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Transition to a Resource-circulating Society

Strategies and Initiatives in Asia

EDITED BY

Tohru Morioka
Kazuhito Haruki
Helmut Yabar

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Transition to a Resource-circulating Society

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Strategies and Initiatives in Asia

— Proceedings of 2006 International Symposia —

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Preface

The rapid economic growth of emerging nations in Asia is bringing welfare and higher living standards to many people. However, this economic growth is usually accompanied by huge material resources and energy consumption that, due to the lack of appropriate technology development, is putting an enormous burden on our already fragile environment. Problems such as environmental degradation, solid waste and air pollution, energy and resource depletion, biodiversity loss, and overpopulation in urban regions constitute a bottleneck for the transition to a sustainable Asia. In order to promote a smooth transition towards sustainability, we need an integral system innovation that can decouple economic growth from environmental pressure while bringing welfare to our societies. This means we have to improve our current socio-economic and engineering practices and strategies in such areas as renewable energy promotion and utilization, emission reduction in production and consumption, and urban and regional planning, etc.

Terms like "sustainability" have been widely used in recent years. However, given its complex and wide-ranging meaning, there are considerable differences among people, regions and countries. In addition, until recently the sustainability issue was addressed separately by engineering science and social science, eliciting only limited results. In an attempt to address the sustainability challenge, Osaka University's Research Institute for Sustainability Science (RISS) proposes a dynamic system innovation, where science and technology play a central role in fulfilling societal functions within the limits of the earth life support systems. The system innovation is based on a problem-solving approach that exploits backcasting techniques with long-term visions and mid-term strategic goals.

As part of its research program, RISS organized two international symposia in 2006: "Sustainable Society and Industry Transformation" in Ho Chi Minh City, Vietnam and "Strategies to Achieve a Closed-loop Economy in Asia" in Osaka, Japan. This volume contains a selection of fifteen papers that were presented at both events. The volume is divided into three chapters. The first, entitled "The Pathway to a Sustainable Industrial Society" addresses the various efforts and initiatives to promote system innovation through science and technology and sustainable engineering practices, industrial systems development based on the industrial ecology approach, the application of sustainable management practices in corporations and the Asian trade in end of life products through the introduction of extended producer responsibility (EPR) on a regional scale. The second, entitled "Sustainable

Management of Food, Biomass and Water Resources", outlines the different strategies at local, national and regional levels to preserve these valuable resources. The articles outline specific practices to promote sustainable agriculture through bio-diversity augmentation and polycultural agriculture, the management of water resources based on financial mechanisms, energy alternatives to fossil fuels through the development and dissemination of biomass energy conversion technologies, and sustainable biomass production through biological productivity conservation. Finally, the third chapter, entitled "Policy Measures towards Sustainability at Different Scales", addresses the policy initiatives used to achieve a sustainability transition. The articles introduce multiple approaches towards sustainability in Asia through sustainable cities, a de-carbonized society, the 3R initiatives (reduce, reuse and recycle), national environmental and land-use management policies, initiatives to address environmental degradation caused by rapid industrialization, and local legislation to promote the circular economy.

By introducing innovative ideas and strategies in environmental and social changes, policy innovation, and industrial transformation, this book expects to contribute to the advancement and cooperation of the research and education activities towards a sustainable Asia.

We would like to express our gratitude to the Special Coordination Funds for Promoting Science and Technology of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan for their support. We also would like to thank the co-organizers of these events: Integrated Research System for Sustainability Science (IR3S), The United Nations University Zero Emissions Forum (UNU/ZERI), Hokkaido University Sustainability Governance Project (SGP), University of Natural Sciences Vietnam National University Ho Chi Minh City (VNU-HCMC), Nong Lam University, Ho Chi Minh City Department of Natural Resources and Environment (DONRE) and EBARA Hatakeyama Memorial Fund. Finally we would like to thank the participants for their important contribution to the success of these symposia.

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The Pathway to a Sustainable Industrial Society

1. Industrial Transformation Strategies towards Sustainable Development

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ABSTRACT

Strategies towards a closed-loop economy with green industry, on local, nationwide and regional scales, are among the most important sustainability-oriented initiatives. In Japan, the 3 Rs (Reduce, Re-use and Recycle) programs, eco-town promotion, and green product design initiatives have dramatically improved its eco-efficient performance in terms of both production/consumption and urban activities. Japan has passed through various stages in addressing environmental issues: the reactive policies driven by the environmental degradation of the 60's and 70's, the strategies to improve efficiency in the production process through resource use optimization following the oil crises in the late 70's and 80's and the development of markets based on improved eco-efficiency performance, the dissemination of "green" products through integrated supply management, the introduction and dissemination of product and service systems and corporate social responsibility from the 90's. In this article, based on successful experiences in Japan and other developed nations, the authors outline the efforts and strategies to achieve a sustainable Asia through 3R programs, Eco-town and Eco Industrial Park (EIP) networking systems, Product and Service Systems (PSS), urban-rural linkages, and eco-infrastructure management in metropolitan areas. This initiative is discussed within the research framework of the Research Institute for Sustainability Science (RISS), as well as the research framework of the Integrated Research System for Sustainability Science (IR3S) Flagship research project "the design and development of sustainable closed-loop economies in Asia". The authors also introduce a research framework for sustainable urban metabolism. A comprehensive understanding of the urban metabolism is imperative to promote sustainable urban development. In this sense, MFA is an important tool that allows us to identify the main problems and constraints along the total material throughput of the economy, while seeking viable and sustainable alternatives to overcome these constraints. The article also stresses that while the physical analysis of the economy is important, it may be more important to monitor the level of societal services provided by the economy, such as health, employment, education, housing and recreation.

Keywords: Industrial transformation, Sustainability science, Regional strategies, Green product design

INTRODUCTION

The strategies to develop a "closed-loop ecologically sound and innovative society" have some similarities with the International Human Dimensions Program on Global Environmental Change – Industrial Transformation project (IHDP-IT) research frame (IHDP-IT 2001). These research initiatives have in common the search for a transition towards a sustainable society. This article outlines current generic efforts, particularly the Research Institute for Sustainability Science (RISS) initiative, to achieve a sustainable Asia by promoting a closed-loop economy through 3R programs, Eco-town and eco-industrial park (EIP) network systems, product and service systems (PSS) and the harmonization of urban-rural-industry linkages. These industrial metabolism issues are discussed within the research framework of RISS, as well as the research framework of the Integrated Research System for Sustainability Science (IR3S) flagship research project.

JAPANESE STRATEGIES TOWARDS SUSTAINABILITY

One of the most important challenges modern societies face is how to bridge the socio-economic gap between developed and developing nations while also promoting and reorienting current strategies towards sustainable development in a cooperative way. The promotion and transfer of technology development and management for environmental conservation are among the key strategies to bridge this gap. Even though product and process innovations are important to address the problems generated by current production and consumption patterns (Morioka et al. 2006a) they are insufficient to achieve a sustainability transition.

Sustainable urban metabolism strategies aim to decouple economic growth from environmental degradation at the level of the firm as well as locally and nationwide. The IHDP-IT program, for instance, deals with decoupling economic growth from environmental pressure via system transformation. The program established five flagship research activities, namely: energy and material flows, food (production and consumption), water and transport in urban contexts, Information and Communication Technology (ICT) and governance and transformation processes (IHDP-IT 2001). In Japan, the 3R programs, eco-town promotion, and green product design initiatives have helped dramatically improve the resource productivity of the economy.

Environmental policies in Japan

Figure 1.1 shows the linkage between the fundamental law for establishing a sound material cycle society and specific related laws in Japan. These laws perceive, for instance, containers and packages (glass, PET and other plastic and paper cartons), end-of life (EOL) home appliances and EOL vehicles as resources rather than waste and demand their appropriate recovery. In this sense, the policy priority clearly emphasizes that resource recovery must follow the hierarchical order of reduce, reuse and recycle. At the same time the government has promoted local and regional action plans for “Establishing Environmentally Sound Material-Cycle Society” in local governments through eco-town projects. Eco-towns are local/regional initiatives that promote sustainable resource management. Currently, a variety of EOL resources are being recycled and/or recovered on local and regional scales.

Japanese policies based on macroscopic metabolism accounting

In order to promote sustainable production and consumption patterns, the Japanese government went one step further and formulated the “Basic Plan for Establishing a Recycling-based Society” in 2003, which introduced indicators derived from physical material flow accounting (MOE 2003). The objective of the plan is to promote comprehensive policies towards a closed-loop economy. More specifically, the plan sets a target for each of the three indicators representing the three aspects of the material flows of the economy. These are namely input, cycle and output indicators. The three indicators with quantitative targets for the period 2000-2010 are:

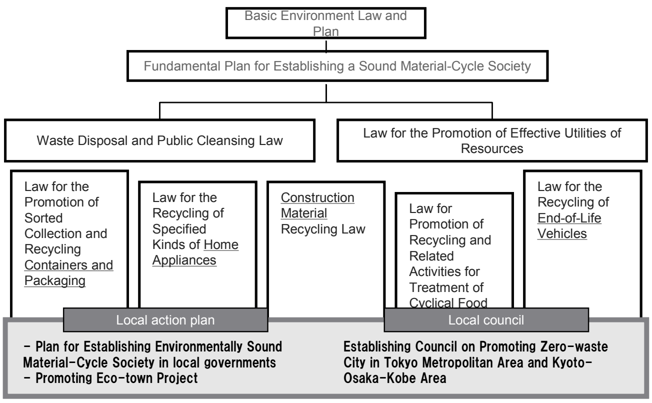

Figure 1.1 Implementation plan towards a closed-loop economy in Japan

- Resource input: Resource productivity: GDP/DMI (40% improvement);
- Material recycling rate (40% improvement); and
- Waste output: Waste for final disposal (50% decrease).

Whereas the material recycling rate and waste output indicators relate to the conventional view of waste management, the input indicator reflects a comprehensive view of the relationship between economic activities and natural resources use, i.e. the decoupling of economic growth from environmental degradation.

Japanese governmental efforts also include the sustainable use of energy resources. The legal framework of Japan's strategies to combat global warming includes two main policies: the law concerning the promotion and measures to cope with global warming and the law concerning the rational use of energy. With this policy platform and societal collaboration, Japan expects to achieve the Kyoto Protocol 6% GHG emissions reduction commitment by the period 2008-2012.

Along with its national policies, the government also promotes local and regional action plans for establishing an environmentally sound material-cycle society in local governments by means of eco-town projects. Eco-towns are regional initiatives that target the mutual utilization of by-products and waste among industries at a local level. Currently, a variety of EOL resources are being recycled and/or recovered at local and regional levels. Eco-town initiatives not only encourage the application of industrial ecology practices through the exchange of by-products, but also promote sustainable business models by promoting the extension of the products/services life-cycle by means of repair and maintenance services (Morioka et al. 2005).

Practical implementation on a local scale towards a closed-loop economy: Eco-towns in Japan

The Japanese Ministry of Economy, Trade and Industry (METI) and Ministry of the Environment (MOE) introduced the eco-town initiatives in Japan in 1997. Eco towns are environmentally harmonized industrial recycling sites with governmental financial support (Morioka et al. 2003). These projects were triggered by learning from EIP experiences, such as Chattanooga in the USA and Kalundborg in Denmark and their efforts to promote the circulation of resources in industrial areas by using the practices and concept of industrial ecology. Eco-town projects can be defined as regional scale initiatives that target the effective resource circulation of a full range of by-products.

Currently there are 26 eco-town projects in Japan (Fig. 1.2). Among the most representative eco-towns, Kitakyushu eco-town, for instance, focuses on the comprehensive management of EOL resources, such as PET bottles, home appliances, office automation (OA) equipment, and EOL automobiles. Some other eco-towns, such as Aomori, Kamaishi, and Toyama, focus on biomass resources, while others focus on the development and promotion of advanced technology, such as gasification plants, to produce industrial chemical products from EOL resources. There are also efforts to promote integral cooperation among eco-towns through clustering. Tokyo, Kawasaki and Chiba eco-towns started a clustering initiative in 2001. There have been some efforts to classify the eco-towns in terms of their most predominant characteristics. Sato et al (2004), for instance, categorized the eco-towns into: eco-towns that promote the development of environmental industries, eco-towns that focus on waste treatment and those that promote and enhance citizens' participation.

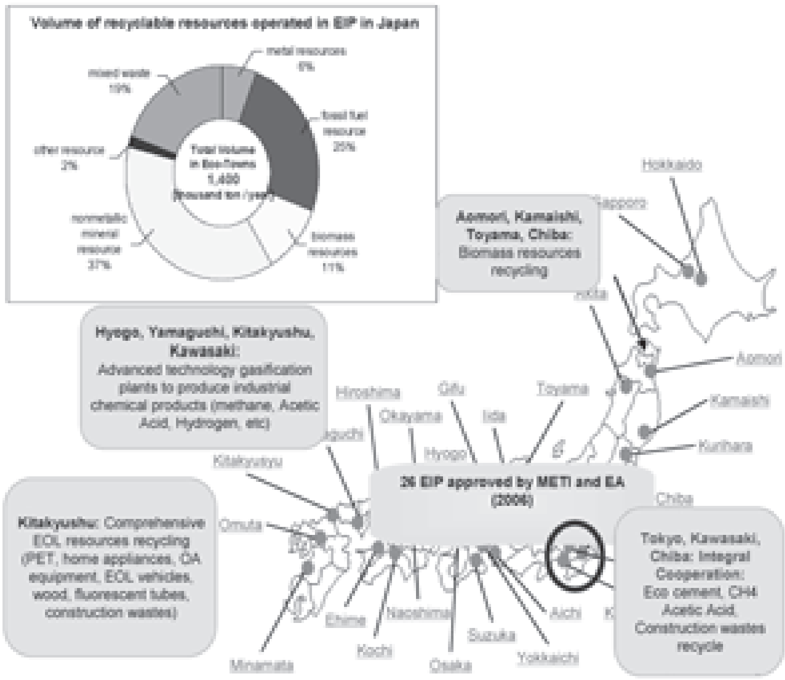

Figure 1.2 Eco-town projects in Japan

Green product design

Developed nations have passed through four stages along the path to a sustainable society. The environmental policies of the 60's and 70's were driven by environmental degradation caused by rapid economic growth. Improving efficiency in the production process through resource use optimization became a major task following the oil crises in the 70's and 80's. From the 90's onward, the environmental concerns were transformed into opportunities to develop markets, based on improved eco-efficiency performance and the dissemination of "green" products through integrated product policy. These product and process innovations included design for the environment (DfE), design for Disassembly (DfD), and energy-efficient equipment. Environmentally-aware producers showed the benefits of their products through labeling and other means of communication, while governmental bodies also promoted the green market development through green procurement. Finally, in the fourth stage of social evolution, our challenge is to achieve a system innovation: large-scale transformations in the way societal functions, such as transportation and communication, are fulfilled i.e a transition from one socio-technical system to another (Geels 2004).

