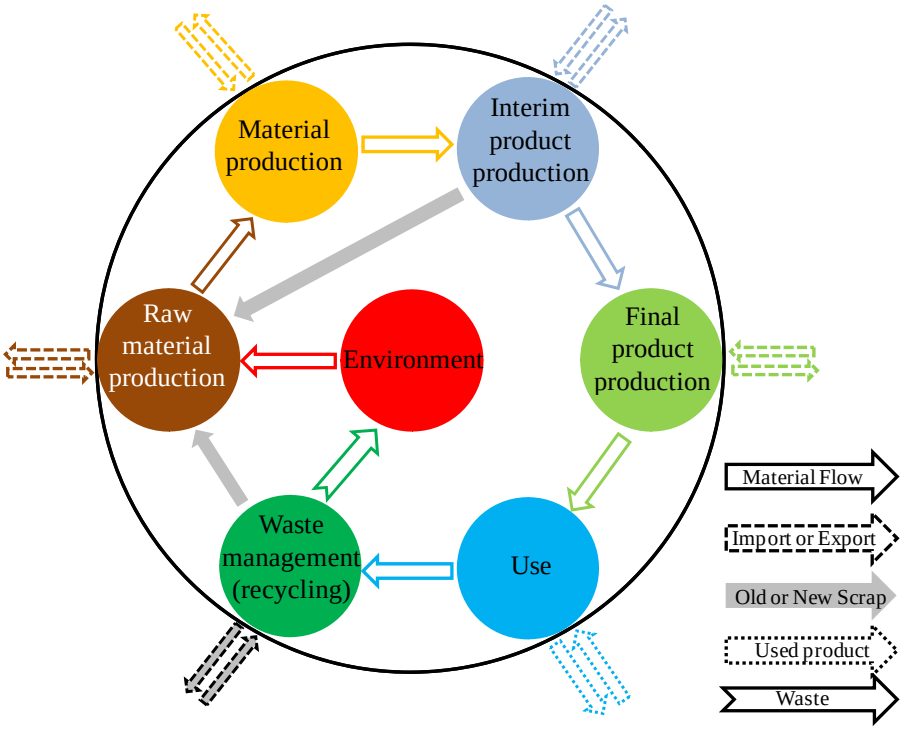



## Resource constraints / supply scenarios

- Identified materials to be covered by this study with review of data availability:
  - Base metals: iron, copper, aluminum, lead, zinc
  - Rare metals: nickel (and indium, lithium and rare earths, as much as possible)
  - Precious metals: gold, platinum (palladium to be considered)
- It was confirmed that existing MFA studies cover all base metals (outside Japan, Yale University's Stocks And Flow project significantly contributes). But the extraction process and the international resource circulation perspective is relatively less studied.
- Preliminary econometric analysis of copper market structure was conducted. It was found that the copper market structure changed around August 2003, and this must be taken into account for the analysis.

# Resource constraints / supply scenarios: Prototype of material flow / stock model (MFSA)

- Base model identifies 6 stages of product life cycle:
  - Raw material prod.
  - Material prod.
  - Interim product prod.
  - Final product prod.
  - Use
  - Waste management
- For several metals, it is necessary to connect respective MFSA at different stages.

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# Case study on domestic resource circulation policies

- Priority policy issues in Asian countries are identified as follows:
  - Institutional flaws: lack of incentives for appropriate waste management and recycling (inappropriate environmental and labour standards)
  - Flaws in industrial infra for 3R: Appropriate resource circulation requires a certain scale of recycling industry with sound financial and technical basis.
  - Informational flaws: Lack of hazardous substances in recyclables may cause significant environmental problems.
- Priority recyclable resources in Asian countries are identified as follows:
  - E-wastes
  - Iron scraps
  - End-of-life vehicle (ELV)
  - Waste plastics



