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Highlights

Resources, Conservation and Recycling xx (2012) xxx–xxx

Comparative assessment of the co-evolution of environmental indicator systems in Japan and China

Helmut Yabar*, Keishiro Hara, Michinori Uwasu

► The lack of natural resources and space for waste disposal has resulted in Japanese policy focusing on resource management. ► China's economic growth has relied on coal as primary energy source and small-scale industry for production. ► China's environmental policy has focused on decoupling economic growth from energy consumption. ► Environmental indicator systems and policies are important but they need to be comprehensive.

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Comparative assessment of the co-evolution of environmental indicator systems in Japan and China

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ABSTRACT

This paper analyzes the evolution of environmental policies and the related indicator systems that have been introduced in both Japan and China. The findings reveal that the lack of both natural resources and space for the final disposal of wastes, resulted in Japanese policy placing special emphasis on, initially, waste treatment technologies with high capacities such as incineration, and more recently, on integrated resource management. This trend is also reflected in the recycling targets for specific waste policies proposed in the 1990s and the introduction of comprehensive resource management indicators in the early 2000s. In China, the impressive economic growth of the last decades has relied both on coal as the primary energy source and mostly small scale industries for production. However, the environmental impacts and low energy efficiency associated with both coal-power plants and small-scale industry forced the government to introduce emission reduction targets followed by energy efficiency and macro energy intensity indicators. While the importance of indicator systems and policies has been demonstrated for specific cases, such policies are not yet comprehensive. This is reflected by the finding that while Japan has improved both its resource productivity and reduced total direct material inputs into the economy, overall CO_2 emissions and waste generation have increased. China also suffered a setback when its overall energy intensity started to increase in 2000 after 20 years of improvement. This study argues that a comprehensive sustainability policy is necessary in order to overcome the problems associated with production and consumption patterns and their impact on the environment. In this sense it is important to consider the different comprehensive assessment methods proposed by the scientific community in the policy making process. Finally the paper proposes that the experience of Japan and China in dealing with environmental issues could be an important reference for policy development in Asia.

1. Introduction

Decoupling economic growth from increased environmental pressure in order to keep resource utilization within the limits of the earth's carrying capacity is probably one of the greatest challenges of our time. If we consider extant socio-economic disparities, both between and within countries, the challenge becomes even more complicated. In recent decades, Asian countries have enjoyed a sustained period of rapid economic growth. However, this economic growth has been accompanied by extensive and inefficient use of natural resources, environmental degradation, and urban–rural socio-economic disparities.

The role of indicators in environmental protection and management has been stressed in many scientific studies (see Hammond et al., 1995; Jackson et al., 2000; Cloquell-Ballester et al., 2006). Indeed environmental indicators not only track the success or failure of policies on protecting the environment but also engage public participation. Moreover environmental indicators may also help policy makers in the decision-making as well as in the monitoring and evaluation processes (OECD, 1999).

This paper analyzes the evolution of environmental policies and the related indicator systems that have been introduced in both Japan and China, and discusses the role and effectiveness of indicator systems in dealing with environmental problems. We hypothesize that in both countries the introduction of environmental indicators may have had a positive impact in addressing their environmental problems. In Japan, for instance, the introduction of specific solid waste management and material flow analysis (MFA) based indicators possibly helped the country increase significantly its recycling levels and at the same time reduce the amount of final disposal waste (Yabar et al., 2010). In addition these indicators may have also had a positive impact on the development of

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technological innovations (Yabar et al., 2008). China also experienced some success in tackling its environmental problems, especially air and water pollution, since the introduction of the *Environmental Protection Law* in 1989 (Yabar et al., 2009). The concerns for environment protection are also shown in the five year plans as well as in the introduction of stricter environmental regulations (Alford et al., 2002).

The paper also argues that the indicators introduced in both countries still lack a comprehensive approach to tackle sustainability issues. Indeed, although Japan has improved its resource productivity and reduced the total direct material input into the economy, overall CO_2 emissions have increased (MOE, 2009). China has also suffered setbacks as its overall energy intensity increased in the 2000s after having shown an improvement over the preceding 20 years. Thus, a comprehensive sustainability policy must be implemented to better clarify our production and consumption patterns and their impact on the environment. In this sense the paper also analyzes some of the sustainability initiatives currently proposed in Asia. Finally, this study proposes that the experience of Japan and China in dealing with environmental issues could be used as an important reference for policy development in Asia and regional efforts such as the Asia 3R (reduce, reuse and recycle) initiative must be encouraged.

2. Environmental policy in Japan: historical development

Japan experienced rapid rural–urban migration during the post-war period. As a consequence of the rapid urbanization and industrialization, the cities began generating increasing amounts of urban waste. To address this issue, the government introduced the "*Public Cleansing Law*" in 1954 (Tanaka, 2007). The law provided for the proper treatment and disposal of wastes by means of incineration, disposal at home and the use of landfills (MOE, 2002). The rapid economic growth of the 1960s led to significant lifestyle changes, which in turn translated into further increases in waste generation. Not only had the waste generation exceeded the local governments forecasts (MOE, 2006), but higher living standards also led to mass consumption of relatively new products such as electrical home appliances. The lack of proper treatment and disposal systems for the newly generated wastes prompted widespread illegal dumping of wastes in the mountainous areas.