Developed nations are now at a stage where environmental concerns have been transformed into opportunities to develop markets; based on improved eco-efficiency performance and the dissemination of "green" products and services through integrated supply management.

In order to enhance the eco-efficiency and resource productivity of the total material-product chains, it is essential to follow the approach shown in Figure 1.3 to address all the stages of the product chain management: resources input, product design and manufacture, use and consumption, and recycling and recovery. In Japan, thanks to the introduction of a comprehensive environmental policy, technological development has had a great impact on eco-design. Morioka et al (2006b) showed the correlation between the introduction of these policies and the rapid increase in the number of environmental-related technological patents. It is also important to enhance the social participation and collaboration among stakeholders for shared responsibility towards sustainable production and consumption.

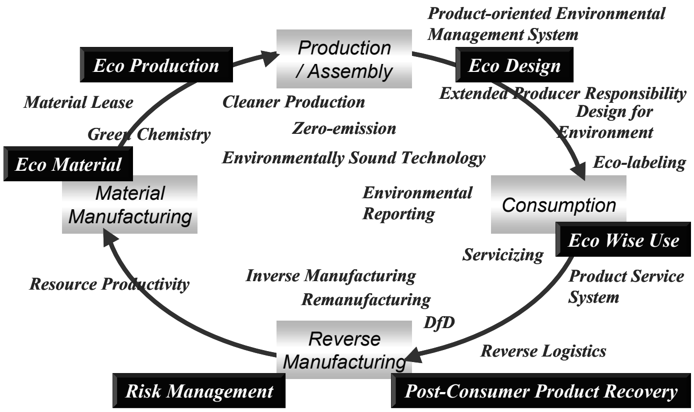

Figure 1.3 Product and process policy: green product design

Corporate green management

The participation of both producers and consumers is important to promote and enhance sustainable production and consumption. Consumers play a key role with their increasing demands for environmentally-friendlier products and services while producers provide more eco-efficient products and services to meet those incresing demands. Green product and process policies are also very important. However, these policies will not be effective without an appropriate corporate management strategy. In this sense, the Japanese METI introduced the path towards green corporate management through internal and external strategies (see Figure 1.4). In the internal strategies, the manufacturing corporations prioritize green management practices in all the upstream stages of the product lifecycle: green procurements for materials, components, eco-design, zero-emissions through energy saving systems at the manufacturing stage and the strengthening of sales for green products and services.

The external strategies are related to corporate efforts to maintain smooth relationships with shareholders, employees, consumers and the community. Among external strategies, we can mention the employee incentive systems and performance evaluation systems, the strengthening of risk communication, the release of environmental reports, eco-labeling, and the corporate social responsibility (CSR) efforts toward the community.

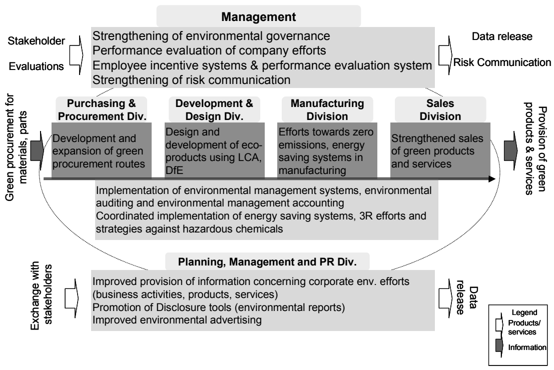

Figure 1.4 Corporate green management strategies

REGIONAL STRATEGIES AND INITIATIVES TOWARDS A SUSTAINABLE ASIA

The Asian region has become a major player in the global economy. For instance, Asia provides 40% of global pig iron and steel, 90% of global personal computers (PC), 85% of shipbuilding, etc (Kojima 2005). While this rapid economic growth is good in the sense that it provides higher living conditions to the citizens, at the same time these industrial activities require huge amounts of material resources and energy and, to make matters worse, due to the lack of appropriate technological development, most of the industrial activities in Asian developing nations are causing severe environmental degradation.

Figure 1.5 shows the CO2 emissions and GDP trends in Asian nations for the period 1990-2000. In this decade, for instance, although the amount of CO2 emissions per GDP in China decreased considerably, these levels still remain high. At the same time, the amount of CO2 emissions for the Association of Southeast Asian Nations plus the People's Republic of China, Japan, and Republic of Korea (ASEAN+3) showed the highest levels. Besides China, Vietnam also shows a steady decreasing pattern. Although this decreasing pattern indicates some level of decoupling, they remain far behind those of developed nations.

Along with CO2 emissions, one of the major problems faced by emerging nations in Asia is how to deal with increasing amounts of both domestic and industrial waste generation (Morioka et al. 2006b). Observing the environmental pressure per GDP in terms of municipal and industrial solid waste, there seems to be an Environmental Kuznets Curve (EKC) pattern: decoupling of economic growth from environmental pressure after reaching a certain level of economic development, but again these values are still far from those of developed nations, such as Japan.

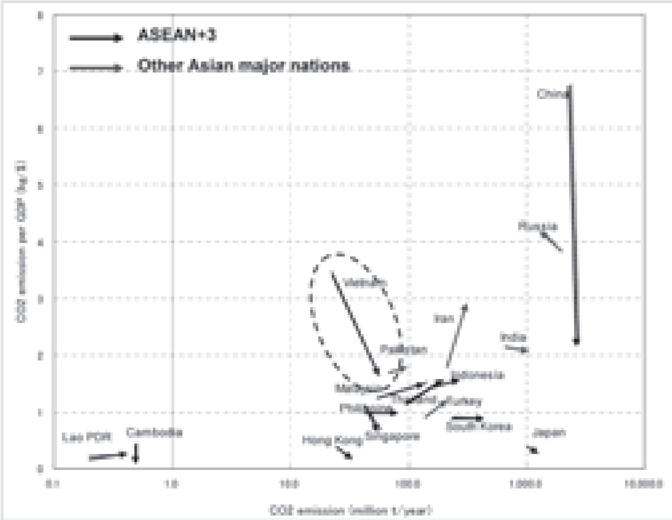

Figure 1.5 CO2 emission trends in Asia (1990-2000)

Urban environmental problems come mainly from the need to satisfy increasing demands for food, water, energy, and mobility. Strategies towards a sustainable urban metabolism management are vital to address this task. On the upstream side, cities provide major opportunities for change in areas such as energy production, transportation, water and food supply, resources management, etc. Japan started its integral policies of urban management with the introduction of an urban environmental restoration program; ecologically sound river-basin management, urban compact cities initiatives, and mobility management and environmentally sustainable transport with the priority on public transportation (Hayashi et al. 2004).

When emphasizing intervention in the sections of the driving forces towards sustainable urban metabolism, waste treatment becomes integrated waste management and subsequently integrated resources management. The introduction and development of green building and zero-emission programs for the recycling of construction materials are among the most important measures towards sustainable urban infrastructure management (Obayashi 2002). Action programs targeting zero-waste in metropolitan regions through area-wide eco-town collaboration have enhanced the development of green industries and promoted an urban-distributed energy supply web, furnished by renewable energy technologies, such as photovoltaic and biomass technologies (Koizawa 2006).

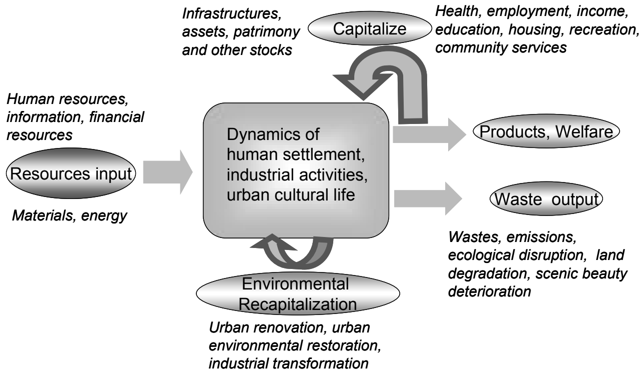

Figure 1.6 Urban redevelopment with sustainable urban metabolism

A comprehensive understanding of the urban metabolism is imperative to promote sustainable urban development (Fig. 1.6). In this sense, material flow analysis (MFA) is an important tool that allows us to identify the main problems and constraints along the total material throughput of the economy while seeking viable and sustainable alternatives to overcoming the same (Yabar and Morioka 2006). Along with the physical analysis of the economy, it is also important to monitor the level of societal services provided by the economy, such as health, employment, education, housing and recreation. On the downstream side, while introducing measures to minimize solid waste and emissions, we must also develop strategies to avoid ecological disruption, land degradation and scenic beauty deterioration. Urban renovation, urban environmental restoration and industrial transformation are among the measures to promote environmental recapitalization.

In Asian countries that are experiencing rapid economic development, it is crucial to take precautionary actions to achieve environmental sustainability alongside economic development policy. It is also important to integrate trans-sectoral policies, with anticipated synergy effects among the sectors, and to introduce technologies together with effective institutional design that will maximize the potential outcome of the technologies application. In rapidly developing countries it is imperative to facilitate social infrastructures that would result in a more effective implementation of environmental protection.

Japan's action plans to develop a global zero-waste society

Sustainable urban metabolism strategies aim at decoupling economic growth from environmental degradation at the level of the firm and also on local, nationwide, regional and global scales. (IHDP-IT), for instance, has been dealing with decoupling economic growth from environmental degradation by means of industrial transformation (IHDP-IT 2001). IHDP-IT has established five flagship research activities to achieve this objective, namely: energy and material flows, food, water and transport in urban contexts, information and communication technology (ICT) and governance and transformation processes.

In Japan, the 3R programs, eco-town promotion, and green product design programs are supported to achieve eco-efficient performance improvements in production/consumption and urban activities. The Japan Action Plan for Developing a Global Zero Waste Society through the 3R initiative could be an important starting point for a steady decoupling of economic growth from environmental pressure at local, nationwide and Asian levels.

As shown in figure 1.7, Japan's 3R plan has the following three main strategies: achieving a zero-waste society by means of the fundamental plan towards a sound-material-cycle society, supporting developing nations' initiatives towards zero-waste societies with capacity building and international cooperation. The plan focuses particularly on the promotion of 3R initiatives at all levels, the reduction of barriers to the international flow of goods and services, cooperation among developed and developing nations and the promotion of science and technology (S&T) suitable for the 3R initiative.

Figure 1.7 Japan's action plan for the global promotion of zero waste

Asian policies towards a resource-circulating society

Table 1.1 outlines the basic orientation of the laws that promote resource conservation and waste management strategies in Asia (JEC 2005). In the case of the Asian initiatives, some countries, like China, utilize a resource-circulating and circular economy law approach to target the effective utilization of resources in its economic system, while others, like Indonesia, have a comprehensive environmental policy agenda including waste recycling among other initiatives. In recent years, the Japanese government and MOE have promoted the 3R initiative and enhanced cooperation with other Asian countries.

China introduced the “harmony society” initiative, which pursues symbiosis, such as in harmony between people and nature, while promoting well-balanced economic growth between development actions and conservation initiatives. The initiative also promotes the improvement of national economic strength and competitiveness, and helps encourage sustainable approaches for the economy and the environment. The Chinese government also proposed a set of sustainability indicators as the means to measure the effects of this policy. Among the main targets of the Chinese policy for the period 2006-2010, we can highlight the 20% decrease in energy consumption per GDP, the 10% decrease in the emission of major pollutants and the 5% increase in per capita income. With the introduction of these targets, China is also trying to decouple economic growth from environmental pressure. This and other initiatives have been developed in conformance with the Japanese 3R programs, which encourage resource and energy saving while promoting economic development.

Table 1.1 Asian environmental policy: 3R and integrated waste management orientation

	3R position in laws, plans and the like	Program
South Korea	“Act Relating to the Promotion of Resource Saving and Reutilization” (enacted in 1992) Promotion of efficient use of resources, waste prevention, resources reutilization towards improving environmental conservation, sustainable economic development and citizens well-being	-Product charge system (pesticide and cosmetic containers, batteries, etc) -Deposit system, disposable items use regulation -EPR (tires, oil, electric machinery, fluorescent lamps)
China	“Law on the Prevention and Control of Environmental Pollution by Solid Waste” (enacted in1995) Promotion of waste prevention and treatment as well as loop economic development (law after the amending enforcement of 2005)	-Tax reduction/exemption to entities undertaking recycling (from 1994) -Construction of recycling industrial parks to handle imported wastes
Taiwan	“Waste Disposal Act” (amended in 1997) Installation of resource recycling fund committee under the Environmental Protection department “resource Recycling Act” (enacted in 2002) Waste reduction, recycling/reuse promotion	- “Basic System”: advanced payment of treatment/recycling costs by producers (waste dry-cell batteries, tires, lead batteries, plastics, home appliances, computers, etc. Payment to recycling businesses
Philippine	“Ecological Solid Waste Management Act 2000” (enacted in 2001) Guidelines for promotion of wise utilization of resources, resources saving and recovery and waste reduction	-Enforcement of the sorting and recycling in local governments -Support pilot projects
Thailand	“Enhancement and Conservation of National Environmental Quality Act” (1996 cabinet approval) Waste generation below 1 kg/cap, recycling/reuse promotion	-Establishment of “Waste Utilization Data Center” (Ministry of Technology) -Cooperation and experience sharing in the local governments recycling activities leading to waste reduction.
Malaysia	“The Third Outline Perspective Plan” Promotion of zero emission technologies, energy use reduction, reuse and recycling of wastes (regeneration)	-National recycling programs (from 2000/12), waste reduction promotion through 3R, Construction of the Waste Reduction master plan with JICA cooperation
Singapore	“Singapore Green Plan 2012” (released in 2002) Recycling targets: 44% by 2001, 60% by 2012	-National recycling program from 2002: call for the participation of complex housing, schools, factories. Introduction of 3R initiatives through internet
Indonesia	“Agenda 21-Indonesia” (released in 1997) Waste minimization, enhancement of sustainable resource management	-Research in composting and plastic recycling under the Agency for the Assessment and Application of Technology -Establishment of the Cleaner Production Center (MOE)
Vietnam	“Environmental Law Act” (released in 2005) Clean industrialization, Recycling enforcement, sorting at source (households)	-Establishment of Cleaner Production Center (Hanoi University of Technology) and technical assistance to corporations

RISS INITIATIVE TOWARDS A SUSTAINABLE ASIA

The integration of both bottom-up and top-down strategies are important to achieve a sustainable Asia. The Osaka University RISS, for instance, leads a flagship research project which targets the design and development of sustainable closed-loop economies in Asia. As shown in Figure 1.8, within national and local boundaries, it is important to focus on 3R programs and EIP initiatives in the first stage of development, as well as on green products and supply chain management strategies during the mature stage. As typically for such stage, China, for instance, focuses its current environmental policies on land and energy management, land cover and land use change in urban-rural linkages, and energy efficiency and conservation, with particular focus on renewable energy development.

