Building Resource-circulating Societies in Asia:

Application of Backcasting Approach

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The East Asia region is facing serious environmental pollution and increasing resources consumption problems associated with its rapid economic growth. Under this condition, it is becoming highly imperative to promote resource-circulating societies in Asia. This paper firstly summarizes Japan's approach and strategies towards a sound material cycle/resource-circulating society, and argues some implications to building resource circulating societies in Asia. The paper then introduces "backcasting approach" - an innovative method to direct the society to a sustainable path by envisioning future scenarios, taking the case of promoting resource-circulating societies in the Yangtze River Delta region in China.

Key Words: *Backcasting, Future Scenarios, Material Flow Indicators, Resource-circulation, Sustainability,*

1. Introduction

The Asian region has enjoyed a continuous and rapid economic growth in the last decades and is now a key player in the global economy. Although this rapid economic growth has helped many people escape from poverty, it has brought over-consumption of resources, environmental degradation and urban-rural socio-economic gaps among other consequences (Morioka and Yabar, 2007). Shen et al (2005), for instance, analyzed the relationships between urbanization and the supply and demand of major energy and mineral resources for China, and concluded that China would face a great shortage of resources if future urbanization is faster than predicted. Based on these trends, it is now an urgent challenge to envision sound resource-circulating societies in order to cope with the increasing and inefficient resource consumption and the associated environmental loads. In addition to the

environmental aspect, it is also imperative to take into account the societal aspects, such as the widening socio-economic gap between and within countries.

This paper firstly summarizes Japan's approaches towards building a sound material-cycle/resource-circulating society and proposes measures to promote resource-circulating societies in Asia. The paper then introduces an innovative method - future scenario writing in the context of backcasting approach - in order to direct the society towards a resource-circulating society. Finally the method is applied to the case of the Yangtze River Delta region in China.

2. Japan's Approach towards Resource Circulating Society

2.1 From Sanitary treatment to integrated resource management

Japan passed through various stages in addressing its environmental issues. From the mid 50's to the late 70's, Japan experienced a rapid economic growth which led to drastic changes in lifestyles. The higher incomes led to mass consumption of electric home appliances especially televisions, refrigerators and washing machines. Most of the industrial waste was difficult to treat and exceeded the treatment capacity of the municipal facilities (Ministry of Environment, Japan, 2006). In the decade of the 80's, the Japanese economy continued its expansion and the change in lifestyle again was one of the major causes of the increase in volume and change in the nature of waste. Consumers started to demand diversity in products which specially increased the production of plastic containers and wrapping materials in small volumes. Under such transition of periods of the late 20th century, the targets of Japan's solid waste management have changed in the following manner.

1) Landfill of most of the wastes in large cities in the 50's and 60's
2) Promotion of the incineration for most of the domestic wastes in the 70's and 80's
3) Abandonment of small size and batch-type incineration facilities due to the emission of "dioxin" in the 90's
4) Promotion of Reduce, Reuse, and Recycling measures with a series of laws from the second half of the 90's

Japan has put special emphasis on waste volume reduction by means of incineration to reduce the pressure on landfill. However the problems deriving from the End of Life (EOL) approach arose including the human health impact due to toxic emissions, the increase in total waste generation especially from domestic sources and the continuous input of commodities into the economy to fulfill people's demand. In order to address these issues, the government designed two key strategies towards a sound material-cycle society: a) Technology innovations to address environmental risks and b) Integral policies to decouple economic growth from environmental loads.

2.1.1 Technology innovations to address environmental risk: Dioxin problem

When the Japanese government introduced the waste management and public cleansing law in 1970, it aimed at the public health protection by promoting waste treatment technologies with high capacities, such as incineration. Incineration was important because of its function to reduce waste

volume and destruct organic toxic parts. In the early 90's the health concerns due to dioxin emissions from plastic burning started to grow. Many research studies concluded that dioxin emissions were higher in batch-type and low combustion temperature's incinerators (Bagnati et al., 1990; Moyeda et al., 1990; Ohta et al., 1997). In order to drastically reduce the dioxin emissions, together with policies that promoted the recycling of plastic wastes, the government enacted the Law Concerning Special Measures against Dioxin in 1999. The law established the target to reduce dioxin emissions by 90% by the year 2003 based on 1997 emissions and introduced the following measures:

• Regulation of emissions by monitoring the effects on health and the environment;

• Establishment of standards based on the World Health Organization for tolerable daily intake;