The severe industrial pollution that arose during this period also became a social concern. A variety of pollution-related diseases emerged, including Minamata disease (mercury poisoning) and Yokkaichi Asthma (airborne sulfur dioxide pollution) (MOE, 2005). In response to this situation the government promulgated the "*Waste Management and Public Cleansing Law*" in 1970 which forms the pillar of the current resource conservation policies in Japan. For the first time, the law placed the responsibility for the management of industrial wastes on the generators, which meant that local governments could deal with municipal wastes. The Law was amended in 1971, setting stricter standards on the disposal of hazardous materials.

The 1980s also witnessed impressive economic growth which translated into further lifestyle changes. Consumer demand for diversity in daily items, such as food products, boosted the production of materials such as plastic containers and packaging materials in small volumes. In 1980s and 1990s concerns over the environment intensified in many parts of the world. The Basic Environmental Law of 1993 addressed environmental degradation on a global scale. The environmental plan of 1994 introduced the long-term goals of the policy as consisting of circulation of resources, harmonious coexistence, participation of society, and international efforts (GETPC, 2003). The plan also outlined the necessity to incorporate comprehensive indicators in the monitoring of the long-term goals. Along with the environmental plan of 1994 and based on the 3R (reduce, reuse and recycle) principle, the government introduced the *Law for Promotion of Utilization of Recyclables* in 1991. Subsequently, the government enacted specific laws promoting more judicious use of resources, including the *Containers and Packaging Recycling Law* (1995); the *Home Appliance Recycling Law* (1998); the *Construction Materials Recycling Law* (2000), the *Food Recycling Law* (2000), and the *End-of-Life Vehicles Recycling Law* (2002) (METI, 2004a). In the year 2000, the government introduced the *Fundamental Law for Establishing a Sound Material-Cycle Society* which established the foundations for the move towards a sustainable society (Morioka et al., 2005). The law aimed at integrating resource management through optimizing resource utilization and minimizing environmental impacts. To achieve the aims of the law the government proposed a "Fundamental Plan for Establishing a Sound Material-Cycle Society" in 2003 (MOE, 2003). The Plan was first to introduce quantitative indicators based on material flow accounts. These indicators not only focused on improving overall recycling levels and final waste disposal, but they also targeted upstream flow through improving resource productivity.

3. Indicators in Japanese environmental policy

Japan has essentially tackled its environmental issues in three stages: the policies of the post-war which focused on public sanitation, the responsive measures of the 1960s and 1970s which introduced waste classification and standards for waste disposal, and the constructive policies of the 1980s and 1990s which are based on the 3R principle. These policies have evolved further, and the targets and indicators that were based on the waste recycling targets of the 1990s, have been developed into the current range of comprehensive indicator systems.

3.1. Specific targets for waste recycling

The Law for Promotion of Effective Utilization of Resources of 2001, henceforth called the Law, which is based on the *Law for Promotion of Utilization of Recyclables* of 1991, aimed at establishing a sound material-cycle economic system as follows (METI, 2001):

- Increasing recycling levels of specific wastes through the implementation of collection and recycling systems.
- Encourage waste minimization through the promotion of resource saving and implementing measures to extend product life.
- Implement measures to promote the reuse of parts and the use of guidelines for industrial waste reduction.

Fig. 1 shows the specific laws and regulations and their relationship with the waste stream from both municipal and industrial sources.

Based on the Law, the government identified targets for recycling specific wastes, including containers and packaging, home appliances, construction materials, food, and end-of-life vehicles. The Law also set waste reduction targets for specific industries, including iron and steel, paper and pulp, chemicals, non-ferrous metals, electricity, automobiles, and electronic devices. Table 1 summarizes the guidelines for both specific items and those from the industrial sector. The target setting for specific wastes in Japanese policies have been important in the sense that these regulations have pushed the design of technological innovations to meet recycling targets. Furthermore these regulations may have also promoted innovation at the product design phase since the manufacturing industry realized that designing easier-to-recycle

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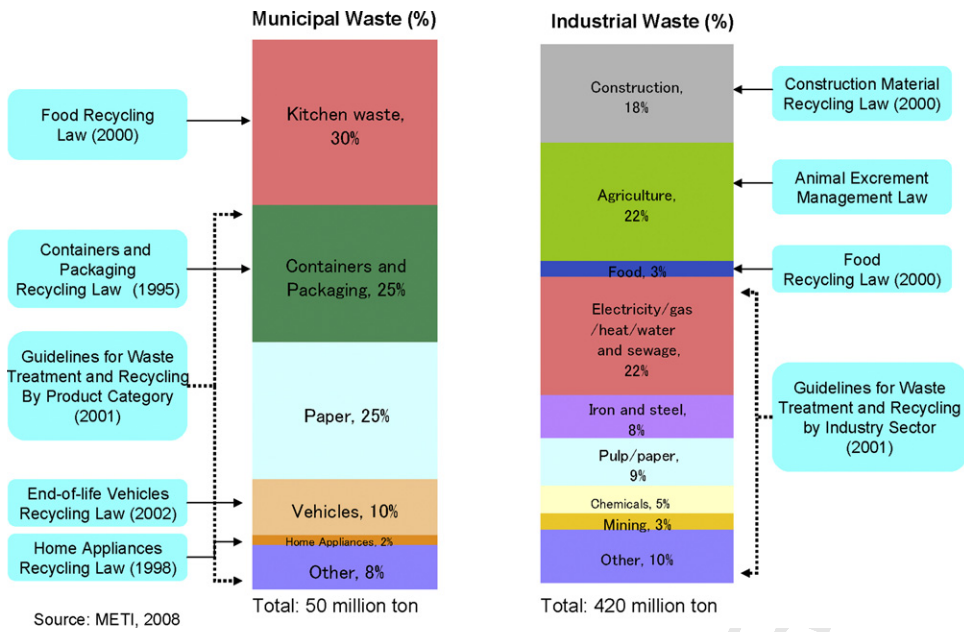