At the regional level we emphasize the Asian trade level. The trade of recyclable goods in Asia also requires new regulations as well as the promotion of technology transfer. For the Asian trade to work successfully, consumers and especially producers must take into account the impacts of their products and services along the lifecycle and supply chains. Firstly, it is important to introduce the three principles of environmental responsibility along product life cycles:

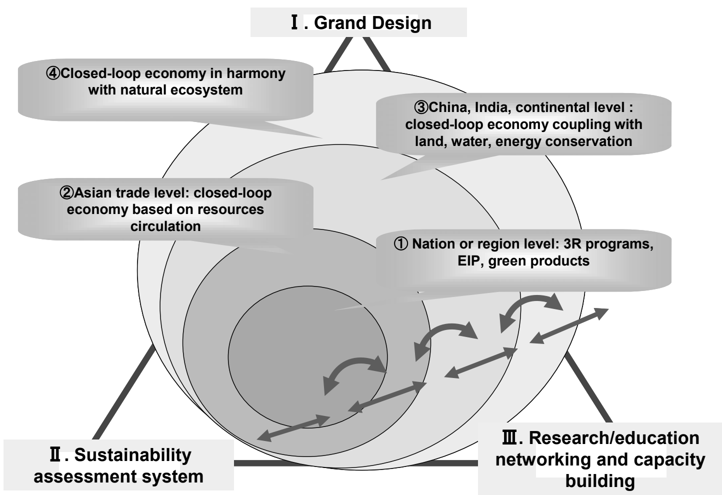

Figure 1.8 RISS flagship project: achieving a closed-loop economy in Asia

- The polluter pays principle (PPP), which implies that those who use and produce pollutants must bear the responsibility for their actions;
- The extended producer responsibility (EPR), which implies that the producer responsibility for the product is extended to the post-consumer stage of the product life-cycle; and
- The advanced shared responsibility for indirect or shadow effects, which implies that all partners in the production and consumption chain have considerable roles to play in their particular parts of this chain.

These principles have not yet been established in Asia, despite the pre-existing European regulations, such as the restriction on hazardous substances (RoHS), energy-using products (EUP), or the registration, evaluation and authorization of chemicals (REACH).

To promote the fair trade of goods and EOL products in Asia, it is important to overcome three major barriers. Firstly, the international division of labor cites the standardization of environmental regulations as a benchmark to clearly establish the allocation of responsibility. Secondly, the current inappropriate trade in EOL products causes pollution, especially from persistent organic pollutants (POPs) and heavy metals contained in electric and electronic waste. The main reason is the lack of monitoring capacity within the recipient country. Stricter trade- restrictions, on the other hand, will hinder the trade of these secondary materials for appropriate recovery. Finally, Asia still lacks the necessary capacity building and has not established a legal framework that could promote an environmentally friendly and fair form of trade.

At the continental level, including China and India, we must pay particular attention to the sustainable closed-loop economy alongside land, water, and energy conservation. The project vision is to promote a loop-closing society in harmony with the natural ecosystem.

A detailed analysis of this strategy reveals three main pillars. The first is the grand design for the closed-loop economy in Asia. Morioka et al (2006a) argued that the transition to sustainability is a long-term journey that must be addressed now. The backcasting approach – i.e. envisioning a desirable sustainable society based on defined parameters and designing strategies identifying alternative paths towards that end – is the approach that most ably serves the sustainability goal. RISS research will firstly analyze the related initiatives in Asia, secondly design mid and long-term future scenarios and finally propose an integrated research framework by means of long-term visions and mid-term strategic goals with their inclusive roadmaps. The second pillar is the sustainability assessment system. In order to measure our progress towards sustainability, we must have a comprehensive sustainability assessment system. RISS flagship research includes three main steps: the analysis and revision of existing indicators, and intervention to bridge the gap between the targeted vision and the present condition in terms of the legal framework, economy, information/ knowledge and education. Finally, the third pillar is the research/education network and capacity building. Sustainability science unifies knowledge systems and practical, global and local perspectives, both from views in developed and developing nations, and disciplines across the natural and social sciences. RISS stresses the role of universities as centers that identify, promote and disseminate successful practices and strategies through local/regional cooperation. We expect to build a cross-cutting platform towards the design of an Asian research and education network, upgrade the information infrastructure and build capacity to support knowledge and experience sharing towards improving problem-identification, analysis, and solving skills.

CONCLUSION

The strategies and initiatives to decouple economic development from human activities that impact on the earth life support systems must focus on a broader scope, namely system innovation. A system innovation implies the improvement of the chain of production, distribution, consumption and disposal activities. Greening industry initiatives on both a local and nationwide scale are among the most important sustainability-oriented initiatives. In Japan, 3R programs, eco-town promotion, and green product design programs have improved its resource productivity performance in terms of both production/consumption and urban activities. In order to pursue the path to a sustainable society, governments have to change and/or actualize their policies and engineering practices in the promotion of energy efficiency and conservation and promote sustainable land use planning in urban and rural regions. It is also necessary to enhance cooperative and comprehensive initiatives on a regional scale, such as regional development policy, urban management and industrial transformation strategies towards sustainable development. This article addresses both regional and national initiatives to promote the transition towards a sustainable Asia, with particular emphasis on the current research by the Osaka University Research Institute for Sustainability Science (RISS). At a local and national level, the article outlined the framework of the Japanese implementation plan towards a sustainable closed-loop economy, which includes action plans for developing a global zero-waste society, macroscopic metabolism accounting, the fundamental plan for establishing a sound material-cycle society, product and process policy by means of green product design, corporate green management strategy, and the practical implementation at a local scale through eco-towns. The article also addressed current Asian policies towards a resource-circulating society. Finally, the article introduced RISS strategies towards the design and development of sustainable closed-loop economies in Asia. These strategies stand on three main pillars: grand design, a sustainability assessment system and research/education networking and capacity building along local, national, regional and continental boundaries.

RISS future research tasks include:

- The construction of a statistical database access and exchange platform that will allow us to improve our research in sustainability science.
- The continuous promotion of scientific events and release of academic journals. RISS has organized many domestic and international workshops where researchers from various disciplines and countries exchange innovative ideas and strategies towards a sustainable Asia. The Japanese Integrated Research System for Sustainability Science (IR3S), of which RISS is a member, launched the Journal of Sustainability Science this year. This journal provides a platform for building a new academic discipline in sustainability science.
- Collaborative research pilot models with Asian countries. RISS is developing a collaborative pilot research with Vietnam and China as an initial step.

With these initiatives, RISS research expects to make an important contribution in the design of the platform towards a sustainable Asia.

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2. Rethinking, Reform and Renovation: Switch the Eco-complexity of Production-Consumption into Sustainability of Efficiency-Harmony

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ABSTRACT

The Ecological Industry (EI) has its own theory and methodology for planning, implementation and management. Industrial ecosystems should be managed in an integrative manner, combining eco-technology or technical innovation (hardware), institutional reform (software) and capacity building (mindware). Eco-technology encourages ecologically sound, economically productive, behaviourally acceptable and systematically responsible technology characterized by the integration of various single low and high technologies, of primary, secondary and tertiary industries. In order to promote an ecological production and consumption society, we need not only to promote 3R Policies (reduce, reuse and recycle), but more importantly, we need to promote rethinking, reform and renovation policies. In the planning process, a methodological transition towards ecological integration is performed from planning physical being to ecological becoming, from mathematical quantification to functional optimization; from rigid control to adaptive learning. It is also important to analyze structural and functional coupling, metabolism balancing and eco-order cultivating. This paper presents a case study of Dafeng, Jiangsu province, China, where ecopolis development planning began in 1987 and eco-agricultural, eco-industrial and eco-communal systems have been developed.

Keywords: Sustainability industry, Complexity, Planning, Management

HUMAN PRODUCTION-CONSUMPTION SYSTEM: SOCIAL-ECONOMIC-NATURAL COMPLEX ECOSYSTEM (SENCE)

Unlike biological communities, the human production-consumption system is a kind of artificial ecosystem dominated by human behavior, sustained by natural life support systems, and vitalized by ecological processes. Ma and Wang (1984) called this system a “Social-Economic-Natural Complex Ecosystem” (SENCE), which is driven by energy, capital, power and spirit, and maintained by ecological cybernetics of competition, co-evolution, circulation and self-organization. Its natural subsystem consists of five traditional Chinese elements: metal (minerals), wood (living organisms), water, fire (energy) and soil (nutrients and land). Its economic subsystem includes the components of production, consumption, reduction, transportation and regulation and its social subsystem includes technology, institutions and culture, which is steered by humankind (Fig. 2.1). Ecological sustainability can only be assured with a human ecological understanding of the complex interactions among environmental, economic, political, and social/cultural factors and with careful planning and management grounded in ecological principles in the context of time, space, process, structure and function.

In dealing with this complexity, people used to focus on the physical "being" rather than ecological "becoming", and focused on the engineering structure, economic process and social function while neglecting its system context.

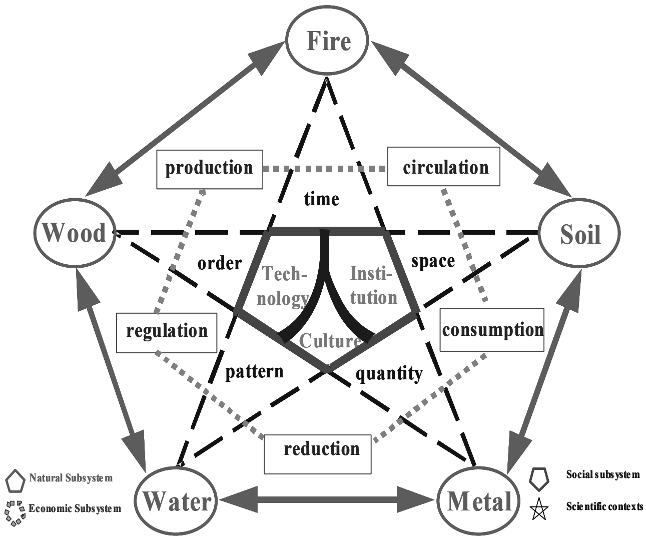

Figure 2.1 Closing the loop: social-economic-natural complex ecosystem

Through this synergetic function, the economy, society and physical environment interacts to sustain a harmonized human ecosystem. According to Lao Dan, a famous ancient Chinese philosopher, this sustaining function “issues forth from nowhere, and yet penetrates everywhere. It is formless, shapeless, vague, indefinite, imperceptible and indescribable, always changing, and reverting to the state of nothingness”. To measure this nothingness, it is essential to image the complicated interactions, how to simplify and integrate the diversified relationship, and how to develop a practical instrument for promoting sustainable development. The SENCE method checks its internal mechanism of competition, symbiosis and self-reliance; its process, pattern and order; its structural wealth, functional health and people’s faith; its efficiency, equity and vitality; the balance among the four driving forces of energy, money, power and spirit and the human interference of technology, institution and culture, from both internal and external, upper and lower scaling, long and short terms, and centralized and decentralized positions.

In some areas of China, the model of early industrialization is characterized by short-sighted behavior, “pollution first, treatment followed; construction first, planning followed; quantity first, quality followed; disorder first, probity followed”; cultural fragmentation such as reductionism dominated philosophy; cause-effect linked cognition; discipline isolated science and nature separated engineering problem-solving oriented decision-making, short term and local scope planning and management. Institutional fragmentation separates resources from the environment; products from services; cities from the countryside; the economy from social development; industries from regional development; the environment from development; production from consumption; waste producing from recycling; and nature exploitation from restoration.

This is an inappropriate model to use for countries to develop. Instead, an ecologically sound society uses resources efficiently, develops at a moderate pace and consumes non-renewable resources at a low level. Building a healthy ecological order means turning the production from end-of-pipe control of pollutants emissions to ecosystem-based zero emissions with a self-reliant by-products exchange mechanism.

From a human ecological point of view, the essence of environmental pollution is the inefficient use and unreasonable exploitation of resources steered by human behavior. There are two significant ecological deterioration processes in production and consumption. One is ecosystem exhaustion due to resource exploitation, where the input of producers “I”, is much lower than the output “O” from the ecosystem. Since there is insufficient input to be used for restoring the deteriorated function, this results in resource exhaustion such as the degradation of soil fertility, watershed function, biodiversity and indigenous' heritage. Here the ratio of I/O is lower than 1. The other ecological deterioration process occurs when the input into the system is much greater than the output from it. In this case energy and materials leak into the environment from the production and consumption process, resulting in ecological stagnation such as eutrophication and heat island effects.

There are several kinds of technology involving a relationship between humans and the environment: environmental technology, cleaner technology, nature conservation technology and eco-technology. Environmental technology aims at reducing and treating pollutants released by human activities; cleaner technology aims at establishing a cleaner production process within any production process so that less or zero pollutants are produced; while eco-technology aims at systematically directing the whole human steering process from resource exploitation, production, consumption to recycling in an ecological manner in order to sustain the optimal function of the whole ecosystem.

The ecological industry (EI), which emerged in the 1990s, combines eco-technology to encourage ecologically sound, economically productive, behaviorally acceptable and systematically responsible technology characterized by the integration of single technologies, both high and low, of primary, secondary and tertiary industries, of factories and surrounding ecosystems.

According to Lowe (2001), "industrial ecology is an approach for managing human activity on a sustainable basis by seeking the essential integration of human systems into natural systems; minimizing energy and materials usage; minimizing the ecological impact of human activity to levels natural systems can sustain." This definition may be too general; to make it more relevant to industry, we refer to industrial ecology as a kind of philosophy in understanding and reforming the relationship between economic development and environmental enhancement in an industry related ecosystem; a kind of scientific theory and methodology on system dynamics and the cybernetics of industrial material and energy metabolism between nature and human society and its physical, economic and human ecological impacts; and a kind of technical and aesthetical instrument for integrative planning, design and management of the production, consumption, transportation, recycling and regulation processes.

The EI has its own theory and methodology for planning, implementation and management. Although EI may be related to consumption and governance, its scope is only confined within the industry itself including all sectors of primary, secondary and tertiary production.

CHARACTERS OF THE ECOLOGICAL INDUSTRY IN CHINA: INTEGRATIVE MANAGEMENT OF AN INDUSTRIAL ECOSYSTEM

Industrial ecosystems should be managed in an integrative manner, combining eco-technology or technical innovation (hardware), institutional reform (software) and capacity building (mindware). Eco-technology encourages ecologically sound, economically productive, behaviorally acceptable and systematically responsible technology characterized by the integration of various single low and high technologies, of primary, secondary and tertiary industries (Fig. 2.2).