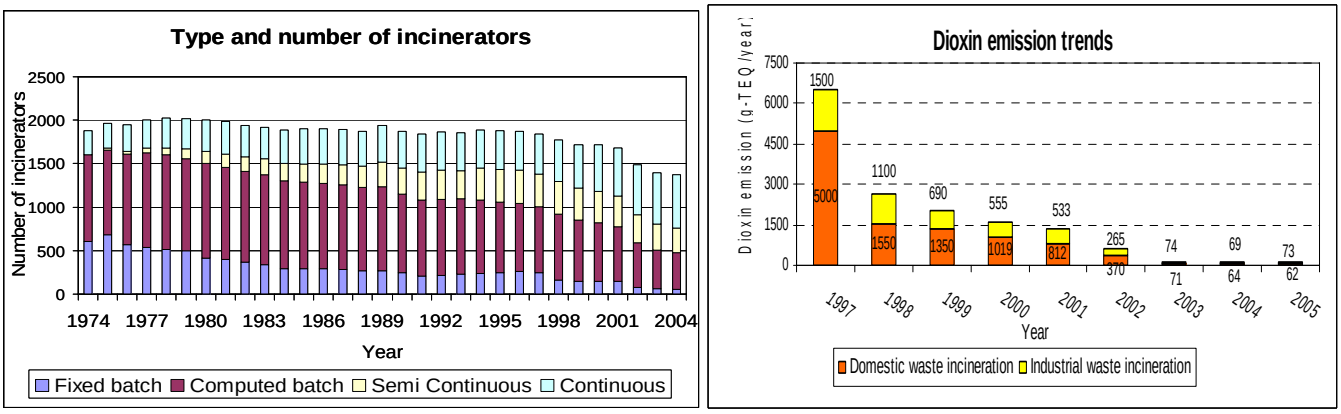
• Promotion of waste generation prevention and recycling.

The law proved to be very effective in terms of dioxin emission reduction by phasing out the old, small scale and batch incinerators while promoting the introduction of high efficient, continuous and large scale incinerators as can be observed in **Fig.1**

2.1.2 Integral policies to decouple economic growth from environmental pressure

To promote wiser use of resources and minimize the environmental impacts of consumption, Japan started to introduce specific laws based on the 3R (Reduce, Reuse, Recycle) principles. Among others, such laws include the Law for Promotion of Utilization of Recycled Resources (1991); the Containers and Packaging Recycling Law (1995); the Home Appliance Recycling Law (1998); the Basic Law for Promoting the Creation of a Recycling-Oriented Society (2000), the Law for Promotion of Effective Utilization of Resources (2000), the Construction Materials Recycling Law (2000), the Green Purchasing Law (2000), the Food Recycling Law (2000); and the End-of-Life (EOL) Vehicles Recycling Law (2002) (**Fig. 2**).

With these initiatives, there have been significant improvements in the increasing of recycling levels and reducing final disposal wastes for both industrial and domestic sources. In the period 1996-2005, for instance, the aluminum can recycling has increased from 70.2 % to 91.7%, steel can recycling from 77.3% to 88.7%, PET bottle from 2.9% to 47.3%, and paper from 18.5% to 24.6% (Ministry of Japan, 2007).



Data source: Ministry of Environment of Japan http://www.env.go.jp/doc/toukei/contents/index.html