Fig. 1. Specific laws and guidelines for waste management in Japan.

products would eventually reduce final disposal costs (Yabar et al., 2008).

For example, the main driver of the Containers and Packaging Recycling Law of 1995 was that these wastes account for 60–66% of the municipal waste stream by volume and 20–25% by weight (METI, 2006). The objective of the law is to reduce the final disposal of municipal wastes through the promotion of sorting, collecting and recycling the targeted containers and packages. As can be seen in Fig. 2, the recycling rates for the most common container-types and packages have been steadily increasing since the Law was enacted. In particular, the impact of the Law on the recycling of PET bottles is apparent; the rate of recycling has increased from 3% in 1996 to 69% in 2007 (Council for PET Bottle Recycling, 2008).

Table 1
Summary of targets contained in the law for promotion of effective utilization of resources.

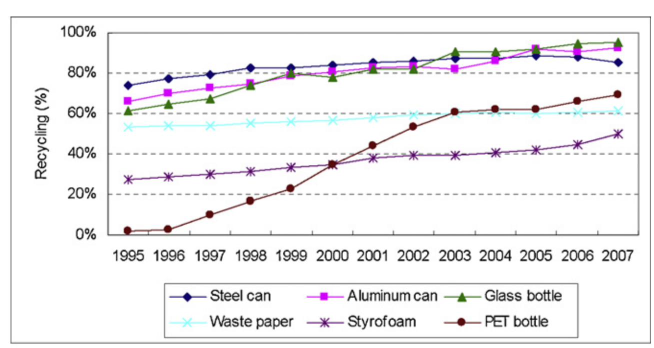
Guidelines for specific items		
Containers and Packaging Recycling Law	Glass bottles	Use rate for cullet 91% (2010)
	Steel cans	Maintenance of recycling rate over 85%
	Aluminum cans	Maintenance of recycling rate over 85%
	Plastics	PET bottle collection rate over 80%
ELV Recycling Law	Automobiles	Recycling rate of 85% (2002–2014)
Home Appliances Recycling Law	Air-conditioner	60%
	TV sets	55%
	Refrigerators	50%
	Washing machines	50%
Other Laws	Paper	Paper recycling rate 62% (2010)
	Personal computers and peripherals	Overall 60% by 2005. Actual rates in 2003: Desktops (78%), Laptops (50.3%), CRT displays (72.8%), LCD displays (64.8%)

Guidelines by industry	
Iron and steel	Reduction of final disposal amount to 50% of 1998 levels by 2010
Paper/pulp	Reduction of final disposal amount to 57% of 1998 levels by 2010
Chemicals	Reduction of final disposal amount to 70% of 1998 levels by 2010
Non ferrous metal	Final disposal targets for 1998–2010: Mining Industry Association (76%), Brass Makers Association (76%), Aluminum Association (14%), Electric Wire And Cable Association (50%)
Electricity	Maintenance of final disposal waste similar to 2006 (8%) by 2010
Automobile	Reduction of final disposal amount to 87% of 1998 levels by 2010
Electronic devices	Reduction of final disposal amount to 5% of 1998 levels by 2010

Source: METI (2004b,c, 2007, 2008).