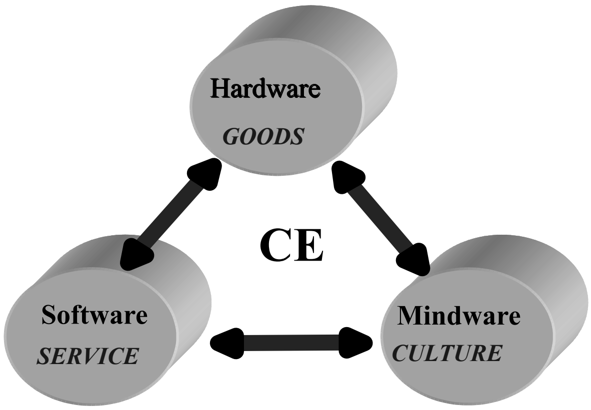

Figure 2.2 Three goals of circular economy

The main characteristics of the integrative management of industrial ecosystem are as follows (Wang 2001; Yan 1992):

- *Food web-based horizontal/parallel coupling:* connecting the different production processes to gain benefit from the negative environmental impacts through sharing unused resources.
- *Life cycle-oriented vertical/serial coupling:* combining primary, secondary and tertiary industries, consumption and recycling sectors into one eco-industrial complex along the life cycle to allow a more systematically responsible production.
- *Ecosystem-based regional coupling:* integrating regional environment, local community, dominant enterprises and other diversified sectors into one agro-industrial service

eco-complexity to internalize environmental costs and to allow pollutants to be assimilated and minimized within the system itself.

- *Flexible and adaptive structure:* multiple production function, diversified products and easy-to-change processes rather than being rigid, unified and imitative in order to adapt to external changes.
- *Functional services rather than products output oriented production:* switching the production focus from products to services with three kinds of final outputs: goods, services and culture; switching the mono-goal of production from profits to the three-dimensional niches of wealth, health and faith.
- *Capacity building:* enhancing the capacity of services and training (S&T); research and development (R&D); incubation and consultation (I&C); adaptive and comprehensive decision-making, sensitive information feedback, effective networking of knowledge, experience and experts, and eco-integrated decision-making.
- *Employment enhancement:* increasing rather than decreasing working opportunities through creating more jobs in R&D, services and training within the industrial ecosystem, although the processing work place might be reduced due to automation.
- *Respecting human dignity:* working as a learning and innovation process, a social interactive and self-enjoyment engagement, rather than being a slave to a machine and oriented mainly to earn one's living. Human ecological gains based on moral beliefs are much more important than a materialistic approach to life.

In order to promote an ecological production and consumption society, we need to implement 3R Policies (reduce, reuse and recycle), and more importantly, we need to promote rethinking, reform and renovation policies.

- *Rethinking:* recycling means not only material processing but also renewable energy, information feedback, financial circulation, personal capacity, including comprehensive planning and management of resource exploitation, processing, transportation, consumption and restoration. Rethinking is to induce value change from reductionism to holism; from environmental exploitation to ecological symbiosis; from an open materialized cycle to a closed ecological cycle; and from external control to self-reliance.
- *Reform:* multi-scale, inter-sectoral and multi-stakeholders' integration is the key for institutional reform. Hierarchy and networking, dominance and diversity, openness and independence, robustness and flexibility are used to measure the eco-sustainability of structural coupling. Reform is to encourage institutional reform; from chain link to life

cycle-oriented vertical/serial coupling; from fragmentized and isolated to food web based horizontal/parallel coupling; from systematically disconnected to ecosystem-based regional coupling; from rigid and non-adaptive to flexible and adaptive production and products structure.

- *Renovation:* technological innovation is the key to a circular economy. Renovation is to redefine the economic function through enhancing functional planning, design and management of the ecological industry; from output and profits oriented to multi-functional services and culture-oriented production; from hardware-oriented investment to knowledge-based and capacity building oriented adaptive economy; from labor decreasing to employment enhancement through creating more jobs in R&D, I&C, S&T; from being slave-like employees to respecting human dignity, working is a learning and innovation process, a social interactive and self-enjoyment engagement, rather than being a slave to machines and money.

APPROACHES OF ECOLOGICAL INDUSTRY PLANNING

In the planning process, a methodological transition towards ecological integration is performed from planning physical being to ecological becoming, from mathematical quantification to functional optimization; from rigid control to adaptive learning (Wang et al. 1991), following structural and functional coupling, metabolism balancing and eco-order cultivating should be analyzed:

Structural coupling

- *Hierarchy and networking*: having an ecological organization through both vertical and horizontal connections enables the human eco-complex to form different scales of eco-unit from individual, community to ecosystem.
- *Dominance and diversity*: having dominant and diversified components enables society to drive and maintain its productive and sustainable development.
- *Openness and independence:* being open to the outside enables the complex ecosystem to make full use of external resources, and being independent from outside enables the ecosystem to be more self-reliant and avoid outside risks.
- *Robustness and flexibility:* a robust structure enables the ecosystem to have fertile productivity, while a flexible structure enables the ecosystem to adapt to the changing

environment.

Functional coupling

- *Exploitation and adaptation:* severe environmental stress leads to adaptation through changing its eco-niche and suiting itself to alternative resources. Successful development maximizes the available eco-niche and optimizes life strategies in order to adapt itself to and make full use of its environment.
- *Competition and symbiosis:* all urban sectors survive through competition for resources and fertile production as well as symbiosis for maintaining sustainability. Competition stimulates high efficiency of resource use and symbiosis encouraging sustainability of the ecosystem.
- *Proliferation and compensation:* when the function of an ecosystem is disturbed, some of its components might take the chance to expand or proliferate unusually so as to dominate the system while other components might make up the missing function or substitute automatically for the malfunctioning components so as to maintain the original function of the system. An ecosystem may benefit or suffer from these proliferation and compensation mechanisms. To stabilize an ecosystem, a compensation mechanism should be encouraged, whereas, raising its productivity, proliferation may play a key role.
- *Exhaustion and stagnancy:* due to resource exploitation, when the output from an ecosystem is much higher than the input into it, which is usually far from the minimum cost for restoring its depleted function, ecological exhaustion will occur. When the input into an ecosystem is much higher than the output from it with a large quantity of materials and energy leaking into the environment, ecological stagnancy will occur. In a totally functioning ecosystem, the I/O ratio is appropriately 1.

Eco-order cultivating

- *Spatial order:* balances the geographical, atmospheric, hydrological, eco-systematic and esthetical harmony.
- *Temporal order*: balances the continuity and sustainability of past, current and future development.
- *Quantity order*: balances the positive and negative feedback to ensure there is no stagnancy and exhaustion.
- *Structural order*: maintains an institutional harmony coupled from different components,

chains, loops and networks of the system.

- *Functional order*: vitalizes the ecological order of competition, symbiosis and self-reliance of the complex ecosystem.

COMBINATORY MODELING FOR THE ECOLOGICAL INDUSTRY

The combinatory EI model includes a learning model, a planning model and a regulation model:

Social learning model of EI

- Dynamics model for understanding the main driving forces and main metabolism processes.
- Cybernetics model for understanding the main positive and negative feedback, and the main risk and opportunities.
- Contexts model for understanding the temporal evolution, spatial pattern, metabolism balance, institutional coupling & functional order.

Adaptive planning model of EI

- *Key identification model*: key limiting, promoting, buffering and critical factors, key dominating and compensating components and key negative and positive feedback.
- *Partial simulation model*: problem diagnosing, process tracing, and policy testing.
- *Adaptive optimization model*: pan-objective ecological programming.

Interactive regulation model of EI

- *Eco-engineering Model*: technological innovation for incubating totally functioning technology.
- *Eco-governance Model:* institutional reform for cultivating systematically responsible institutions.
- *Eco-culture Model:* behavioral inducement to encourage an ecologically vivid culture.

DAFENG –AN ECO-INDUSTRIAL DEVELOPMENT EXAMPLE OF 20 YEARS' IMPLEMENTATION

Dafeng was a relatively less developed county in Jiangsu province in the 1980s with 2376 km^2 land and 740,000 people. An ecopolis was developed and implemented including eco-agriculture, eco-industry and an eco-community in 1987.

Dafeng ecopolis development's main achievements

- Dafeng, a relatively less developed and average level county in the 1980s, ranked in the 100 strongest counties in the economy among 2862 counties in China in 2002.
- By 2004, the GDP and revenue of the county had increased by 16 and 13 times respectively compared with those of 1986.
- The environmental quality improved or maintained the same level as that of 1980 when there were few industries.
- The average life expectancy rose from 71.05 in 1986 to 73.47 in 2004.
- Soil organic content rose from 1.19% in 1986 to 1.45% in 2004.
- Forest coverage increased from 10.61% in 1986 to 17.6% in 2004.
- The core area of National Reserve of crowned crane and David's deer doubled and the deer population has increased by 10 times.
- Water productivity increased from 1.40 kg/m^3 in 1990 to 1.71 kg/m^3 in 2004.
- The organic and green food production ratio increased from 0 in 1990 to 12% in 2004.
- Urban green area per capita increased from 1.86 m^2 in 1989 to 4.56 m^2 in 2004.
- The eco-awareness of decision-makers, industries and ordinary people is much higher than that of neighboring counties.
- More than 30 National Awards/Honors in national greening, forestation, agro-environmental protection, energy development, education, culture, science, sanitation and other social development have been conferred to the county by relevant ministries in the past 15 years.

Main measures of Dafeng ecopolis management

Multi-scale ecological integration and adaptive economic innovation

- Five types of coordination between economic and ecological, agricultural and industrial, urban and regional, territorial and coastal, and between internal and external development across multi-scales from households, villages, industrial parks, towns, watersheds, regions to distant areas such as Shanghai.
- Six kinds of ecological models for coastal wetland conservation and reclamation have been developed.

Eco-agriculture

- Crop – livestock – mixed processing;
- Family- integrative farm-factory-enterprises;
- Local-regional-global cooperative; and
- multi-scale and multi-dimensional eco-agro industry.

Web-linked eco-industrial complex

- Farming-manufacture-trade;
- Cotton planting, ginning, filature, weaving, printing and dyeing-clothing integrative textile eco-complex.

Regional eco-integrity

- Two ecological industrial parks established to promote eco-complex incubation and allow heavy pollution and resource intensive industries enter the parks for intensive treatment.
- Regional cooperation promoted among production-consumption-nature conservation sectors through eco-town & eco-infrastructure development.

Bottleneck of Dafeng ecopolis management

Dafeng eco-county planning was finalized in 1989 but not completely put into implementation. Most of the chain industry was not brought into practice or failed to execution. The main reason for this was inconsistency between the ideal planning with its unsustainable social and economic environment, the pressure of an unreasonable economic structure, the resource-intensive production mode, and the unreasonable spatial layout also resulted in environmental pollution due to the static and fragile coastal plane water network.

Lessons and challenges

Institutional barrier; behavioral bottlenecks and technical insufficiencies

Dafeng ecopolis development suffered from many institutional, cultural and technological conflicts between ecological integration and fragmentized institutions, ecological theory and economic practice, GDP orientation appraisal systems for politician's achievements and the ultimate goal of ecopolis development, internal and external policy environment, long- and short-term development goals, and local and regional efficiencies. The case of Dafeng shows that successful ecopolis development requires:

- Innovatory leaders;
- Advanced hard and soft technology;
- Multi-scale institutional coordination; and
- Technology incubation systems, information dissemination and capacity building networks.

Main problems

- Fragmentized institutions in sectors and times;
- External inconsistencies in policy;
- Weak legislation;
- Insufficiently qualified human resources;
- Weak information feedback;
- Lack of incentives of governance achievements appraisal;
- Lack of ecosystem based resource management;
- Low investment in eco infrastructure; and
- Low input on research & development, services & training.

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3. Towards a Closed-loop Economy: Experiences from the Zhejiang Region in China

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ABSTRACT

This paper introduces the experience of Zhejiang province, China towards a circular economy. The Zhejiang province is a forerunner of the circular economy in China. Nowadays, the recycling industries in Zhejiang operate on a large scale. The main recycled materials are copper, stainless steel, aluminum, plastic and paper. The pathway towards a closed-loop economy is based on two stages in Zhejiang. The first involves the recycling of waste materials and the second is the efficient use of recovered materials. The main catalyst for the development of the circular economy in Zhejiang is the industries' efforts to pursue profit, which means that the circular economy should be profitable for the industries. A significant characteristic of the circular economy in Zhejiang is the geographic concentration of recycling industries. The recycling industries of the same materials, such as copper, paper, etc and the industries of the sectors using these recycled materials as raw materials in their production are gathered together spatially in a region, where they form many industrial clusters of waste material recycling. Clustering may facilitate the formation of an industrial chain of resource recycling and may help in preventing secondary pollution during the process of recycling waste materials.

Keywords: Circular economy, Recycling of waste materials, Geographic concentration, Industrial cluster

INTRODUCTION

This paper introduces the experience of Zhejiang province, China towards a circular economy. Zhejiang is a region with a comparatively high level of economic development in China. The GDP per capita in 2004 reached 23,942 Yuan, which is more than double the average level of China. However Zhejiang is also deeply deficient and dependent in terms of natural resource consumption. 95% of the energy resources of Zhejiang come from other provinces. Another characteristic of the region is that 99% of the industries are private enterprises. As we know, due to increasing demand, nowadays it has become very difficult to get cheap natural resources. With this in mind, enterprises have focused on the recovery and recycling of waste materials. Industries in Zhejian have been taking these steps since the 1980s and consequently, Zhejiang has become a forerunner of the circular economy in China.

CIRCULAR ECONOMY IN ZHEJIANG: CURRENT SITUATION

In 2004, the amount of waste materials recycled by industries in Zhejiang reached 18.17 million tons, including 8.21 million tons of waste metals, 6.2 million tons of waste paper and 2 million tons of waste plastic. The most recycled materials in the province are copper, stainless steel, aluminum, plastic and paper.

Nowadays the recycling industries in Zhejiang operate on a large scale. The output of copper processing based on copper recycling was 1.186 million tons in 2003, which represents 37% of the total in China. 50% of the raw materials used in the processing were reclaimed copper. In 2004, the output of stainless steel based on stainless steel recycling was 1.06 million tons and the output of stainless steel products was 1.46 million tons respectively. The output of both stainless steel and its products accounts for 40% of the total in China.

Various recycling clusters have been formed in Zhejian province in recent years. The main recycling clusters include Yongkang cluster, Luqiao-Wenling cluster, Yuyao-Cixi cluster and Fuyan cluster. The Yongkang cluster mainly focuses on the recycling of waste metals (copper and aluminum) and the production of hardware products. The Luqiao-Wenling cluster focuses on the production of motorcars, motorcycles, sewing machines, sanitaryware, and fittings of motorcars and motorcycles. The raw materials for its production come mainly from the disassembly of waste electrical equipment. The Yuyao-Cixi cluster focuses on the production of household appliances and uses recycled metals and plastic as raw materials. Today, Yuyao has become the largest household appliance production region in China.