Fig. 1 Impact of the incinerator type on dioxin emissions in Japan

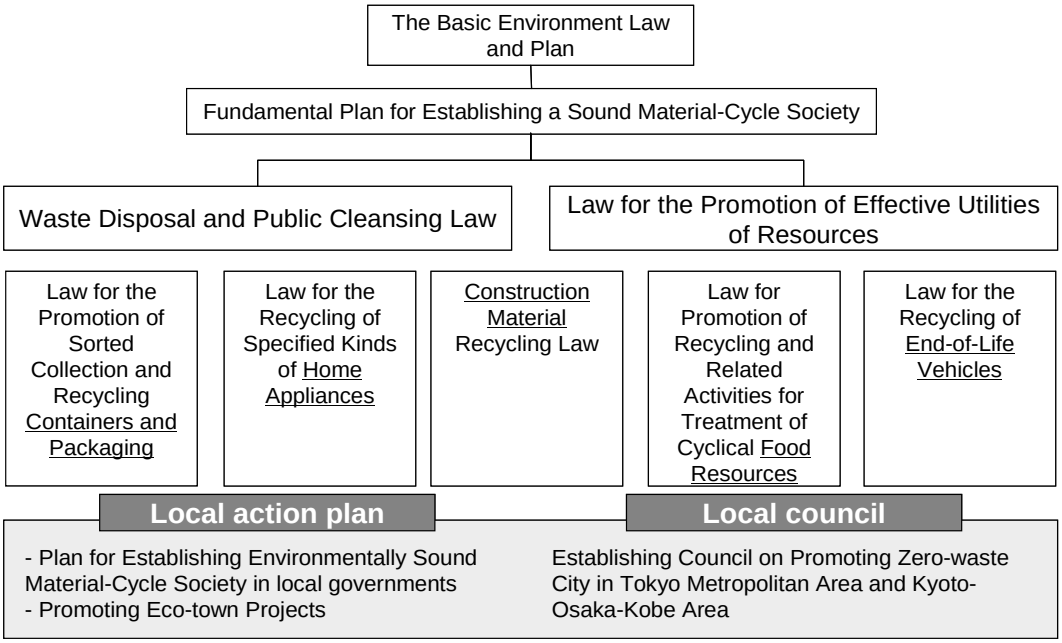


Fig 2. Framework of laws related a Sound material cycle society in Japan

The "Fundamental Law for Establishing a Sound Material-Cycle Society" (2000) introduced the basic principles towards a sustainable and resource-circulating society in Japan. This law set a foundation of a recycling oriented society that aims to minimize the environmental impacts of human activities while streamlining the use of natural resources by promoting waste reduction, reuse of recycled resources and appropriate disposal (Morioka and Yabar, 2007). In the following section, some specific strategies taken for resource-circulating society in Japan are briefly summarized.

2.2 Japan's strategies towards resources circulating society

2.2.1 Action plans for developing a global zero-waste society

Sustainable urban metabolism strategies aim at decoupling economic growth from environmental degradation at the firm, local, nation-wide, regional and global scales. The Japan's Action Plan for Developing Global Zero Waste Society through 3R initiative is an important starting point for a steady decoupling of economic growth from environmental pressure at the local, nation-wide and Asian level. Japan's 3R plan has three main strategies: 1) achieving zero-waste society by means of the fundamental plan towards a sound-material-cycle society, 2) supporting the developing nations' initiatives towards zero-waste societies with capacity building and 3) international cooperation. The plan emphasizes the promotion of 3R initiatives at all levels, targeting reduction of barriers to the international flow of goods and services, cooperation among developed and developing nations and promotion of Science and Technology suitable for 3R.

2.2.2 Indicators based on Material Flow Accounting

In order to change the production and consumption patterns towards sustainable ones, the Japanese

government formulated the “Basic Plan for Establishing a Recycling-based Society” in 2003 which introduced three macro indicators derived from physical material flow accounting. The aim of the plan is to promote comprehensive policies towards a sound material-cycle society. More specifically, the plan set a target for indicators that represent the three aspects of the material flows in our society. They are “Resource input (resource productivity)”, “Material circulation (recycling rate)” and “Waste output (final disposal)” indicators. The three indicators with quantitative targets for the period 2000–2010 are the following:

1) ***Resource input***: Resource Productivity in terms of Direct Material Input (DMI) (40% improvement of GDP/DMI from 280,000 yen/ton to 390,000 yen/ton)
2) ***Material circulation ratio***: recycling rate (40% improvement: from 10% to 14%)
3) ***Waste output***: Final Waste Disposal in landfill (50% decrease: from 56 million ton/year to 28 million ton/year).

Whereas the material circulation ratio and final disposal waste indicators are somehow related to the conventional view of integral waste management and recycling, the input indicator reflects a comprehensive view of the relationship between economic activities and resources use i.e., the decoupling of economic growth from environmental degradation (Morioka and Yabar, 2007). The three indicators have been showing positive trends towards achieving the target values (**Fig. 3**).

2.2.3 Integrated Product and process policy

Improving efficiency in the production process through resource use optimisation became a major task after the oil crises in the 1970 and 1980 in Japan. From the 1990 the environmental concerns were transformed into opportunities to develop markets based on improved eco-efficiency performance, dissemination of green products by means of integrated product policy. These product and process