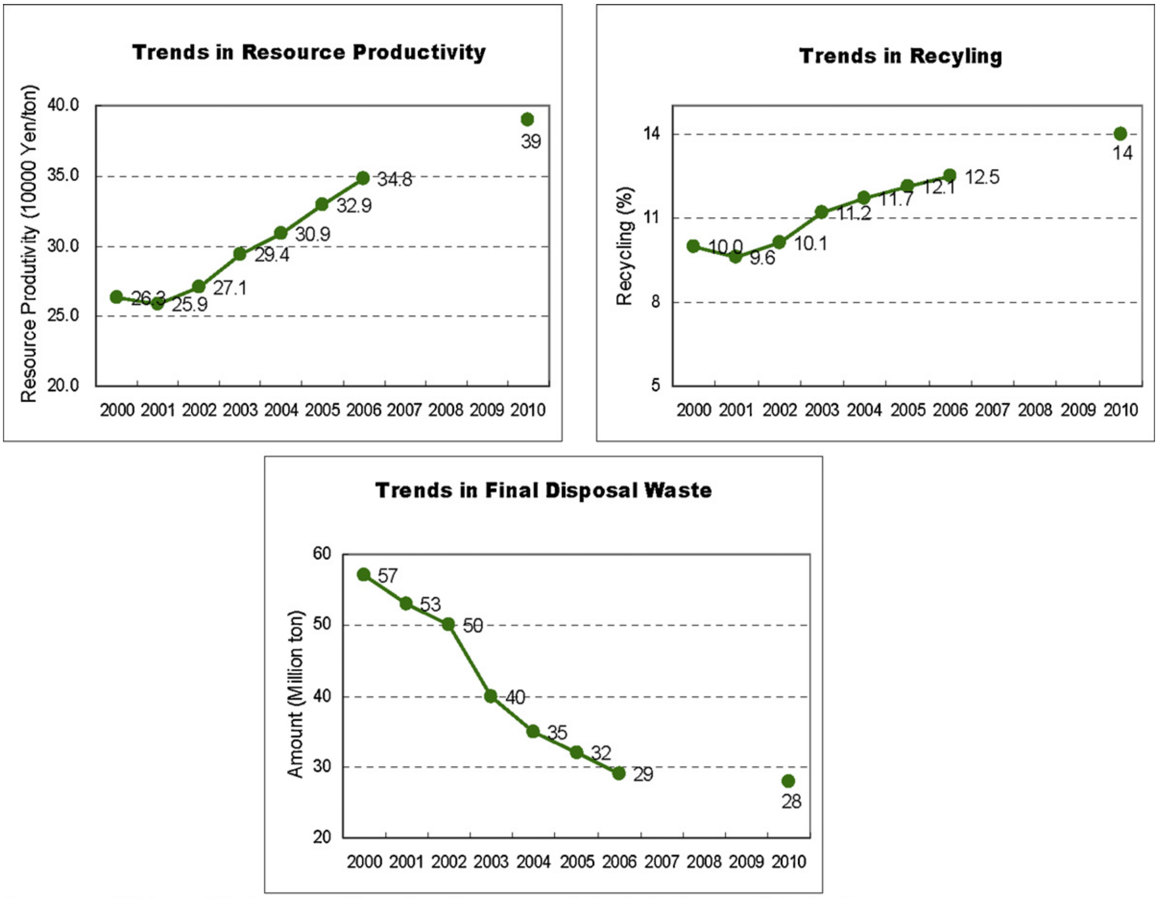
3.2. Comprehensive indicators based on material flows

As stated in Section 2, the Japanese government designed a plan for establishing a sound material-cycle society in 2003. The plan established the use of quantitative indicators derived from material flow analysis. The indicators not only focused on increasing recycling levels and minimizing the final volume of disposed wastes, but also on promoting wiser use of resources in the upstream stages of urban metabolism. At present, target indicators are a 40% improvement in resource productivity (in terms of GDP and Direct Material Input (DMI)), a 40% improvement in recycling levels (in terms of total recycled materials and DMI), and a 50% decrease in the final disposal of wastes. The reference year is 2000 and all of the targets must be achieved by the year 2010 (Fig. 3). Another important



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

Fig. 2. Trends in the recycling of containers and packaging in Japan.



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

Fig. 3. Material-flow based indicators trends in Japanese Policy.

characteristic of the proposed indicators is that, unlike conventional recycling targets which are based on the total amount of generated wastes, the recycling indicators proposed in this plan are based on the total amount of materials entering the economy i.e. the DMI. The results obtained from the indicator to date show very promising trends.

3.3. *Integral indicators of sustainability: mid and long term policy*

The "Fundamental Plan for Establishing a Sound Material-Cycle Society" in 2003 was the first attempt to tackle Japanese production and consumption patterns in a holistic way. The introduction of the three indicators explained in Section 3.2 shows that improving resource productivity and increasing overall recycling levels would translate into more effective use of our scarce resources and in so doing, would promote environmental impact minimization.

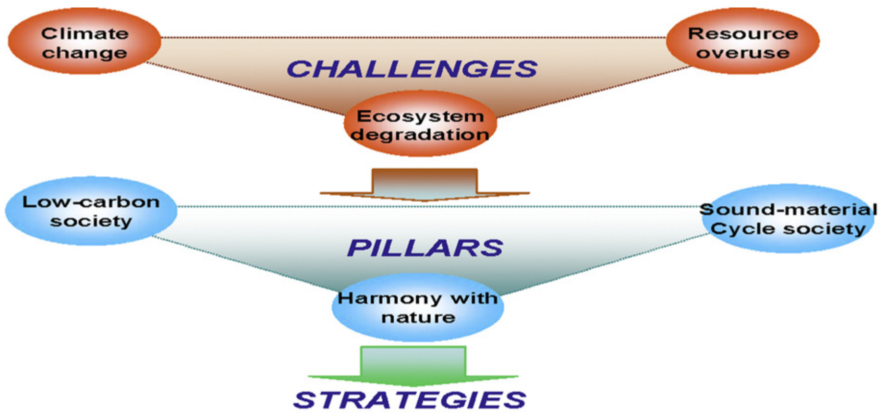
In order to address pressing global environmental issues, such as the excessive consumption of resources and the threat of climate change, the Government introduced the Second Fundamental Plan for Establishing a Sound Material-Cycle Society (SMC) in March 2008 (MOE, 2008). The plan proposed the same three indicators proposed in the first plan for the period 2000–2105, but the numerical targets were revised to a 60% increase in resource productivity, a 40–50% increase in recycling levels, and a 60% reduction in final disposal wastes. The plan proposes specific indices related to the macro indicators, including a 60% reduction in both domestic and industrial wastes, doubling the market for SMC society business, and changes in the awareness and actions of citizens (90% awareness and 50% in actions). The plan also set specific targets related with individual efforts like the 10% reduction in waste generation per person/day, business organizations with the same waste reduction target as individuals, and local governments with promotion of green purchasing and further implementation of the recycling laws (MOE, 2008).