The recycling of waste materials and their further use in production dramatically reduces energy consumption and air pollution emissions. For example, the hardware production by using reclaimed aluminum reduces the energy consumption by 5% and cuts air pollution emissions by 10% compared to the use of virgin raw material (mainly ore bauxite). However, the dissembly and recycling of waste materials may cause secondary pollution. In fact, in some regions, the secondary pollution generated by the recycling process of waste materials has become a serious environmental problem.

DEVELOPMENT OF THE CIRCULAR ECONOMY: DRIVING FORCES

The Zhejian region follows two main stages in the path towards a closed-loop economy. The first involves the recycling of waste materials and the second, the efficient use of the recovered materials. During the first stage, since a steady supply of raw material is essential for the industries, they ensure the supply of raw materials by recycling waste materials. By using low-price recycled materials, industries may reduce production costs, which is an important advantage when competing with other firms. At this stage, industries collect waste materials through suppliers, which are usually small firms. They mainly produce primary products by using simple equipment. At the second stage, in order to increase their competitiveness, firms improve the quality of products and add value through technological innovation. They collect waste materials in designated stations or through imports. Many firms have become modern enterprises and produce manufacturing products on a large scale. One famous example is Geely Motorcar, which is the only private motorcar firm in China.

The main driver for the development of the circular economy in Zhejiang is the industries' efforts to pursue profit. As mentioned before, most firms in Zhejiang are private enterprises. Due to increasing demand, nowadays it has become very difficult to obtain cheap natural resources. With this in mind, enterprises have focused on the recovery and recycling of waste materials. By recycling waste materials, firms may reduce production costs. For example, the cost of reclaimed copper is 3000-5000 Yuan/t lower than that of raw copper, and the price of products using reclaimed copper is 2000 Yuan/t lower than that by those using raw copper. Technological innovation has two main roles in the pursuit of the circular economy in Zhejian: it makes it possible to recycle waste materials at the first stage of resource recycling and increases the quality of products at the second stage through the efficient use of the recycled materials.

GEOGRAPHIC CONCENTRATION OF RECYCLING INDUSTRIES

A significant characteristic of the circular economy in Zhejiang is the geographic concentration of the recycling industries. The various recycling firms for the same material and the production firms of the sectors making use of the recycled materials are gathered together in a specific area. In the case of stainless steel, Ningbo and Wenzhou provinces concentrate 92% of stainless steel production and 95% of stainless steel products respectively. In Ningbo, the output of coiled sheets accounts for 49% and that of welding pipes 57%. In Ningbo, around 200 industries gather together in Yuyao, Fenghua and Yinzou, while in Wenzhou, 170 industries gather together in the Longwan district. The output of seamless stainless pipes reaches 207,500 tons, which accounts for 90% of the country production, and the export of seamless stainless pipe accounts for 50% of the nation’s total. In the case of waste copper recycling, over 60% of waste copper recycling in Ningbo comes from the Cicheng town of Jiangbei and the Jinghan town of Cixi. Waste plastic recycling is mostly done in Dongyang, Cixi and Taizhou. In Dongyang, industries are amassed in Huaxi town. There are more than 1500 industries, employing around fifty thousand people.

As a result of this geographic concentration, many industrial clusters of waste material recycling have been established in Zhejiang. The following are some examples of recycling industrial clusters formed in Zhejian.

The industrial cluster of recycling waste metals in Yongkang

There are more than 1000 industries that recycle waste metals and in Yongkang city, they employ more than 100,000 employees. The Yongkang industrial cluster recycles 250,000 tons of waste aluminum, 120,000 tons of waste copper and 300,000 tons of waste steel per year. Today, Yongkang has become the main production and processing base of hardware products in China, mostly by using reclaimed aluminum and copper. The main hardware products include electric tools, electric cars, fittings for motorcars and motorcycles, stainless steel products, and burglarproof doors. The production of electric tools accounts for 25% of the national total and total exports account for 33% of the same.

The industrial cluster of disassembled waste electric equipment in Luqiao

This is an industrial park for the disassembly of waste electric equipment with an area of 106 ha at Fengjiang town of Luqiao. 40 industries are gathered in the park, which has an annual disassembly capacity of 2 million tons. The disassembled waste materials are then supplied to manufacturing sectors. In the industrial park, the secondary pollution that comes from the disassembly process is treated effectively, significantly reducing the overall environmental impact.

The industrial cluster of recycling waste metals in Yuyao city and industrial cluster of recycling waste plastic in Cixi city

In Hemudu town of Yuyao, there are 110 stainless steel industries. The processing capacity is 250,000 tons per year. The production value of stainless steel accounts for 80% of the total production of the region. In Cixi, there are 30 industries and 20 thousand employees engaged in the reclamation of terylene fibre. The annual output of reclaimed terylene fibre is 700,000 tons, with annual sales income of 5000 million Yuan. Both values account for 25% of the national totals. All the raw materials used in production come from waste silk or plastic bottles. About 30-40% of the raw materials come from domestic sources, and the rest are imported.

The industrial cluster of paper mills in Fuyang

Fuyang is a traditional paper producing area. In 2004, the amount of waste paper recycled by paper mills in Fuyang reached 4 million tons, which accounts for nearly 10% of the total quantity paper production in China. The production value of paper making, namely 8500 million Yuan, accounts for 20% of the total industry product in Fuyang.

CONCLUSION

Since Zhejiang is deficient in natural resources, industries have started to focus on the recovery and recycling of waste materials and take strides towards a closed-loop economy since the 1980s. The development of the circular economy in Zhejiang has two main stages: the first involving the recycling of waste materials and the second the efficient use of the recycled materials. During the first stage, since a steady supply of raw materials is essential for industries, they ensure this supply of raw materials by recycling waste materials. By using low-price recycled materials, industries may reduce their production costs, which is an important advantage when competing with other firms. At the second stage, in order to increase their competitiveness, firms improve the quality of products and add value through technological innovation. Due to increasing demand, nowadays it has become very difficult to obtain cheap natural resources. With this in mind, enterprises have focused on the recovery and recycling of waste materials. By recycling waste materials, firms may also reduce production costs.

The development of the circular economy in Zhejiang is characterized by the geographic concentration of recycling industries. As a result, many industrial clusters of waste material recycling have been formed in this province. There are several representatives, such as an industrial cluster of recovery aluminum by recycling waste aluminum in Yongkang, an industrial cluster of motors and sewing machines by recycling waste electric equipment in Luqiao-Wenling, and an industrial cluster of home electronics by recycling waste metals and plastic in Yuyao-Cixi.

The initiatives of firms to pursue profit and technological innovation are vital for a closed-loop economy, which means that the circular economy should be profitable for the firms. The geographic concentration of recycling industries contributes largely to the formation of an industrial chain in resource recycling and external economies of scale. The clustering of industries also helps reduce secondary pollution during the process of recycling waste materials. In this sense, local governments play an important role in realizing the circular economy through the promotion of industrial clusters.

4. Environmental Management in Industrial Development: Resource Conservation and Material Recycling Strategy in Vietnam

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ABSTRACT

After choosing industrialization as a key development strategy, Vietnam is now facing environmental challenges. Our generation has no right to gain short-term economic benefits, bequeathing long-term environmental disasters to future generations and measures to compromise economic and environmental goals should be considered. One of these involves organizing industrial systems based on an industrial ecology approach. The main idea of Industrial Ecology is that for sustainable development, industrial systems should mimic natural ecosystems. In other words, the material cycles in industrial systems should be closed, similar to those in natural ecosystems. The purpose of this paper is to analyze the advantages and constraints in applying the concept of industrial ecology, and to suggest some ideas to promote industrial ecology in Vietnam.

Keywords: Industrial metabolism, Industrial ecosystem, Industrial ecology, Pollution prevention, Resources conservation, Material recycling

INTRODUCTION

Industrial development has recently had to face the major challenges of natural resource scarcity, and environmental deterioration. Although end-of-pipe technologies can help reduce the environmental impact of waste, these technologies tend to be costly and provide no help in solving the problem of natural resource scarcity. Recently, environmentalists have sought to apply a preventive approach instead of relying solely on a reactive approach to solve environmental problems. The Industrial Ecology concept has emerged as a solution to address these challenges, providing us with a new perspective to develop industrial systems in an ecologically sound direction. In this paper, the concept of Industrial Ecology will be introduced, followed by the illustration of Industrial Ecology in practice, the analysis of the advantages and constraints in applying this concept in Vietnam, and some conclusions and recommendations to promote Industrial Ecology in Vietnam.

INDUSTRIAL ECOLOGY: RESOURCE CONSERVATION AND POLLUTION PREVENTION APPROACH

Industrial Ecology is known as the resource conservation and pollution prevention approach. The concept of Industrial Ecology is introduced in literature under different terms such as *Industrial Metabolism, Industrial Ecosystems*, *and Industrial Ecology* by different authors. Some authors use these terms similarly, while others have distinguished them (see for example Ayres and Simonis 1994; Cote 1995; Graedel and Allenby 1995; Lowe et al 1997; Ayres 1997; Erkman 1997; Durney 1997). Although a discussion on the terminology is not the purpose of this paper, it is necessary to make the distinctions among these terms in order to understand the concept of Industrial Ecology.

Industrial metabolism

In 1988, the concept of industrial metabolism was officially formulated for the first time during the International Geosphere-Biosphere Programme Conference in Tokyo (Ayres 1995). The term “industrial metabolism” was defined as follows:
“The metabolism of industry is the whole integrated collection of physical processes that convert raw materials and energy plus labour, into finished products and waste in a (more or

less) steady-state condition." (Ayres 1994)

With the introduction of the concept of industrial metabolism, scientists emphasise that industrial activities are not separated from the metabolism of the biosphere and that it is the human economic and industrial activities that cause the problem of global change through their interference in the ecological balance and natural cycles (Ayres 1997). Therefore, the industrial metabolism concept has suggested that:

- Businesses must improve material efficiency, as unbalanced inputs (raw materials) and outputs (waste and products) have negative impacts on the natural world.
- Industrial systems must begin to use alternative energy sources and improve the efficiency of current energy sources.
- The metabolism of industry can be modified to reduce the negative impacts of industrial activities on the biosphere.

After being introduced, the concept of industrial metabolism continues to gain international recognition as a theoretical framework useful for investigating the material and energy flows, both within industry and between industry and the natural environment.

Industrial ecosystem

As living organisms live in an ecosystem, they have to interact with other living and nonliving things to survive. Similarly, in order to maintain and carry out industrial activities, industrial firms must interact with other actors in the industrial system in particular, and in society in general. However, differences exist between an ecosystem and an industrial system in terms of material cycles. An ecosystem is more efficient than an industrial system, because natural cycles (water, carbon/oxygen, nitrogen, sulphur, etc.) are closed, whereas industrial cycles are open. In order to increase the efficiency of industrial systems, Frosch and Gallopoulos (1989) suggested that industrial systems should mimic ecosystems, and they introduced the concept of the industrial ecosystem. They proposed the transformation of the traditional model of industrial activity, in which individual manufacturing takes in raw materials and generates products to be sold plus waste to be disposed of, into a more integrated system, in which the consumption of energy and materials is optimized and the effluents of one process serve as the raw material for another. This concept focuses on the relations between companies in a direct waste/by-product exchange.

Although the term industrial ecosystem has been present in the writings of many ecologists such as Odum, Margalef, Hall, and geochemists such as Cloud, according to Erkman (1997), it is Frosch and Gallopoulos who make a vital contribution to the introduction and dissemination of this concept.

Industrial Ecology

Cote (1995) compiled many definitions from the early literature on Industrial Ecology, but according to Erkman (1997), `there is no standard definition of Industrial Ecology, and a number of authors make no clear distinction between industrial metabolism, industrial ecosystem, industrial symbiosis, and industrial ecology. However, whatever the definition, all authors are more or less in agreement on at least three key elements of the industrial ecology perspective:

- It is a systemic, comprehensive, integrated view of all the components of the industrial economy and their relations with the biosphere.
- It emphasizes the biophysical substratum of human activities, i.e. the complex patterns of material flows within and outside the industrial system, in contrast with current approaches that mostly consider the economy in terms of monetary units.
- It considers technological dynamics as a crucial (but not exclusive) element for the transition from the presently unsustainable industrial system to a viable industrial ecosystem.

As current industrial systems are much more open than their ecological counterparts, relying heavily on energy, materials from the environment and discharging much waste into the environment, industrial ecology has tried to demonstrate that, based on the principles of ecological science, industrial systems can be developed on a more sustainable basis. According to industrial ecology scholars, we must first understand how the industrial system works, how it is regulated, and how it interacts with the biosphere. Subsequently, based on what we know about ecosystems, we can restructure industrial systems towards a more sustainable model, akin to the way natural ecosystems work. At the most basic level, the Industrial Ecology perspective describes a system in which the waste of one industry (output) becomes the raw material of another (input). With such an exchange of waste, fewer materials/energy would be expended and fewer input materials/energy required. At least three groups of people will benefit from such exchange: the waste generator can save on waste treatment and disposal costs, and gain revenue from the sale of the waste at the same time;

while the waste user can reduce the input cost; and the public, in general, can enjoy a better environment.

In brief, *Industrial Ecology* acknowledges the existence of a wide range of *industrial ecosystems* with varying degrees and patterns of interactions with the biosphere. Each industrial ecosystem is characterized by the flows of materials and energy *(industrial metabolism)* similar to those going through a natural ecosystem.

INDUSTRIAL ECOLOGY IN PRACTICE

The concept of industrial ecology has become increasingly attractive in recent years. However, many prerequisites exist for the success of its application. Firstly, the main requirement is that there be a major “export product’ for the system as a whole, and that most of the waste and by-products be utilised locally. Secondly, large scale operation is required, in which there exist at least three components locally, namely: the waste producers; the waste consumers; and intermediate firms specialised in converting the waste into useful raw materials. Thirdly, a reliable mechanism is also required to ensure close and long-term co-operation among participants (Ayres and Ayres 1996).

The exchange of waste in the industrial ecology concept can take place between industrial sectors, but the distance from the waste generator to the waste user will be problematic. Certain waste or by-products cannot be transported over a long distance or doing so is not worthwhile. Hence, due to the fact that there is a diversity of industrial sectors in industrial zones (IZ), and the proximity of industrial firms within IZ, it is clear that IZ represent ideal venues to apply the industrial ecology concept (UNEP 1997; Hamner 1998; Cote 1998). Moreover, many industrial ecologists have focused upon industrial ecosystems as a key strategy for implementing industrial ecology (Ernes 1997).