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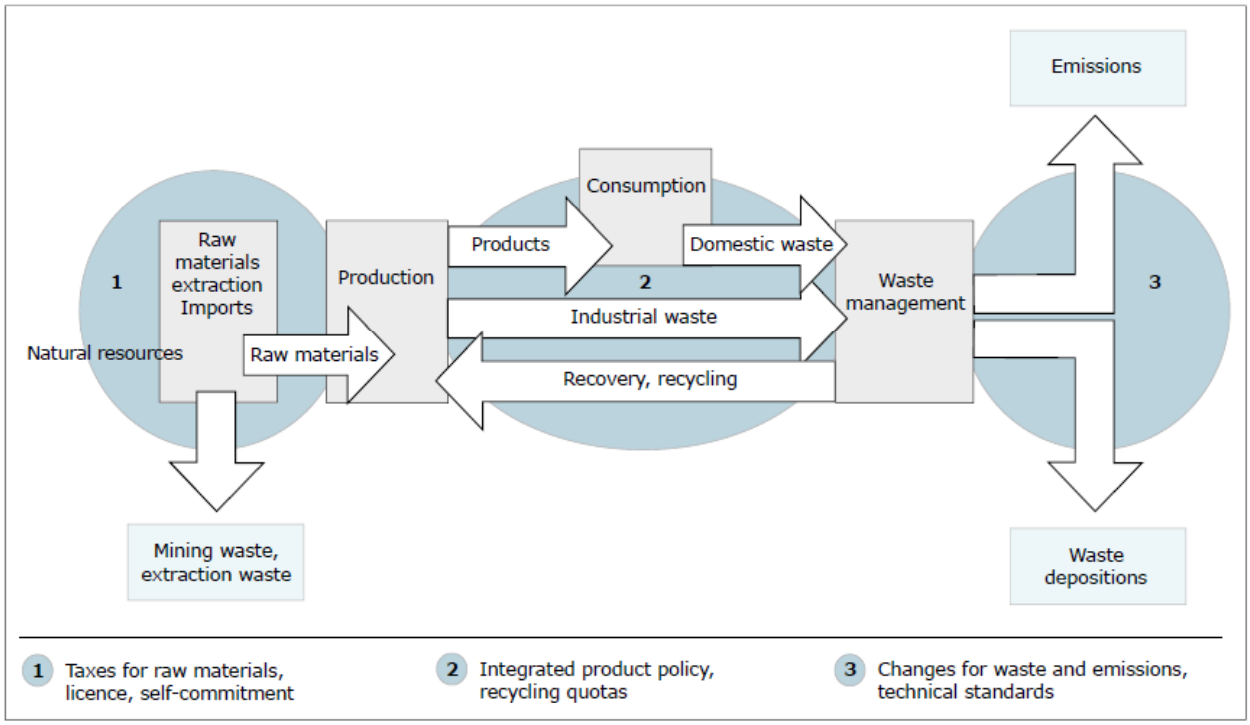
# Case study on domestic resource circulation policies: Classification of policy options based on intervention points




**Source:** Bringezu, 2002.





# Case study on domestic resource circulation policies: Policy options

- Extraction stage
  - Primary resource tax
- Production stage
  - Extended producer responsibility
- Consumption stage
  - Waste segregation and collection
  - Labelling/environmental info disclosure based on LCA, ecological rucksac, etc.
- Waste treatment stage
  - Waste treatment fee charge
  - Landfill tax
  - Landfill ban
  - Subsidy system for recycling industrial clusters

## Regional case study on E-waste

- In order to examine the effectiveness of export ban of E-waste scraps, the export demand functions of major E-waste scraps exporters to China were estimated. Major exporters are Japan, USA, EU, and Hong Kong.
- For the trade statistics of "miscellaneous scraps" (H.S. code 7204.49.900), the following Error Correction Model was estimated.

$$\Delta \ln X_t^i = \alpha_0 + \alpha_1 \Delta \ln Y_t + \alpha_2 \Delta \ln P_t^i + \alpha_3 EC_{t-1}^i + u_t$$

$X_{it}$: Country $i$'s scrap exports to China in period $t$

$Y_t$: Production level of Chinese mining industry in period $t$

$P_{it}$: Relative export price of country $i$ in period $t$

$EC_{it}$: Error correction terms of country $i$ in period $t$

$u_t$: Error terms in period $t$





## Estimation results of scrap export demand functions

| | Japan (n=112) | |
|---|---|---|
| Variable | Coefficient | (Std.Err.) |
| ΔlnPt | 0.022 | -0.049 |
| ΔlnYt | 0.558** | -0.198 |
| ECt-1 | -0.188** | -0.057 |
| Intercept | 0.008 | -0.022 |
| D.W. | 2.270242 | |
| Adj $R^2$ | 0.135 | |

| | EU15 (n=112) | |
|---|---|---|
| Variable | Coefficient | (Std.Err.) |
| ΔlnPt | -0.683** | -0.149 |
| ΔlnYt | 0.946 | -0.617 |
| ECt-1 | -0.236** | -0.062 |
| Intercept | 0.031 | -0.069 |
| D.W. | 2.548088 | |
| Adj $R^2$ | 0.29 | |