In 2007, the Japanese government introduced its long-term strategy for achieving a sustainable society (GOJ, 2007). The strategy identified three major global environmental challenges: climate change, unsustainable use of natural resources, and ecosystems degradation (which is also the basis of the Second Fundamental Law for Establishing a Sound Material-Cycle Society). To address these major challenges, the strategy proposes comprehensive measures which integrate the following three main pillars of a sustainable society: a low carbon society, a society in harmony with nature, and a sound material-cycle society. Fig. 4 shows a scheme of the long-term Japanese strategy.

In sum these trends show an evolution from end-of-pipe and reactive policies of the 1950s to the current proactive policies that focus on a more integral approach towards sustainability.

4. Environmental policy evolution in China

As in Japan in the 1960s and 1970s, the rapid industrialization of China has caused a considerable environmental burden, especially since the late 1980s. The rapid economic growth has resulted in resource over consumption, air pollution, extensive waste generation, water pollution, and desertification, among other environmental problems (Fheng and Yan, 2007). The environmental



Overall	Strategy 1	International leadership to address climate change
	Strategy 2	Conservation of biodiversity
	Strategy 3	Design of sustainable material cycles based on 3R
Specific	Strategy 4	International cooperation: technology and human resources
	Strategy 5	Economic growth based on environmental and energy technologies
	Strategy 6	Promoting vibrant local communities
	Strategy 7	Environmental education and awareness
	Strategy 8	System to support a leading environmental nation

Fig. 4. Scheme of Japan's long-term strategy for achieving sustainability.

degradation has also affected neighboring countries through trans-boundary air emissions, pollution of the ocean, and desertification (OECD, 2006a).

In order to promote socio-economic development in the country, China introduced Five Year Plans (FYP) in 1953. Although these instruments started to address environmental issues from the late 1970s, few targets focusing only on the most pressing issues were included. The government introduced the Environmental Protection Law in 1989, which was directed at the protection of the environment and public health, and the prevention and treatment of pollution (Li and Li, 2004). In promulgating the 8th FYP (1991–1995), the government introduced the first plan for environmental protection. This plan had five main pillars: water management in rivers and lakes, hazardous waste management, air pollution reduction, and nature conservation (OECD, 2006b). The 9th FYP introduced specific targets for 12 pollutants at a national level in three main categories: solid waste, air pollutants and water pollutants (Dudek et al., 2001). Most of these emission targets were met and surpassed, including industrial SO_2, soot and dust (OECD, 2007). The 10th FYP included the first attempt to integrate both environmental protection and economic growth. Local governments were given the primary responsibility of environmental conservation (SEPA, 2001).

4.1. The 11th Five Year Plan

The 11th FYP differs from the previous plans in that it employs a comprehensive approach to dealing with environmental issues. The plan highlights the importance of improving living standards in a sustainable fashion and establishing long term policies for environmental protection and resource use. The plan identifies three major challenges: the increasing demand for energy and natural resources, environmental degradation, and the socio-economic gap between urban and rural areas. The plan introduced the concept of the circular economy for achieving efficient use of energy and resources, environmental preservation, and health protection. Boosting technological innovation is considered to be the main pillar to minimizing resource use and environmental degradation. The plan provides economic support for rural development and employment through investment in education and health to narrow the gap in the development of urban and rural areas. In addition, the plan proposes to improve the transport, information technology (IT) and the finance systems that provide opportunities for development to all citizens. By implementing these policies more effectively, the plan is expected to promote the development of an environmental-friendly and energy efficient infrastructure (OECD, 2006a).

4.2. Circular economy

The Circular Economy model contained within the 11th FYP focuses on promoting economic growth while minimizing the environmental impact of human activities. The model uses the Japanese 3R (reduce, reuse and recycle) approach as a means of increasing resource productivity and energy efficiency in the industry sector by identifying three levels where efficiency can be improved:

- Small scale resource circulation: Incentives for cleaner production methods in individual industries. Currently, there are more than 8000 ISO 14000-certified companies (OECD, 2006a)
- Mid-scale resource circulation: Promoting eco-industrial parks (EIP). The State Environmental Protection Administration (SEPA) has already ratified 13 EIP projects in China (Fang et al., 2007)
- Regional-scale resource circulation: promotion of resource management at the city and provincial-level through the symbiosis of industrial, urban and ecological systems. There are currently two regional demonstration projects, one in Guiyang City and Liaoning Province.