In practice, the concept of industrial ecology is applied in the forms of industrial symbiosis and industrial ecosystems or eco-industrial zones or eco-parks. Industrial symbiosis is a group of industries that work collaboratively through exchanges of materials, energy, water, and by-products to reduce natural resource consumption and pollution. Industrial Ecosystem/Eco-Industrial Zone/Eco-Park is a community or network of companies and other organizations in a region or physical zone/park that interact by exchanging and making use of by-products and/or energy in a way that provides one or multiple benefits over traditional, non-linked operations. Those benefits include a reduction in the use of natural resources for input; a reduction in pollution; a reduction in energy use; a reduction in waste disposal and an increase in the value of non-product outputs.

Since the late 1980s when the concept of Industrial Ecology was first developed, many industrial ecosystems have been designed and operated. The following provide some ideas of the experiences gained to date.

Denmark

The best-known global example of industrial ecology is Kalundborg - a small Danish industrial ecosystem - located roughly 75 miles from Copenhagen in Denmark. Participants in the industrial ecosystem of Kalundborg are Asnaes (an electric power plant), Statoil (an oil refinery), Gyroc (a plasterboard factory), and Novo Nordisk (a pharmaceutical plant). The Kalundborg Industrial Ecosystem began when the Asnaes electric power plant modified its operation to produce process heat in the form of steam that could be sent to the nearby Statoil refinery. Besides, the power plant could also sell steam to a pharmaceutical plant, and hot water to greenhouses, local homes, and its own fish farm. Moreover, the Asnaes power plant can also sell fly ash for road building and cement making; and gypsum (calcium sulphate), recovered from sulphur dioxide scrubber, is supplied to the Gyroc plasterboard factory. In contrast, it receives surplus gas, cooling water, and cleaned wastewater from the Statoil. The Statoil refinery produces ethane and methane for Gyro's drying ovens and for the power station's boilers; while the residue from Statoil's sulphur scrubbers is used in the production of sulphuric acid. Nutrient-rich sludge from the Novo Nordisk pharmaceutical plant is piped to surrounding farm to be used as fertiliser, for Novo Nordisk, this is the cheapest way to comply with regulations prohibiting dumping of such sludge at sea. The waste exchange network between participants in the Kalundborg Industrial Ecosystem is presented in Figure 4.1.

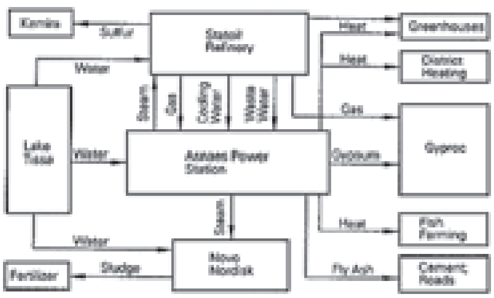

Figure 4.1 Kalundborg industrial ecosystem

Obviously most of the components of an industrial ecosystem are present in Kalundborg, from the primary producers to the equivalent of the decay organism. This model of the industrial ecosystem in Kalundborg has helped reduce air, water, soil pollution as well as resource consumption at the same time. Based on an investment of 60 Million USD, the participating companies have generated 129 Million USD in revenues from by-product exchanges and additional cost saving from business efficiency improvements (UNEP 1997). In terms of environmental quality, with such an exchange of waste, the Kalundborg industrial ecosystem can reduce SO_2 emissions by 3,700 T/year and wastewater by 600,000 m^3/year (Gertler 1995). Large savings have also been achieved in the consumption of raw materials, with annual oil consumption reduced by 45,000 T and coal consumption by 15,000 T (Karamanos 1995).

The USA

In the USA, with an interest in applying the ecological concept to industrial activities, the President's Council on Sustainable Development chose four communities as demonstration sites for Eco Parks (1994): Baltimore, Maryland; Cape Charles, Virginia; Brownsville, Texas; and Chattanooga, Tennessee. The principles of the design are based on an industrial ecology framework, seeing the possibilities of creating waste exchange and seeking greater interconnection between suppliers, producers, and customers for high quality performance.

Fairfield Industrial Park in Baltimore is one template for the design of Eco Parks in the USA. It consists primarily of producers with processes based on petroleum and organic chemicals (e.g. asphalt manufacturing and distribution, oil and chemical companies) and smaller companies, which aid the larger producers (e.g. trucking, tire retreating, and box manufacturing). Fairfield has been described as a ”carbon based economy”. This creates a great opportunity for the further recycling of organic compounds. The Fairfield Eco Park will retrofit industrial ecology principles to existing companies, and recruit companies that fit into the carbon-based economy. The strategy is to welcome the following types of enterprises: manufacturing that fits with the current ecology (e.g. chemical companies, film/photo companies); environmental technologies; recyclers and waste exchanges (Rosenthal 1996).

Canada

A group at Dalhousie University, Nova Scotia, Canada has been studying the application of ecological concepts to the design and operation of industrial zones. Burnside Industrial Park in Dartmouth was chosen for the purpose of converting an existing, traditional park into an industrial ecosystem. Largely because of its diversity, the park was selected as a working laboratory for the Eco Park. In an initial study, a research team identified a number of strategies, guidelines, potential symbiotic relationships and support systems, which would facilitate the transformation of Burnside. In order to convert Burnside into an Eco Park, the collaboration and networking required have occurred at different levels: 1) the university and municipality in the study and the application of industrial ecology to an industrial park; 2) the university, the private electric utility company and governments in the creation of the Eco-Efficiency Centre; 3) material exchanges between two or more companies; 4) the establishment of new companies to take advantage of opportunities in the reuse, rental, repair, remanufacturing and recycling. Based on the Burnside project experience we can conclude that that while an interest in eco-industrial development and a willingness to participate are important for launching projects, the main success factor is a continuing commitment by a group of partners from government, industry, academia, and community organisations. Eco-industrial developments are not short-term initiatives, and without this commitment, projects cannot be sustained (Cote 2001).

The Netherlands

In the Netherlands, the industrial area in Rotterdam (the largest port in the world) covers about 700 km^2 with 69 companies, consisting of mixed industries: refineries (7 companies), petrochemistry (13 companies), industrial services (10 companies), inorganic chemistry (11 companies), mass goods (13 companies), and storage and transport (15 companies). In this industrial area, an industrial ecosystem project (INES) has started in order to look at the potential for companies to reuse waste streams, by-products and energy from each other (Baas 1997).

Many cities/provinces in the Netherlands, such as Arnhem, Den Bosch, Apeldoorn, and Utrecht have developed industrial estates towards the concept of an industrial ecosystem by seeking the opportunities to exchange energy, raw materials, and water; to facilitate the common use of utilities, combining the transport of goods and people, and the collective gathering and treatment of waste flows (Ministry of Economic Affairs 1998).

Thailand

Thailand has recently had a project on the Implementation of the Eco Park Concept at Map Ta Phut Industrial Estate. Map Ta Phut Industrial Estate is located in the western area of Rayong City, in the Rayong Province, which is on the eastern shore of the Gulf of Thailand. It is a large gas-related and heavy industrial complex. Most of the industries invested in this area are petrochemical plants (42%), and chemical and fertiliser plants (30%), with the remainder steel plants (14%), electricity, steam, gas plants (10%), and oil refinery plants (4%). The Eco park project in this area develops a close loop between industries to promote the clean and green industrial development concept, to maximise the benefits from the utilisation of natural resources and minimise pollution problems, and to generate co-operation among industrial operators, local communities and regulators (IEAT 2001).

INDUSTRIAL TRANSFORMATION IN VIETNAM: RESOURCE CONSERVATION AND MATERIAL RECYCLING

Vietnam, with its specific conditions, has its own opportunities and barriers to adopt the concept of industrial ecology. Based on literature, surveys and interviews carried out with factories/enterprises in seven industrial zones (IZ) in the Southern Key Economic Region of Vietnam[1] we can summarise some advantages and constraints to apply to the industrial ecology concept in Vietnam.

Advantages

- The Environmental Law (1994), Chapter II, Article 11 states that ‘the government encourages individuals and organizations to use and exploit natural resources reasonably, to apply advanced technologies, clean technologies, reuse waste, save materials, use renewable energy, ... in scientific research, production and consumption’. This forms the legal basis for the application of industrial ecology.
- In Vietnam, the establishment of dozens of IZs under the management of Industrial Zone

Infrastructure Development Companies (IZIDC)[2] with the diversity of industrial sectors is one of the advantages of introducing industrial ecology. Many half-empty IZs that can be filled according to industrial ecology criteria are also an advantage. Because industrial ecology can be introduced to both existing and planned IZs, Kallundborg (Denmark), Burnside (Canada), Rotterdam (The Netherlands), etc are among examples involving the conversion of existing IZ into an industrial ecosystem by investigating the possibilities of creating waste exchange and seeking greater interconnection between existing industries within IZs. Chattanooga (The USA) and the eco projects in many cities/provinces in the Netherlands are among the examples of designs for an industrial ecosystem. Half-filled IZs also present an advantage for the design of industrial ecosystems, since new industries will be recruited to complement existing businesses and enhance waste exchange.

- The relocation of small and medium enterprises (SMEs) to newly established IZs may offer an advantage to promote waste exchange on the one hand, and on the other, the industrial ecosystem might make it attractive for SMEs to relocate. Because SMEs usually lack capital, when they participate in the closed loop program in the industrial ecosystem, these enterprises could have considerable opportunities to save their capital on the sale or purchase of by-products. They also benefit from economies-of-scale advantages in the waste treatment facilities in Izs, which may increase the appeal of the industrial ecosystem. On the other hand, since many SMEs are waste recycling enterprises themselves, the relocation of these enterprises to Izs, which mostly lack the most important components of the ideal industrial ecosystem – the recycler - could help to enhance waste exchange.
- Ad-hoc waste exchange experiences must be institutionalized. This can, in a number of cases, be done in an IZ, where IZIDC takes the role of intermediate stimulator and co-ordinator.
- The recent establishment of the Vietnam National Cleaner Production Centre is the starting point for introducing a cleaner production and pollution prevention approach. Industrial ecology can be integrated in the activities of this organization[3]
- Vietnam can benefit from the available reuse technologies (e.g. Rosenthal 1996; UNEP 1997; Ayres 1996). A variety of waste, such as paper, rubber, glass, food waste; and cloth waste, etc. have been reused in many ways in Vietnam (Tran Kim Qui 1979). Considerable research on waste reuse can also be found in Vietnam (Vo Thoi Trung 1990;

Pham Thi Tran Chau et al. 1981; Lam Thi Kim Chau et al. 2000; Hoang and Nguyen 2000; and Tran and Nguyen 2000).

- In Vietnam, many factories/enterprises are using waste materials for their input into the production processes, while other factories/enterprises sell their waste. This proves that waste exchange by factories/enterprises operating in Vietnam is not unknown.
- Some studies that focus on waste reuse can be found in Vietnam: black liquor from pulp mills can be used as a supplementary raw material for the concrete industry (Vo Thoi Trung 1990); enzyme bromeline extracted from pineapple can be used in the production of fish sauce (Pham Thi Tran Chau et al. 1981); enzyme protease extracted from food processing waste can be used for the treatment of worm silk to replace imported chemicals (Lam Thi Kim Chau et al. 2000). Recently Hoang and Nguyen (2000) successfully recovered zinc from solid waste disposed by a zinc-covered Sheet Iron Factory; and Tran and Nguyen (2000) produced coloured powder from the sludge of a chemical factory, etc.

Constraints

In general, the application of industrial ecology has some practical constraints. In order for a waste material to become a useful resource, it must be separable and available in a valuable form, which requires appropriate reuse/recycle techniques. Although a number of studies exist on the reuse/recycling of waste, the practical application of these studies remains limited. Resource inflexibility is another potential problem, since the waste user will come to rely on the waste producer for the quantity and quality of the exchanged waste (Karamanos 1995). In an industrial ecosystem, some producers must accept unfamiliar inputs (converted waste) rather than traditional raw materials. In some cases, they have to invest a large sum of money to create new processing facilities; while on the other hand; consumers have to change their behaviour to accept new kind of products produced from “waste” (Ayres 1996). As such, legal, information, technical, organisational and cultural constraints may impede industrial ecology. Specifically, Vietnam has some typical constraints:

- Vietnam has not yet implemented a concrete policy to encourage the reuse and recycling of waste.
- The existing price system does not reflect the real value of raw materials, because it does not internalise the externalities or costs of environmental damage. Consequently, the

price of raw materials is, in general, lower than the real price and industrialists have no incentive to reuse/recycle waste.

- In Vietnam, the price and the quality of the products are the most important for consumers. Little attention is paid to ecological criteria. A cautious attitude towards products made from waste is also popular among consumers, making it difficult for these products to find their way to the domestic market.
- A lack of information between the waste producer and buyer. In particular, the waste producer does not want to reveal the type and amount of the waste concerned to the public for fear of being accused as a polluter.
- Most recycling activities are carried out in the informal sector and there is no systematic recycling sector well developed enough to close the loop of the material cycle (Rekha et al. 1994).
- The quality of products made from waste is usually lower than that of those made from raw materials (e.g. paper, plastic, metal).
- The reuse/recycling are usually related to pollution problem (Rekha et al. 1994; Pham Ngoc Anh 2000). The use of waste as supplementary raw materials in some case produces more pollutants. The use of rubber waste as fuel will produce a lot of toxic pollutants.
- Local recyclers or customers of waste are not always available.

CONCLUSION AND RECOMMENDATIONS

Although there are a number of constraints to apply the concept of industrial ecology in Vietnam, there remain some advantages to introducing industrial ecology to industrial zones. The following are some suggestions to promote the application of industrial ecology so that Vietnam might overcome the environmental challenges of economic development.

- Firstly, the industrial ecology concept should be disseminated and familiarised among policy-makers, decision-makers, industrialists, etc. This can be done through workshops and seminars.
- Secondly, increasing the environmental awareness of consumers is necessary to support the introduction of ecological criteria into consumption behaviour. The dissemination of ecological criteria to consumers can be done through academic curricula and the mass media.