| | US (n=112) | |
|---|---|---|
| Variable | Coefficient | (Std.Err.) |
| ΔlnPt | -1.131** | -0.137 |
| ΔlnYt | -0.77 | -0.612 |
| ECt-1 | -0.498** | -0.084 |
| Intercept | 0.054 | -0.068 |
| D.W. | 2.207198 | |
| Adj $R^2$ | 0.4165 | |

| | HK (n=112) | |
|---|---|---|
| Variable | Coefficient | (Std.Err.) |
| ΔlnPt | -0.131† | -0.077 |
| ΔlnYt | 1.243** | -0.272 |
| ECt-1 | -0.277** | -0.068 |
| Intercept | -0.006 | -0.03 |
| D.W. | 0.2842 | |
| Adj $R^2$ | 0.2643 | |

***** Significant at 1% level, ** significant at 5% level, † significant at 5% level**

## Regional case study on E-waste: Implications

- These estimations are based on the data of “miscellaneous scraps” of which proportion of E-waste scrap is not large. This data limitation must be kept in mind.
- The sign of most coefficients are consistent with our expectation. Only the exception is the coefficient of relative export price of Japan and it is statistically insignificant.
- Based on the estimation results, it is possible to estimate the impacts of Japanese policies to control E-waste scrap exports to China and to promote domestic recycling of E-wastes. For example, it is possible to calculate the change of E-waste scrap exports to China as a result of 1% increase of relative price as a result of such policies.
- We plan to improve the estimation results by elaborating the estimation model.



## Integrated policy impact assessment model (IPAM)

- Integrated resource-environment-economy models were reviewed. In particular, GINFORS model (GWS, IIASA and SERI) integrates energy model/material use model/land use with multiregional economic model (I-O model and macro-econometric model) with global database and highly relevant to IPAM.
- We establish a network with SERI. SERI has compiled global resource use database covering the following material groups.
  - Fossil fuels (6 types)
  - Metal ores (37 types)
  - Industrial minerals (49 types)
  - Construction minerals (17 types)
  - Biomass (158 types)
- We made a significant progress in development of multi-regional recursive dynamic CGE and single country full dynamic CGE as a prototype of core economic module of IPAM.

## IPAM: Development of multi-regional recursive dynamic CGE

- As a database for multi-region CGE model,18-region 38-sector global social accounting matrix (SAM) was constructed based on the GTAP database.
- One important shortcoming of GTAP database, i.e. lack of explicit budget constraint of household and government, was overcome by eliminating “regional household” following McDonald and Sonmez (2004).
- Currently calibration of parameters and initial values based on the SAM is undertaking.
- This version employs fixed saving ration to total household income (i.e. fall into Solow-Swan growth model).
- Once this prototype model is ready, we will incorporate energy use and GHG emission data as well as resource use data.
- We will also try to reflect resource scarcity impacts in this model.





## IPAM: Development of single country dynamic CGE

- We also started the development of full dynamic CGE model, with much simpler setting (1 country with 10 industrial sectors).
- This model falls into Ramsey-Cass-Koopmans growth model, but it replaces perfect foresight assumption in expectation formation by imperfect foresight assumption in which households form their expectation for future price paths based solely on current price information. Then, each time step they update their expectation formation with new information.
- This model distinguishes household asset accumulation (which is “value” or money without physical quantity) and private capital accumulation (which is physical quantity and subject to depreciation), which are often treated as identical.
- Currently the BAU simulation was successful, but giving policy shocks such as significant increase in import tariffs caused errors.
- Once this version will be operational, the multi-regional CGE model will converted into full dynamic version.

## Next steps

- Based on the achievements in this fiscal year, overall research plan will be elaborated such that all subcomponents complement each other in order to fulfill the expected goal of this project.
- With elaborated research plan and some preliminary results, we will materialise more collaboration with “Asia Resource Circulation Policy Research”. In particular, our IPAM may complement economic module of NTU’s IEM model.
- In FY2010 we plan to input some preliminary research results into policy processes, including
  - 3R Forum
  - OECD Global Forum on Environment (October 2010)
  - East Asia Summit
  - MOEJ White Paper
  - OECD Environment Outlook (to be published in 2012)



***Thank you for your attention.***

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