4.3. Indicators in Chinese environmental policy

China has significantly improved its environmental policy since promulgating the 1989 Environmental Protection Law, and the subsequent FYPs show a clear evolution in the measures being implemented: the 8th FYP introduced provisions for environmental management, the 9th FYP established specific environmental

Table 2
Selected environmental targets contained in the Chinese 11th Five Year Plan.

11th Five Year Plan	
Index	Target
Decoupling	
Energy intensity	Reduced by 20%
Water consumption per unit of industrial added value	Reduced by 30%
Pollution prevention	
Recycling of industrial solid waste	Increased to 60% (from 56%)
Discharge of major pollutants (SO_2, COD, etc.)	Reduced by 10%
Rate of urban sewage treatment	Increased to over 70% (from 48%)
Rate of urban domestic waste treatment	Increased to over 60%
Resource conservation	
Farmland area	Maintained at 120 million Ha
Forest coverage	Increased to 20% (from 18.2%)
Water for irrigation	Maintained at current levels

Source: OECD (2007).

objectives for pollution and resource management, and the 10th FYP added new environmental objectives and integrated environmental considerations into economic development initiatives (OECD, 2007).

The Chinese circular economy approach aims to develop a harmonious society, in which the symbiosis between people and nature can be maintained while promoting economic growth. Importantly, the 11th FYP included both absolute and decoupling targets (Table 2). In addition to specific targets for pollution control and resource conservation, the introduction of these targets is a clear attempt to decouple economic growth from environmental pressure. The government has also set a major mid-term decoupling goal to quadruple GDP/capita while doubling energy consumption by the year 2020 based on the year 2000. This energy intensity indicator was proposed based on the performance in 1980–2000 (Zhuang, 2008).

By setting strategies at different scales, the government expects to improve resource and energy conservation and environmental protection while promoting economic development and the transition towards a harmonious society.

5. Initiatives for measuring sustainability

Asian nations are currently facing a number of challenges, including environmental degradation, overconsumption of resources and growing societal inequality in the course of rapid economic growth, urbanization, and industrialization. Under these conditions, it is important to develop assessment tools that can be used to measure the sustainability status of targeted regions in a comprehensive manner. These assessment tools could also be utilized for policy making in moving towards a sustainable society. As has been demonstrated in Section 3, the conventional indicator systems used in the environmental policies in Japan, for example, are relatively sector-specific and there is room for considerable improvement in terms of comprehensive measurement from a sustainability perspective. Given the interwoven nature of environmental issues, it is important to identify comprehensive and robust indicator systems by combining socio-economic aspects with environmental perspectives. In particular, comprehensive assessment initiatives are spreading throughout the Asian region. In this section, we highlight selected initiatives and approaches of comprehensive indicator systems, particularly those directed at assessing the environmental and sustainability status of targeted regions or countries using methods such as scoring.

5.1. *Global initiatives for sustainability assessment*

A wide range of sustainability indicators have been implemented for the purpose of policy evaluation. The representative sustainability indicators used for policy analysis include, but are not limited to, the United Nations Commission on Sustainable Development (UNCSD) indicators, the Environmental Sustainability Index (ESI), and Human Development Index (HDI). The UNCSD Indicators for sustainable development consist of a set of 58 indicators that can be flexibly adapted at the national level. The indicator framework has four dimensions (i.e. society, environment, economy, and institutions) and each dimension is further divided into themes, sub-themes, and indicators (UNCSD, 2001). The ESI is designed with the following five main components: environmental systems, environmental stresses, human vulnerability, social and institutional capability, and global stewardship. Each component consists of a group of indicators and each indicator consists of a group of variables, to give a total of 76 variables. The ESI is an equally weighted average of the 21 indicators and five components, and it has been used to rank countries on a yearly basis since 1975 using scores (Esty et al., 2005). In addition to ranking countries in terms of human development, the HDI also considers three basic dimensions for human development: health, measured in terms of life expectancy at birth; education, measured in terms of adult literacy and primary, secondary, and tertiary institution enrolment; and finally, standard of living, measured in terms of GDP per capita (UNDP, 2006). Indicators like the ESI and HDI play an important role in demonstrating the relative sustainability status of regions using scores, providing essential information for policy evaluation.

In sustainability assessments, it is essential to be able to assess and monitor the interconnected nature and dynamics of human-environment systems that affect sustainability status. The Organization for Economic Cooperation and Development (OECD) published its indicator systems based upon the Pressure-State-Response (PSR) framework for environmental performance reviews in 1993 (OECD, 1993). This OECD framework, which is also employed by the UNCSD, is based on the concept of causality i.e. humans exert pressure on the environment and change its state, forcing the adoption of different types of policy to overcome a particular situation. The framework is widely applied in sustainability assessments at a variety of levels.

5.2. *Initiatives and prospectus for assessment in Asia*

An important characteristic of indicators such as ESI and HDI is that they attempt to analyze the relative nature of the sustainable status among targeted countries or regions for a specific year. On the other hand, there are indicator systems that aim to calculate the relativity of the sustainability status against specific targets. Here we highlight the difference in these two approaches as they are used to measure relative differences in sustainability status.