- Thirdly, it is clear that materials, energy and exchange among firms require a clear understanding of the inputs and outputs of each participant. The first step for putting industrial ecology into practice is to study the material and energy flow and waste auditing is well suited for providing that information. As Erkman and Ramaswamy (2001) stated, waste audit is one of the critical elements in the planning process for industrial ecology. The Dong Nai Department of Science, Technology and Environment (DOSTE), Binh Duong DOSTE and Ho Chi Minh City DOSTE have, to a certain extent, carried out a waste audit in some factories with the help of UNIDO. This can be extended to factories in IZs as a starting point for a waste exchange program and the design for industrial ecosystem(s).
- Fourthly, presently, the available technologies remain limited in Vietnam. Moreover, the recycling processes are usually related to pollution, the quality of products produced from waste have been, in most cases, lower. It is necessary to invest more in R&D to improve the quality of the products, production process, and to identify the best available technologies to facilitate waste exchange practice. A research fund for the study on reuse/recycle technologies is indispensable. Researchers at universities/institutes can play a vital role in this respect if they are motivated.
- Fifthly, it is also necessary to promote collaboration between universities/institutes and factories/enterprises in research and application of the reuse/recycling of waste to fill the gap between research and practice. The provincial DOSTE can play a role as a bridge to connect researchers and industrialists and enhance the collaboration.
- Sixthly, in order to encourage industrialists to participate in waste exchange, on the one hand, the government should have some economic incentive mechanisms, such as a reduction in tax or soft loans for factories/enterprises applying the reuse/recycle of waste. On the other hand, the government should adjust the price distortion (internalisation of the environmental damage cost into the price of raw materials).
- Seventhly, the establishment of waste exchange programs [4] is recommended, through which the lists of waste and by-products will be published, and the waste buyers and waste sellers would have the chance to meet each other. Implementing the waste exchange program requires an organization that collects and disseminates information on the potential for waste exchange, and an intermediate body to connect the waste sellers and buyers. In this respect, the VNCPC can play a significant role in reviewing the available reuse/recycle techniques/technologies both indigenously and globally, and

setting up a data bank to collect and provide information on the possibility of waste exchange. The VNCPC can collaborate with universities/institutes on R&D into reuse/recycle technologies. At a provincial level, DOSTE can coordinate with the Industrial Zone Infrastructure Development Company to carry out a waste exchange program in IZs. DOSTE is responsible for the technical aspects while the Industrial Zone Infrastructure Development Company is responsible for the organisational aspects.

- Eighthly, the relocation program can be integrated into a waste exchange program: recruit the required waste recycling enterprises and waste consuming enterprises to IZ to enhance waste exchange within the IZ. In this respect, DOSTE and Industrial Zone Infrastructure Development Company can coordinate.
- Last but not least, carrying out a demonstration project on industrial ecology at one industrial zone means the results of the project will be multiplied for others.

NOTES

[1] Le Minh Xuan IZ, Binh Chieu IZ, (Ho Chi Minh City); Bien Hoa I IZ, Bien Hoa II IZ, Nhon Trach IZ (Dong Nai Province); VSIP, Viet Huong IZ (Binh Duong Province).

[2] Industrial Zone Infrastructure Development Company is responsible for the development of infrastructure and the environmental quality within the boundary of its IZ.

[3] Experience of Canada: being established in 1995, Burnside Cleaner Production Centre (Canada) plays a significant role in providing information on waste reduction and prevention, cleaner production; and studying the possibilities to apply industrial ecology concept into existing industrial zones (Smolenaars 1996).

[4] Experience of the Philippines (See Favilla 1994).

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5. What does Sustainability Mean to Yuhan-Kimberly?

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ABSTRACT

As one of the leading health and hygiene companies in Korea, Yuhan-Kimberly enjoys the leading position in its field thanks over three decades of continuously introducing many innovative products and social programs into the market. This success can be attributed to the leadership efforts in such fields as Environmental Management, Ethical Management and now Sustainable Management. What does Sustainability mean to Yuhan-Kimberly? It is the Company's belief that a sustainable company should be sustainable together with 4 external customers, namely: the Earth, the Market, the Communities and the Supply Chains. To meet this belief, Yuhan-Kimberly has applied sustainability tools to those 4 customers such as Cleaner Production, Environmental Management System, Eco-Labeling, Eco-Design, Life Cycle Assessment, Environmental Reporting, and Supply Chain Environmental Management. This also shows how Yuhan-Kimberly can crystallize sustainability into feasible and harmonized action steps while retaining consistency throughout company operations.

Keywords: Sustainability, Environmental performance, Environmental management, LCA, Eco-efficiency, Supply chain environmental management, Corporate social responsibility, DfE

INTRODUCTION

Yuhan-Kimberly was established in 1970 as a joint venture by Yuhan Corporation in Korea and Kimberly-Clark, a consumer product company in the USA. Its main business areas are Personal Care Products, Household Products, Industrial Products, Health Care Products and Digital Textile Printing Solutions. As a leading personal care product company in Korea, Yuhan-Kimberly has introduced the most innovative products in the industry achieving a 50% market share in all the product categories in which our company is involved. The company is also the clear leader in Korea in terms of corporate social responsibility activities, including environmental protection activities and ethical management. As a result, Yuhan-Kimberly has earned a good reputation in various aspects. For example, the company was awarded the "best employer and environmental management company" in 2003. It was also the most admired company in 2005. This article introduces the Company's approaches towards sustainable management (SM) and the main outcomes. We will explain how Yuhan-Kimberly defines corporate sustainability and its impact on the environment, products and society. We will particularly focus on the effort and methods with our four external customers (earth, market, suppliers, community).

SUSTAINABILITY IN YUHAN-KIMBERLY

In order to implement Sustainability, Yuhan-Kimberly has a multi-dimensional organization. As can be seen in Figure 5.1, the CEO in the Company may have quadruple meanings; Chief Executive Officer, Chief Environment Officer, Chief Ethics Officer and Chief Education Officer. This implies how important environment, ethics and other aspects are in the company's management. In line with this mindset, a professional team for sustainability has also been established. SM consists of 4 departments. The Supplier Relations Development (SRD) department provides consultation, training and management tools to suppliers and also conducts annual supplier assessment. The Environmental Research Center (ERC) department plays an important role in research for environmental improvement, environmental management and regulations. The Regulatory Affairs (RA) was newly developed to ensure product safety and to enforce the regulatory compliance of Yuhan-Kimberly. Meanwhile, the Safety, health, Environment, Ethics, Education and Quality (ShEQ) department collectively approaches the Company's safety, health, quality and environment. Those 4 teams are strongly integrated and operated systematically for sustainability.

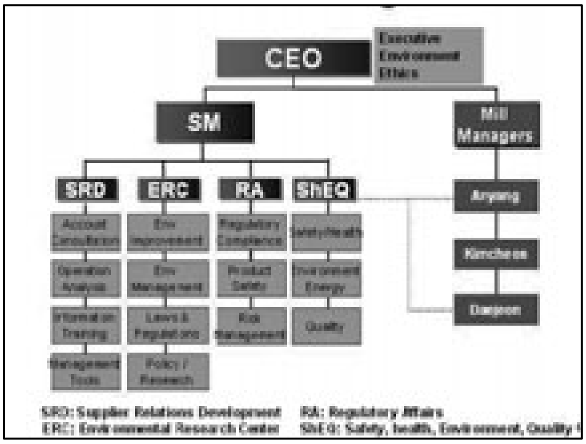

Figure 5.1 Yuhan-Kimberly organization chart for sustainability

What does sustainability mean to Yuhan-Kimberly? Yuhan-Kimberly believes that a sustainable company should be sustainable together with four external customers: the Earth, the Market, the Communities and the Supply Chains. The concept can be illustrated in Figure 5.2.

The four external customers will be described in more detail in terms of (1) how they affect the sustainability policy, (2) which programs are conducted and (3) what the outcomes are to meet with sustainability.

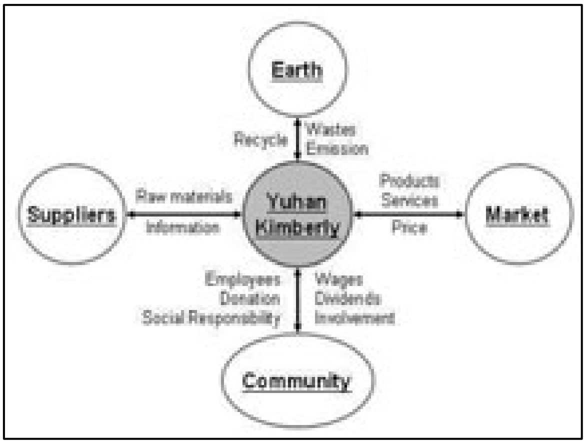

Figure 5.2 A new sustainability paradigm

Earth

Industries intentionally or accidentally affect the earth through their activities. Natural resources and energy are essential to firms and waste and pollutants are inevitably generated. To prevent the abuse of valuable resources and reduce waste, the Company adapts several theories and tools which are embedded in policy.

Yuhan-Kimberly's Environmental policy for sustainability can be defined as follows:

- Compliance with environmental laws and company regulations.
- No. 1 priority involving reducing contaminants at source.
- Continuous improvement through Life Cycle Assessments
- Accident prevention through risk assessment

The Company also promotes the practice of Environmental Policy for sustainable development. For instance, water emissions have been gradually decreased since 1997 and a recycling system for both process and waste water in the factories has been introduced. This water recycling system has helped dramatically reduce the total quantity of water use (Fig. 5.3). The applied recycling system also contributed to a significant decline in total water pollutants. Air Emissions were reduced by means of optimizing the operation temperature in the incinerator and by upgrading prevention utilities for air pollution. In order to promote cleaner energy, Bunker C oil was changed to bunker A oil and again changed to Liquefied Natural Gas (LNG) through a Cleaner Production program since 2001. As can be seen in Figure 5.4, dust, NOx and SOx have all been dramatically reduced while SOx is now not even detectable. Not only do we comply with environmental regulations under our environmental policy but we also strive to restrict pollutants to within 20% of national permitted levels. Furthermore, Yuhan-Kimberly sets lower targets for air emissions every year and attempts to gradually reduce emissions with innovative and the best available technologies.

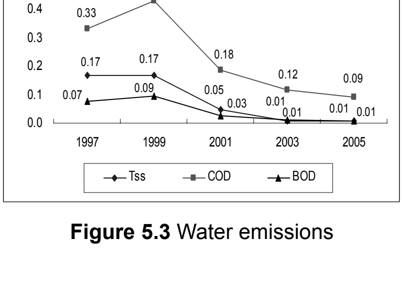

Figure 5.3 Water emissions

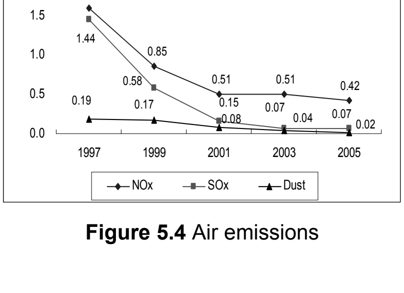

Figure 5.4 Air emissions

Market

Products at Yuhan-Kimberly are designed to reflect environment principles. To manage the holistic life cycle of products, Yuhan-Kimberly conducted various forms of research, such as life cycle assessment of products such as bathroom tissue (2001), a comparative study in digital textile printing vs. conventional printing (2003), incineration (2004) and contract manufactured non-woven (2004). Among them, the bathroom tissue "Popee Plus" acquired ISO 14020, Environmental Labeling, in 2002. As a result of the Life Cycle Assessment of bathroom tissue, we discovered that the manufacturing stage in the Life Cycle is the major contributor to the environmental burden, comprising 71% of the total impact assessment value. Packaging and energy, including electricity and fuel, were confirmed as the major contributors. To reduce the environmental burden of transportation, imported waste paper was switched to local sourcing, which helped save 4,000 tons of CO_2 emissions as compared to importation. At the same time, the domestic recycling market was enlarged and the extent of local sourcing has exceeded 50% since 2001. Since 75% of the local waste paper is used (in 2005), this change can save about U$1,000,000. In addition, the printing method was changed from gravure printing to flexography, which enabled the environmental burden during the packaging process to be reduced by 23% (Fig. 5.5).

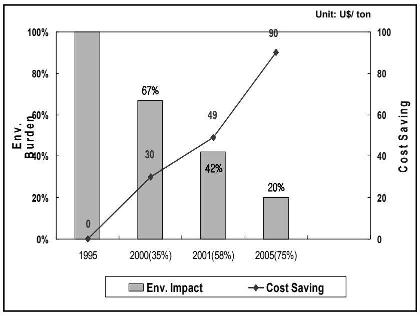

Figure 5.5 Effect of sourcing change in recycled paper

One of the most innovative business areas in cleaner production is the Digital Textile Printing (DTP) Solution. The conventional printing process incurs a massive environmental burden such as mass output, high consumption of material, energy and water, land/building and waste water and solid waste discharge. The main reason is its many treatment steps. An innovative way to reduce this environmental burden is DTP since it needs only 4 steps and involves less chemical / water / energy use in the process (Fig. 5.6). A comparative LCA of DTP proves its superiority in all categories (Fig. 5.7).

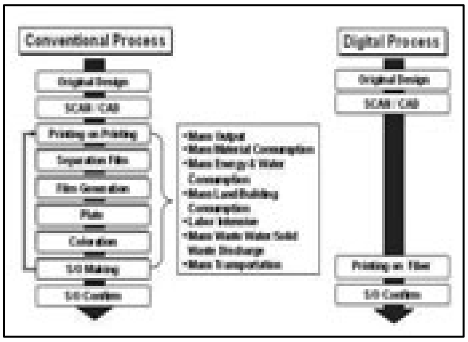

Figure 5.6 Printing process of conventional vs. digital

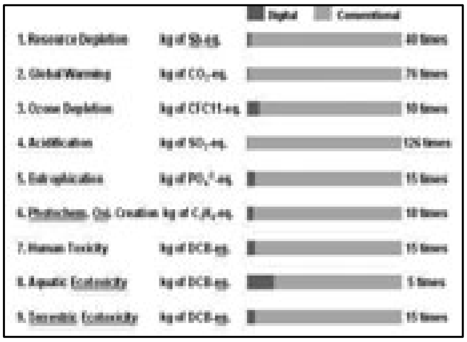

Figure 5.7 LCA result of digital vs. conventional printing

Suppliers

Enterprises cannot fulfill the total demand of their customers alone. We need other independent suppliers who can provide and support specific needs. Since Yuhan-Kimberly is no exception, supply chain management remains one of the key corporate issues. Supply Chain Environmental Management (SCEM) programs were operated with 14 participants out of 40 Yuhan-Kimberly contract manufacturers. Its main programs included cleaner production, EMS, and network systems. A thorough examination of each company's specific background through analysis of their environmental management made it possible for customized training program to be developed for each supplier. The tools for supporting environmental management include LCA, DfE, environmental performance evaluation, environmental accounting and sustainability report (Fig. 5.8). To accomplish sustainable environmental management, the company will set up a supporting system for suppliers to apply effectively via procedural simplification. Figure 5.9 shows the result of the SCEM program in environmental management, waste and energy from 2003 to 2006. Furthermore, a program is planed for expansion to all vendors, including raw material suppliers, solid wastes handlers and distribution channel.