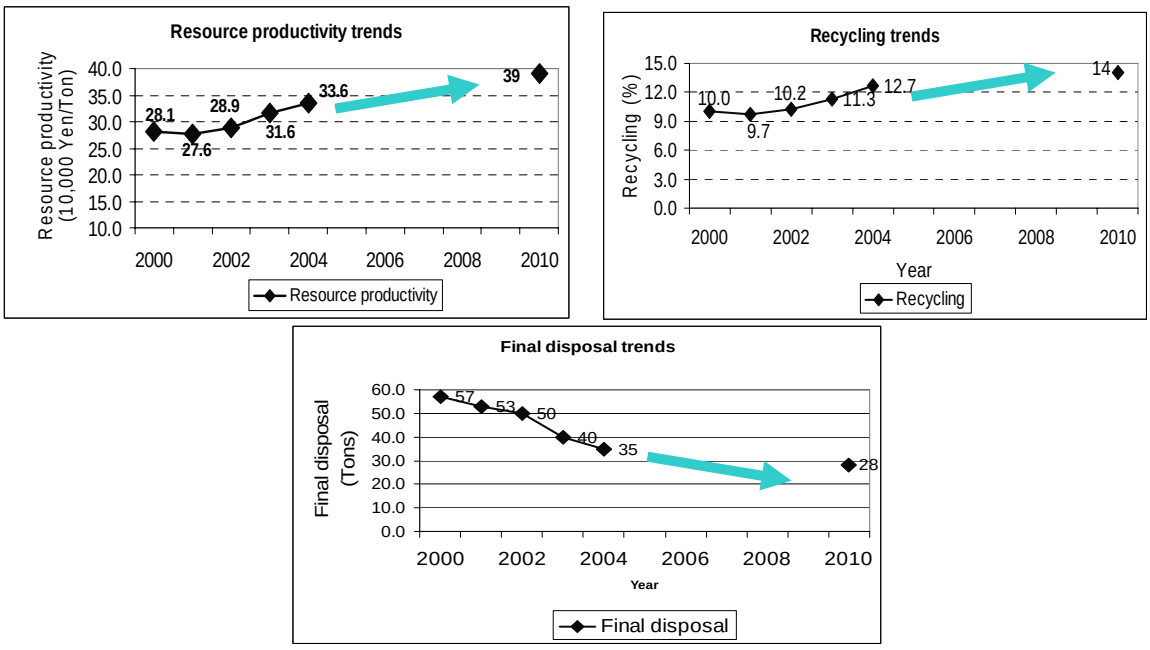


Fig. 3 Japanese integral policy indicators based on Material Flow Analysis

Data source: Ministry of Environment of Japan, http://www.env.go.jp/doc/toukei/contents/index.html

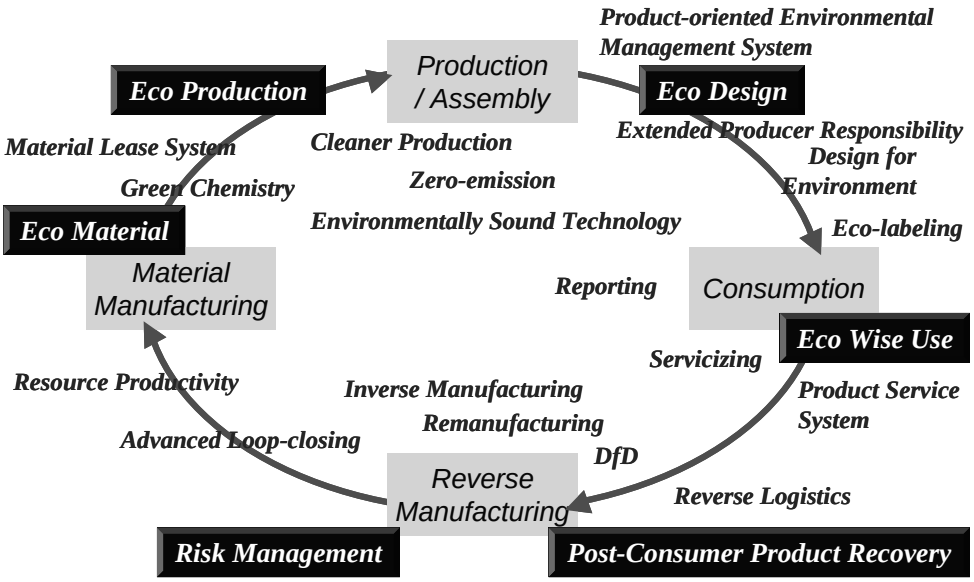


Fig. 4 Concept of integrated product and process policies

innovations included Design for Environment (DfE), Design for Disassembly (DfD), and energy-efficient equipments. Environment-conscious producers revealed the benefits of their products through Eco-labelling and other communication means, while governmental bodies promoted green market development through green procurement. Finally, in the fourth stage of the social evolution, the challenge is to achieve a system innovation: large-scale transformations in the way societal functions, such as transportation and communication, are fulfilled. Japan is now in a stage where the environmental concerns have been transformed into opportunities to develop markets based on improved eco-efficiency performance and dissemination of 'green' products through integrated supply management (Morioka and Yabar, 2007). In order to raise the eco-efficiency and resource productivity of the total material-product chains, it is essential to address all the stages of the product chain management: resources input, product design/manufacture, consumption, and recycling (**Fig. 4**).