One example of target-based indicator is an assessment conducted by Japan for Sustainability (JFS). JFS is a non-for profit organization established in 2002 that provides information on research initiatives directed towards sustainability in Japan. In proposing 20 headline indicators for assessing sustainability, the JFS became the first institution to attempt a quantitative evaluation of national sustainability in Japan (Morioka and Yabar, 2007). The initiative identifies five main components of sustainability: fairness across time, fairness across space, capacity and resources, diversity, and human will and networking. Based on these components, the vision for sustainability in Japan is divided into four areas: nature, economy, society and well-being. These areas are further classified into 20 headline indicators (Table 3). Finally, targets for the year 2050 and ideal targets for the future are set for each headline

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Table 3
Sustainability indicators in Japan.

	Indicators	Current values	Target for 2050	Ideal for future
Nature	Species of Accipitridae (eagles) in Danger of extinction	16/35 species (2002)	0/35 species	0/35 species
	Greenhouse Gas (GHG) emissions per capita (per year)	10.5 tons/person-year (2003)	2 tons/person year	2 tons/person year
	Domestic waste generated per capita	1.11 kg/person day (2002)	0.411 kg/person day	0.411 kg/person day
	Input of synthetic agricultural chemicals (per 10 plots) [approximately 1/4 acre] of open field vegetables	3.1 kg/10 a (2000)	Approaching zero	Approaching zero
	Percentage of green consumers	29.9%	100%	100%
Economy	Percentage of renewable energy and recycled energy	1.2% (2002)	10%	50%
	Resource productivity	275,000 yen/ton (2001)	2.1 million yen/ton	4.2 million yen/ton
	Calorie-based food self-sufficiency ratio	40% (2003)	85%	100%
	General government debt outstanding (as percentage of GDP)	157.7%	40%	0%
	Aid as percentage of Gross National Income (GNI)	0.20%	0.70%	0%
Society	Incidence rate of general crimes	2187 incidents/100,000 people (2003)	200 incidents/100,000 people	Approaching zero
	Percentage of people over 15 years of age who use only bicycles to commute from their home to work or school	12.1% (2000)	30%	30%
	Percentage of diet seats held by women	9.9%	50%	50%
	Production volume of traditional crafts	204.8 billion yen (2002)	600 billion yen	1 trillion yen
	Percentage of SRI-type securities investment fund assets in total investment trust net assets	0.3%	20%	100%
Wellbeing	Percentage of people satisfied with their present lives	59.8% (2004)	Approaching 100%	Approaching 100%
	Academic achievement measured by PISA	Reading ability 498 (OECD top 20), mathematical literacy 534 (top 10%), Scientific literacy 548 (top 10%), problem solving knowledge and skills (top 10%) (2003)	Within top 10% in all fields of the OECD	Within top 10% in all fields of the OECD
	Percentage of daily free time hours spent in volunteering and social participation	1.03% (2001)	10%	10%
	Suicide rate (per 100,000 population)	25.5 persons/100,000 (2003)	7.1 persons/100,000	Approaching zero
	Public assistance rate	11.2 persons/1000 (2004)	7 persons/1000	Approaching zero

Source: based on the Japan for Sustainability homepage: http://www.japanfs.org/en/view/index/index.html.
SRI, socially responsible investing; PISA, program for international student achievement.

indicator. The main objective of this initiative is to raise people's awareness of sustainability.

Other Asian countries have also introduced some initiatives which aim at monitoring sustainable development at the country level through selected indicators (UNESCAP, 2007). Thailand, for instance, has developed a set of indicators that address economic, social and environmental dimensions for assessment purpose and policy planning, and has carried out sustainability assessment. Korea has selected 77 sustainable development indicators under economic, social and environmental dimensions. Malaysia introduced the term "Quality of Life" which comprises 42 indicators under 11 components. The Malaysian Quality of Life 2002 examines the progress and trends in national development for the period 1990–2000, using 1990 as the base year (Economic Planning Unit, 2002). Thus, several initiatives for assessment at the country level have been promoted in Asia, particularly aiming to apply such assessments for policy planning and analysis.

Another approach for developing indicators is to measure relative differences in the sustainability status of targeted regions in different years. Hara et al. (2009), for instance, proposed an indicative assessment method for measuring the relative sustainability status of targeted regions over different time periods by calculating the aggregate scorings. The method is based on the framework of the ESI approach and it allows for a calculation framework in which the performance across regions, in terms of relative sustainability, is comparable for different time periods. The method is designed to estimate aggregate sustainability index scores and consists of the following components: (1) environment (environmental degradation, such as water pollution), (2) resources (efficient resources utilization, such as energy consumption per GDP), and (3) socio-economic aspects (socio-economic issues, such as income disparities and differences in the level of education). The approach of Hara et al. (2009) enables the calculation of the relative sustainability scores of targeted regions for different time periods on the same basis. A case study was conducted involving application of the method to evaluate the relative sustainability status of all Chinese provinces, including municipal governments, with particular emphasis on the chronological trends of sustainability index scores and the scores for each of the three components between the years 2000 and 2005. The results effectively demonstrated the ranking of provinces from the perspective of sustainability as defined by the variables and components adopted in the study. Since the data generated by the method shows the change in scores over time, the results could be used to identify which of the provinces was moving in a positive direction in terms of improvements in the three sustainability components as well as their sustainability status.