2.2.4 Practical Implementation at local scale: Eco-towns

'Eco-town' initiatives have been promoted with governmental supports as an important practice by applying the practices and concept of industrial ecology. These projects started with the learning from Eco-Industrial Park (EIP) experiences such as Chattanooga in USA and Kalundborg in Denmark and their efforts to promote the resources circulation in industrial areas. The Eco-town projects in Japan can be defined as regional scale initiatives aiming at a full range of effective utilization resource circulation of by-products. Currently there are 26 eco-town projects approved by the government in Japan. For example, *Kitakyushu* plan includes comprehensive management of EOL resources, such as PET bottles, home appliances, Office Automation (OA) equipments, EOL automobiles. Some eco-towns also deal with biomass resources while other towns focus on the development and

promotion of advanced technologies, such as gasification plants to produce industrial chemical products from EOL resources.

3 Perspectives for Building Resource-Circulating Societies in Asia

The Japanese economy is already showing signs of absolute decoupling in the case of wastes generation. As shown in **Fig. 5,** in the period 1992-2004 the total amount of municipal waste generation has only increased 3.38% and the per capita industrial waste generation has been almost stable at around 3.2 ton/person while the GDP per capita has increased 12% (World Bank, 2006). In the same period the industrial waste recycling level has increased from 40% to 52.3% of the total wastes and the final disposal waste has decreased 242%.

The concept of sound material-cycle society or resource circulating society should be expanded to include the scope of Asia. Indeed, the region-wide commodity trades between Asian nations are growing rapidly. Measures to streamline the development of resource circulating society in Asia include, but not limited to:

- Overcoming barriers to promote a smooth trans-boundary movements of EOL products;

  To this end, it is important to design an international policy framework to promote the trade of these EOL resources. It is also imperative to incorporate the concept of EPR (Extended Producers Responsibility). It is highly important to prevent possible environmental pollution associated with the trans-boundary recycling.
- Developing consistent and applicable devices to measure, record and report material/resources and products flows through the regional accounting system;
- Building regional resources recovery centers in the form of Eco-Industrial Parks (EIP) or special development zones in order to stimulate the area-wide resources circulation with minimized environmental impacts by means of the cutting-edge industrial recycle practices;
- Including natural resources, such as water and land, into the judgment criteria for evaluating the resources-circulation practices;

  China is currently promoting the concept of “Circular-economy”, which incorporates the circulation and efficient use of natural resources such as water and land, apart from the conventional type of resource circulation, mainly targeting products reuse and recycling.
- Facilitating policy initiatives in order to encourage the private sectors to transform their industrial

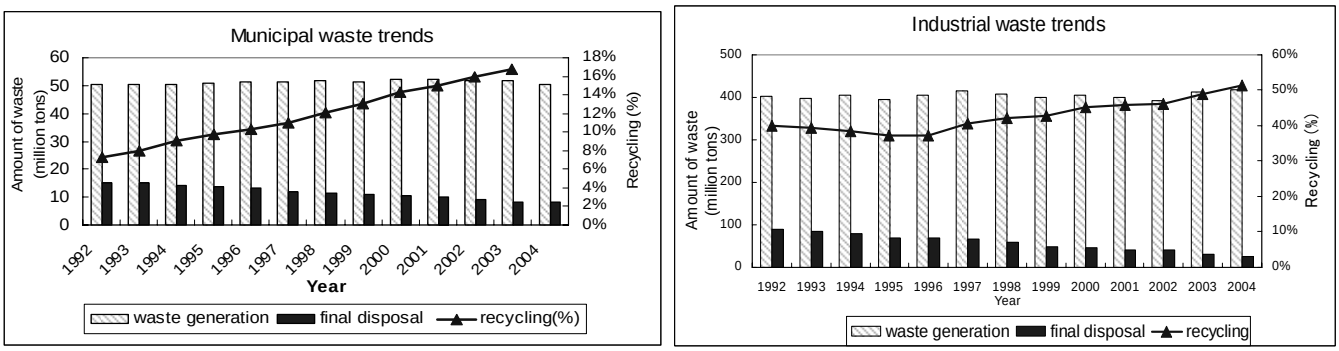


Fig.5 Recent trend in waste generation, recycling ratio and the amount of wastes in landfill

Data source: Ministry of Environment of Japan http://www.env.go.jp/doc/toukei/contents/index.html

processes into zero-emission or waste-minimization practices;

- Promoting regional resource circulation in the context of urban-rural linkage;

  Attention should be paid to proceed with effective urban-rural linkages for the recovery, transportation and utilization of various resources existing in the region and to facilitate regional resource-circulating practices.

4. Backasting Approach and Future Scenario Design

4.1 Scenarios in the context of resource-circulating society

Visioning a sustainable resource-circulating society in the context of the backcasting approach is an innovative method to shift the society to a desirable and sustainable one in the future. Morioka et al (2006) summarized various international scenario studies in terms of five global challenges: climate change, depletion of energy resources, degradation of ecosystem services, over-consumption of non-renewable resources and decoupling of industrialization from environmental pressure.

The future scenario approach is applied to such fields as climate change. For example, "Japan Low Carbon Society Scenarios towards 2050" is among such research projects that introduced the method of future scenario. There are studies on climate change that uses future scenario approach. The Intergovernmental Panel on Climate Change (IPCC) emission scenario is among the well known scenarios. The studies on climate change employing the future scenario approach basically focuses on the carbon cycle and the greenhouse effect. However, such studies as ecosystem services, which were envisioned in the Millennium Assessment (MA), and development of resource-circulating society, have difficulties in employing the future scenario approach. This is simply because that setting clear and integrated targets, such as reduction of CO_2 emission in a quantitative manner, which is usually employed in the study on climate change, is difficult in the other study areas. In fact, very few studies so far have been carried out and reported specifically in the field of promoting a resource-circulating society (Hara et al., 2007). Only similar fields like studies on sustainable resources management are now under development.

Most of the research literature has focused on the analysis of past developments and current trends of material consumption and resource productivity based on the Material Flow Analysis (MFA) approach (Moll et al., 2005). Some studies have also proposed policy frameworks for sustainable resource management. Bringezu (2006), for instance, proposed a generic policy approach that focuses on increased resource efficiency and reduced use of all primary resources. The EU project called MOSUS (Modeling Opportunities and limits for restructuring Europe towards sustainability) actually designed an economic-energy-resource model that simulates development scenarios for Europe until 2020 and evaluates the impacts of the policy measures on both the economic and environmental indicators (Sustainable Europe Research Institute, 2007). The project develops three scenarios: 1) the baseline scenario in which projections of further trends observed in the last 25 years are made and no particular policy strategies are encouraged, 2) weak sustainability scenario which reflects policy goals and measures from key documents of the EU and 3) strong sustainability scenario which includes

more ambitious policy goals, based on the scientific literature (Sustainable Europe Research Institute, 2004)

The main task for developing backcasting and future scenario approach applicable to building resource-circulating societies is to set up a model which could evaluate the effectiveness of policy interventions, based on such factors as "Constraints" for individual variables including energy, relevant materials, land use, water, and "Driving forces" including economic development, population growth, and technology development. A framework where the future scenarios are formed is proposed in this chapter and is applied to the case of the Yangtze River Delta region.

4.2 Yangtze River Delta: A key region for sustainability in China

The Yangtze River Delta region can be considered as a key area for promoting a sustainable resource-circulating society. The region comprises 16 cities of the triangular-shaped territory of Shanghai city, southern Jiangsu province and northern Zhejiang province of China and it is one of the fastest growing regions in China and tremendous land use change has occurred (Long et al., 2005). The followings explain the unique and important positioning of the region as a key area in order to develop the resource circulating society and critical points to be taken into account in realizing such a society.

- The area serves as a driving force of China's rapid and viable economic development. The proportion of gross production outputs of the secondary and tertiary industry in the area, compared with the whole country, accounts for 22 % and 30% respectively in 2004 (Chinese Statistical Bureau, 2005). Economic condition and performances of steel and cement industries in the region are summarized in **Fig 7** and **8,** showing that the product outputs have been increasing particularly in Zhejiang and Jiangsu regions.
- Expansion of floor space areas of buildings in urban areas would tremendously contribute to the increase in environmental loads. According to Chinese Statistical Bureau (2005), the floor spaces of buildings within the region accounts for 17. 5 % of the nationwide, although the land area of the region constitutes only 1.1 % of the total land areas in China. If the trend of urbanization further intensifies, then the associated environmental loads will be exacerbated.

These points mentioned above supports the important position of the Yangtze River Delta as a key region in developing a resource-circulating society, thereby a sustainable society. The shift to such a society should be driven by an innovative method of future scenario writing and roadmap setting.