Given that numerous Asian nations are currently growing rapidly and that such growth potentially threatens sustainable development, it is of critical importance to develop and apply comprehensive methods to assess sustainability. At the same time, a continuously updated and common database for various

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indicators shared by Asian countries is also necessary for effective and appropriate assessment in the region.

6. Discussion and conclusion

Japan's environmental and resource conservation policies have placed particular emphasis on both waste management and, more recently, integrated resource management; two reasons could explain this pattern: Japan lacks the physical space required for final refuse disposal, and it is a foreign natural resource-dependent country. The introduction of specific solid waste management and material flow analysis (MFA) based indicators possibly helped the country increase significantly its recycling levels and at the same time reduce the amount of final disposal waste. This approach may have also had an impact on the development of technological innovations Yabar et al. (2010), for instance, analyzed the impact of regulation targets on innovation using the home appliances recycling and dioxin emissions laws as case studies. In their study they used statistical analysis to compare the number of patents related to each regulation between the period under regulation and period outside the regulation. Furthermore, in order to control for the potential exogenous effects of factors such as business cycles and demand changes on technological development, they also compared the ratios of the case studies related patents to the total number of environment-related patents. Both results showed that the number of related patents for most technological types is larger after the regulations were introduced. More recently, in addition to imposing specific policies and regulations, Japan has recently proposed macro indicators that consider resource productivity, recycling rates, and final disposal. The trends show that these indicators may have been effective in terms of decoupling economic development from resource consumption. However, since it is not yet clear how these improvements benefit to the environment and the society, it is necessary to look into the linkage between these indicators and other direct environmental and resource indicators. For example, resource productivity improved by 37% between 2000 and 2007, and at the same time the total direct material input into the economy decreased by 19% (MOE, 2001). In this same period, the amount of circulation resources increased by 14% and the total municipal solid waste generation decreased by 7.3% showing a positive impact of the decoupling indicators (MOE, 2011). However in this same period, the total GHG emissions increased by 2% and the GHG emissions in 2007 were 13.3% higher than those in 1990 (MOE, 2009). Among other factors, these findings show us the difficulties associated with sustainability transition. In this sense, the Japanese Ministry of Environment plans to include a comprehensive environmental assessment in its third environmental plan. The plan is expected to integrate the three pillars of the Japanese Ministry of Environment's long-term sustainability strategy and measure its progress with the introduction of the following three main macro indicators (MOE, 2007):

- CO_2/GDP which captures the level of decoupling economic growth from environmental pressure;
- GDP/DMI which captures the level environmental efficiency in terms of material use; and
- Ecological footprint which measures our overall demand on the biosphere in terms of the biologically productive land necessary to meet our consumption demand and absorb our wastes (WWF, 2006).

China has made some progress in addressing its environmental issues with the introduction of environmental policy since the Environmental Protection Law in 1989. The FYPs that followed the passing of this law show a clear improvement in the measures taken; for instance, the 8th FYP introduced provisions for environmental management; the 9th FYP established specific environmental objectives for pollution and resource management, and the 10th FYP added new environmental objectives and integrated environmental matters into economic development. The halving of the overall energy intensity in the period 1980–2000 encouraged the government to set a similar target for the period 2000–2020. However, energy intensity trends suffered a setback from the year 2000 and have started to increase again (Yabar et al., 2009), possibly due to the rapid shift towards energy intensive industries, such as steel and cement. In the period 2000–2007, steel production increased from 127 million tons to 502 million tons (4-fold), and cement production increased from 597 million tons to 1350 million tons (2.25-fold) (USGS, 2009). The fact that most of the industries in these sectors are small scale with very low energy efficiency (Wang et al., 2007) has probably triggered the increase in the overall increase in energy intensity.

In conclusion, Japan and China have approached resolving their resource conservation issues by prioritizing the most pressing problems they have faced i.e. by focusing on material resource management in Japan and energy efficiency in China. In this sense, the introduction of indicators in conjunction with policy is important because these instruments enable us to gauge the effectiveness of such policies. Even though these policies have probably induced technological innovation in Japan and China, it is more important to avoid getting locked-in to our current production and consumption patterns; such as the heavy reliance on incineration as a waste treatment option in Japan, or the dependence on coal as the main energy source in China.

Finally, despite the geographical and socio-economic differences between Asian countries it is noteworthy that Japan for instance faced similar environmental issues in the 1970s to those that China currently faces. In this sense, the experience of these two countries could be an important reference for policy development in other Asian countries. In addition working in a cooperative manner shall contribute to the achievement of a sustainable Asia. In this regard, the Asia 3R initiative could be an important starting point for a steady decoupling of economic growth from environmental pressure at the local, nation-wide and Asian level. This initiative, introduced by Japan, has three main strategies: achieving zero-waste society by decoupling economic growth from resource consumption, supporting the developing nations' initiatives towards zero-waste societies with capacity building and international cooperation. The plan puts special emphasis to the promotion of 3R initiatives at all levels, reduction of barriers to the international flow of goods and services, cooperation among developed and developing nations and promotion of Science and Technology (S&T) suitable for 3R.

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