4.3 Application to the Yangtze River Delta region

4.3.1 Framework to envision the scenarios

In this study, we envision three systems; "urban system," "industrial systems," and "biological ecosystem," as the dimension upon which the future scenarios for resource-circulating society are formed. The future scenario is framed through visioning possible or desirable directions of each

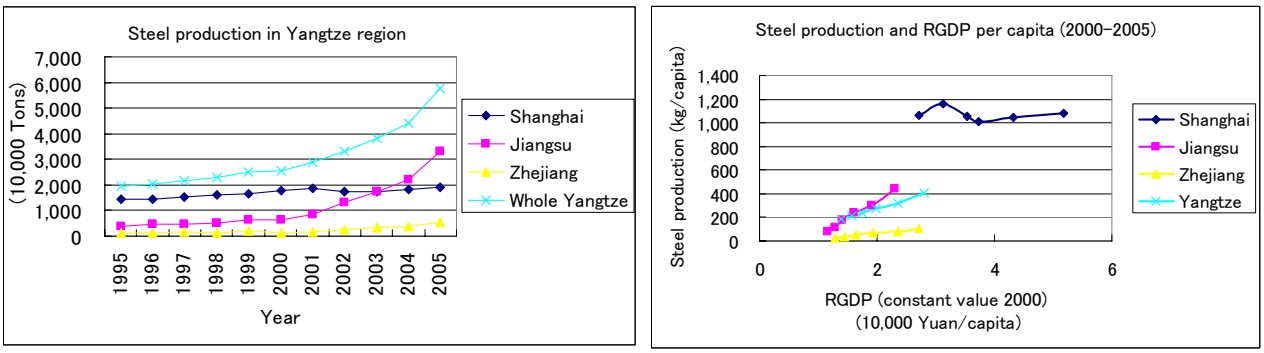


Fig. 7 Economic development and steel production in the region

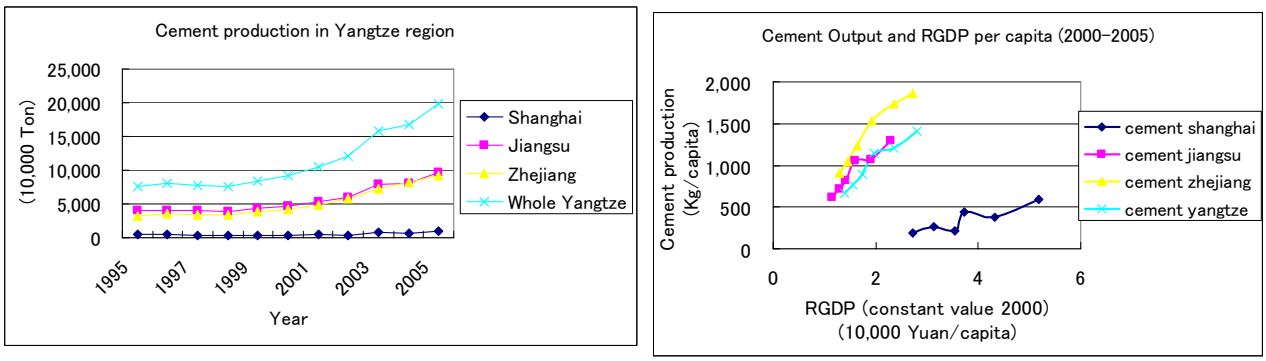


Fig. 8 Economic development and cement production in the region

Data source: National Bureau of Statistics of China

individual system and their interactions within the study area. The biological ecosystem focuses on water and land management for land and production systems. The urban system addresses human settlement, mobility, construction and the consequent environmental degradation. And the industrial system stresses the importance of material processing and recycling. Each system of some targeted areas in the Yangtze River Delta is studies.

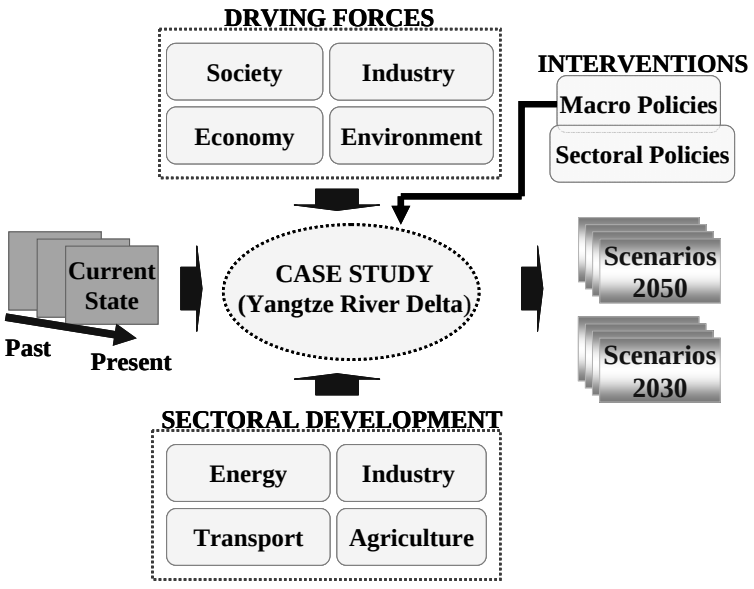


Fig. 9 Proposed framework to form future scenarios

Fig. 9 shows an example of the framework for forming the future scenarios employed in the study. Driving forces in terms of society, industry, economy and environmental aspects are examined quantitatively and qualitatively. A series of meetings, attended by the experts involved in this study, are set up to discuss the appropriate driving sources, which is among the most important factors in constructing the scenarios. The main driving forces selected in the study that will

Table 1 Examples of scenarios envisioned through the combinations of three systems

	Urban system	Industrial system	Ecological system
Scenario (1)	Frequent renewal of urban centers /suburb development	Manufacturing industry stress on exports	Organic circulation based on large-scale plantation type agriculture
Scenario (2)	Environment-conscious lifestyle, modern eco-cities, service society	Acceptable level of industrial transformation, EPR	Appropriate level of organic agriculture, sound urban-rural interrelationship
Scenario (3)	Preservation of historical towns and heritage,	Craftsmanship, emphasis on sophisticated craft skills	Preservation of ecosystems and natural cycles
Scenario (4)	Integrated service-based consumption	Green industry, integral eco-efficiency	Urban-rural symbiosis

possibly shape the future of the Yangtze Delta include population increase, economic growth, land use change which can be represented by the increase in floor space areas, environmental loads represented by air pollution such as SO2 emission, and technological development represented by, for example, energy efficiency in the steel and cement industries. For each item, qualitative and qualitative predictions, with some range of high, middle and low growth, are examined.

In the case of China, sectoral development is already supported by policies and, thus, this has to be taken into considerations when designing the scenarios. At the same time, both macro and sectoral policies are important in the sense that they provide the intervention means to achieve the desired socio-economic and environmental changes. These policies are investigated and reflected in envisioning scenarios.

4.3.2 Envisioned scenarios

Following the framework proposed, together with the expert meetings, the project is now developing the possible scenarios in the context of resource circulating society in the region. As an example, four principal scenarios are shown in a descriptive manner in **Table 1**.

Scenario 1 outlines the modern industrialized system with economic efficiency. This system is characterized by export-oriented production, organic materials recovery in large-scale plantations, rapid renewal of urban center and suburbs development, mass production and consumption, and material recycling in industrialized world by using high-technologies with low emissions. Scenario 2 shows an acceptable level of industrial transformation. This system is characterized by an appropriate-scale and organic agriculture and promotion of urban-rural interrelationship; environment-conscious life-styles and modern eco-cities in an urban stable development; and service systems through product reuse and lease, in parallel with extended producer responsibility (EPR) and green product chain management. Scenario 3 addresses the deep ecology perspectives. The system is characterized by preserved ecosystems, natural cycles, and tranquility; preservation of historical towns, heritages, and classic comfort; and craftsmanship: promotion of sophisticated craft skills. Scenario 4 identifies a harmonious balance of the three systems i.e. industrialization that respects the

environment with the participation of both urban-rural areas. This scenario needs strong relationship and collaboration between consumers who demand environmentally friendly products and services and producers who fulfill the increasing demand.

The method of envisioning the future scenario is still under development. Particularly, the specific and quantitative targets that would address the concept of "resource-circulation", which is indeed possible, for example, in the case of climate change, are of vital importance in the course of development of the study. With more detailed data and information to be obtained in the Yangtze River Delta region, we aim to further grow the methodologies in order to make the scenarios more practical. Additionally, roadmap settings, based on the envisioned future scenarios, shall be considered in due course.

5. Conclusions

This paper reviewed Japan's approach towards resource-circulating society and provided suggestions and some implications to achieving Asian resource-circulation society. It also introduced a framework of future scenario writing by showing an example of case study in Yangtze River Delta region. For a future study, further detailed analysis of the case study in the Yangtze Delta area shall be carried out, with a refined quantification of such factors as driving forces and sectoral developments. Also, possible roadmaps including the technologies and policy options that would allow to filling the gaps between current status and the envisioned scenarios should be drawn as well. Equally important is to develop the assessment methods that could be applied to the research on resource-circulating society. Appropriate selection of indicators and assessment using the multi-dimension indicators selected shall help to judge the proposed scenarios in a quantitative and qualitative manner and assess whether society is moving toward the envisioned futures.

Given the rapid economic growth and integration of Asian nations at all levels, it is urgent as well as essential to promote the research on sustainable resource-circulating society and put it into practices. For this purpose, backcasting approach shall play important role in envisioning such society and directing the society. Further study is needed to develop this method applicable to the resource-circulation debates.

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