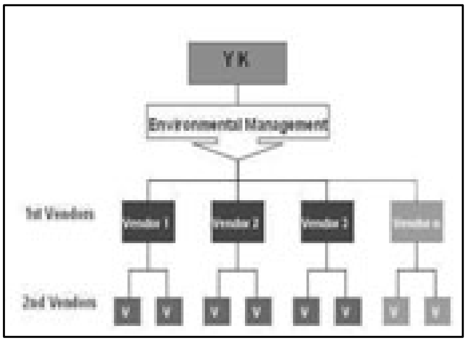

Figure 5.8 Yuhan-Kimberly supply chain environmental management (SCEM)

Item		unit	Before	Current	After	Improvement(%)
ISO Certification		No of Company	3	10	18	
Life Cycle Assessment		No of Company	-	2	10	
WASTE	Volume	kg/ton	43.0	37.4	35	18.6 %
	Recycle Rate	%	72.7	73.5	80	10 %
Energy Saving		MWh	78,585	76,414	70,726	10 %
Dust Reduction		kg/day	120	435	480	400 %

Figure 5.9 Achievement of SCEM in 2006

Community

The corporate philosophy of Yuhan-Kimberly is to give back to the community. Yuhan-Kimberly realizes its gains come from the community and is thus devoted to the same. Yuhan-Kimberly has conducted various community activities aiming to enhance the social health and welfare of the country since 1970. By concentrating on forestation and environment conservation efforts, Yuhan-Kimberly's community contribution activities have been further solidified.

The "Keep Korea Green" campaign has been faithfully implemented throughout the last 20 years. The first step involved entrusting the necessary funds to foster forest resources while engaged in mass media based awareness promotions, programs such as newlyweds' tree planting, green camp, school forest and so on (Fig. 5.10).

As one of the main campaigns for society, Yuhan-Kimberly has operated a web site 'Woorisoop' for information sharing purposes since 2001. It contains information about trees native to Korea, fundamental forest knowledge, forest recreation programs and others (see Figure 5.11).

Yuhan-Kimberly also helps some social programs such as support for 'Seoul Literature House', 'Research and Survey Support and Social Proliferation of Senior Citizen Issues' and other initiatives for the next generation. It also actively encourages all members to get involved in community activities.

Figure 5.10 Campaign logo

Figure 5.11 Planting trees by newly-wed couples since 1985

CONCLUSION

Yuhan-Kimberly believes that a sustainable company should be sustainable together with its main external customers: the earth, the market, the communities and the supply chains. Collaboration with these customers is essential to achieve company sustainability. We believe that promoting sustainable production and sustainable consumption patterns will lead us to a sustainable country. Yuhan-Kimberly is proud of playing a key role in making Korea a sustainable country.

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6. Toward the Sustainable Circulation of Products among Asian Countries

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ABSTRACT

A considerable amount of waste is exported from Japan to Asian countries. Let us call it "global circulation" among countries. This paper discusses the issues and possibilities of the global circulation. Global circulation is driven by economic rationality rather than environmental awareness and therefore causes various problems, such as the dumping of contaminated waste and pollution of air and water, because of inappropriate recycling processes. The main catalyst of the global circulation is the economic and legal disparity between developed and developing countries. Therefore, it is impossible to stop such circulation and we believe that appropriate global circulation can both reduce global environmental loads and increase living standards at the same time. In other words, prerequisites of sustainable global circulation include full care of the environmental loads, traceability, and equity. This paper also describes a simulation-based case study of global circulation of a personal computer. The simulation results indicate that reuse circulation is hopeful, while there is a need for improvement in recycling circulation. We should strive to change the existing global circulations into environmentally aware and, therefore, sustainable forms by ensuring the prerequisites. As a minimum, the accumulation of practical data is vital for scientific discussions on global circulation.

Keywords: Global circulation, Sustainability, Traceability, Life cycle simulation, Risk management, Personal computer

INTRODUCTION

A considerable amount of waste is exported from Japan to Asian countries, including China, the Philippines, and Vietnam. Let us call it "global circulation" among Asian countries. While some of this is appropriately reutilized, most causes various problems, such as the dumping of contaminated waste and the pollution of air and water because of inappropriate recycling processes. Typically, these problems are called "e-Waste problem" (MOE, 2006). Such circulation is driven by economic rationality rather than environmental awareness and the majority goes underground, making it impossible to prevent. However, we believe that appropriate global circulation can reduce environmental loads and also increase living standards at the same time.

In this paper, we discuss the issues and possibilities of global circulation and clarify the prerequisites of sustainable global circulation. Then, as an example, this paper describes a simulation-based case study of the global circulation of a personal computer.

CURRENT STATUS OF GLOBAL CIRCULATION

This section summarizes the status of global circulation; in other words, we discuss the types, driving forces, problems, and potential advantages of global circulation and subsequently clarify the prerequisites of sustainable global circulation.

Types of global circulation

We can classify the current global circulation according to the reutilization level (*viz.* reuse, recycling, or waste dumping) as follows:

- Reuse circulation: Products and their parts are sold in secondhand markets. Examples include cars, construction machinery, and PCs. For instance, Figure 6.1 shows a secondhand market of car parts in Bangkok. In this market, there are several tens of secondhand shops dealing with various kinds of car parts in a district and they supply spare parts indispensable for continuing to use old cars popular in Thailand.
- Recycling circulation: Materials are recycled, such as steel, cupper, precious metals, and plastics. This type is the largest amount in global circulation as a result of a recent shortage of resources in rapidly developing countries. For example, the recent rapid increase in scrap prices makes Japanese recyclers very active.

Figure 6.1 Secondhand market of car parts in Bangkok

- Waste exportation: In some cases, waste is exported just for dumping by pretending it is recyclable. Obviously, this case contravenes the Basel Convention.

Here, note that although not all circulations are illegal, many seem to include undetectable gray paths. There are various reasons; namely, the fact that the operational criteria of the Basel Convention differ from country to country, related legislation changes (*e.g.* the import of secondhand PCs is now prohibited in China), and the validity of laws differs from country to country. In order to establish sustainable global circulation, we should transform these underground or undetectable paths to explicit and traceable ones.

Driving force

Currently, artifacts are circulating for purely economic reasons and environmental awareness is a weak catalyst for global circulation. In other words, the main driving force includes economic disparity between exporting countries (mainly developed countries) and importing countries (mainly developing countries), weaker environmental legislation in importing countries, and a shortage of products and natural resources in rapidly developing countries.

Problems

Such global circulation driven by economic disparity causes various problems. On the one hand, in importing countries, contaminated waste, *e.g.* PCB and material recycling residues containing lead, are thrown away into uncontrolled dumping sites. Moreover, inappropriate recycling processes may pollute water, air, and sites. For instance, in a recycling site, electric motors are burned in a field in order to extract copper. In such sites, lead from solder infiltrates both air and water. Such dumping and processing are not always illegal, based on local weaker environmental legislation. However, if such operations were inappropriate based on the environmental legislation of the exporting country; that circulation should not be sustainable. Such disparity in environmental regulations is a typical issue, inherent on global circulation.

On the other hand, global circulation also causes problems in exporting countries. Many developing countries criticize the fact that global circulation results in waste being pushed onto developing countries in order to keep developed countries clean. Some green NGOs claim similar discussions (Greenpeace homepage). Therefore, Japanese manufacturers or recyclers may receive such criticisms, even if they unintentionally export waste in the course of the reverse supply chain of the same. Moreover, their products, once disposed of, may be resold in underground markets and global circulation may cause recycling industries in developed countries to decline. For example, due to a recent shortage of plastics, more than 50% of collected PET bottles are said to be exported and mainly go to Hong Kong (based on the Council for PET bottle recycling). Consequently, one of the most technologically advanced PET recyclers, which implies a higher cost of recycling, was unable to collect waste PET bottles in 2005. Such unpredicted global circulation also occurs in the statutory recycling systems of electric home appliances and PCs in Japan.

Potential advantages of global circulation

Despite these serious problems, we believe that global circulation is unstoppable and we can establish *sustainable* global circulation with the following potential advantages. Here, sustainable global circulation means global circulation where the environmental loads are equal to or smaller than those of domestic circulation and which is economically feasible. Obviously, we are opposed to any illegal or environmentally threatening global circulations, but we should at least clarify acceptable and rational prerequisites for the latter. Note that, as discussed above, since global circulation is driven by cultural, social, and economic disparity, it is very difficult to evaluate it from the moral perspectives of developed countries. For example, when we discussed this issue with a Chinese expert and he showed photos of a recycling factory where plastics and electric wires are manually recycled, he said that although Japanese may feel this factory is dirty, unhealthy, and environmentally inferior, he perceives this factory as legal and advantageous in supplying resources and providing job opportunities.

If we can establish sustainable global circulation, we can point out two potential advantages. Firstly, the disparity increases the value of the used products and their parts. In other words, used products with no value in developed countries have sufficient saleable value when exported to developing countries. This extends the lifetimes of products and parts and consequently increases living standards in developing countries. While this applies to the reuse type circulation, both the reuse and recycling types have the advantage of increasing resources efficiently from an environmental perspective. Note that the usage of very old products sometimes causes a negative side effect in terms of energy and material consumption (*e.g.* the lower fuel efficiency of old cars). Theoretically, this problem can be reduced by applying an "upgrade design," which designs products such that the performance will be upgraded during its usage (Umeda et al. 2005). As shown in this side effect, "life cycle thinking" is very important in establishing sustainable circulation.

The second potential advantage is the reduced cost of reutilizing used products because of the economic disparity. In particular, the cheaper labor cost enables manual operations, such as the cleaning of reusable products and sorting of plastics. For example, when sorting plastic fragments according to the type of material, such manual operation is superior to any automatic facilities in the developed countries. Therefore, the lower labor cost may lead to higher reuse and recycling rates, which help guarantee resources in the developing countries.

Moreover, we can say that, since many factories of, *e.g.* white goods and PCs, are located in Asian countries, it is natural to send disposed products back to their birthplace to establish closed-loop circulation systems.

As discussed in this section, because the driving force and potential advantages of global circulation come from cultural, social, and economic disparity, it is not *sustainable* in a true sense; *i.e.* for centuries. As the disparity shrinks (as we hope), global circulation may disappear, but it will take a long time.

Examples of well-managed global circulation

Let us illustrate two practical examples of the global circulation we consider sustainable. One is closed-loop plastics recycling in Canon (Canon 2006). In this system, paper trays in photocopiers, which are made of HIPS, a kind of plastic, are collected and shredded in Japan and shipped to Thailand. Subsequently, in Thailand, the material is recycled into m-PPE, a kind of engineering plastic, at a plastics manufacturer. This recycled m-PPE is used to make the power supply casings in inkjet printers manufactured in Thailand. A feature of this recycling system is how they produce higher value engineering plastics from general purpose plastics. However, the economic feasibility is questionable, because the main purpose of this system is to obtain an environmental label for this printer.

Another example is the global recycling network of photocopiers in Fuji Xerox as shown in Figure 6.2 (Fuji Xerox 2006). In this network, they collect end-of-life photocopiers from nine countries and regions in the Asia-Pacific region and transport them to Fuji Xerox Eco-Manufacturing Co., Ltd. (FXEM) in Thailand for disassembly and sorting. Their recycling partners then participate in transforming those products back into resources under the supervision of Fuji Xerox. Features of this network include a higher recycling rate than in traditional local recycling plants; *viz.* a recycling rate of over 99%, a figure almost equal to that in Japan, and strong emphasis on a “tracking system.” We agree that traceability is the key for the sustainable global circulation. In establishing this network, they clarified four principles; namely, 1) prevent illegal disposal, 2) do not impact on the environment of the importing country, 3) do not import waste, and 4) create benefits for the importing country. The expert who established the network highlights two future issues; namely, the fact that unified international regulations on material transfer should be established, for example, the applicability of the Basel Convention differs from country to country, and an organization is needed which authorizes company’s global circulation like this.

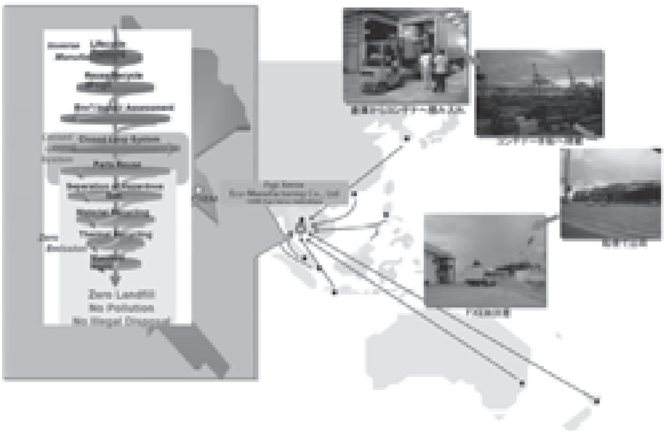

Figure 6.2 Fuji Xerox eco-manufacturing (Fuji Xerox 2006)

Prerequisites for Sustainable Global Circulation

By summarizing the discussion in this section, we can illustrate the following prerequisites for sustainable global circulation, in addition to economic feasibility:

- Full care of the environmental loads: A circulation, directly or indirectly, exerts various kinds of environmental loads. These loads should be monitored or evaluated and, as a minimum, the total loads should be smaller than those of the corresponding domestic circulation.
- Traceability: Traceability is the most important element for establishing sustainable global circulation. Without this, we cannot prevent illegal dumping, inappropriate recycling processes, and underground secondhand markets, and monitor the total environmental loads. Ensuring traceability includes visualization of the flow of circulation and appropriate management of the same.
- Equity: Equity among related countries and related stakeholders should be ensured. This issue includes respect for the cultural and social differences in different countries.

MODELING AND EVALUATION OF THE GLOBAL CIRCULATION

Although we discussed prerequisites for sustainable global circulation and its potential advantages, it remains unclear whether such circulation can exist or not. In order to clarify the conditions for sustainable global circulation and propose some successful patterns, we execute a case study. In this case study, we took a desktop personal computer as an example and collected as much practical data throughout its global circulation as possible. Subsequently, we construct various scenarios of global circulation and evaluate them from both economic and environmental viewpoints, based on the idea of the life cycle simulation (Umeda et al. 2000). The life cycle simulation is a simulation system we have been developing for supporting designers to plan, evaluate, and optimize the total balance of whole product life cycles. The system simulates the flow of artifacts throughout a product life cycle, based on discrete event simulation technique and consequently evaluates the balance of a product life cycle from both economic and environmental perspectives. While we use LCA data to evaluate the environmental aspects, it has certain advantages, such as simulating the dynamics of circulation, such as reuse, the failure of parts, and recycling and it also evaluates the economic aspects of a product life cycle.

Table 6.1 Scenarios of the global circulation

A. Domestic recycling (Japan)	Material recycling other than plastics.
B. Product reuse (coastal area in China)	Products are sold as secondhand.
C. Part reuse and material recycling (coastal area in China)	Reusable parts: HDD, FDD, CD-ROM, and PCB. Others, incl. plastics, are recycled.
D. Material recycling (coastal area in China)	All materials are recycled.
E. Material recycling (inland area in China)	All materials are recycled.
F. Material recycling (Japan + coastal area in China)	Shredded metals are recycled in Japan, and then plastics are exported and recycled in the coastal area.

Scenarios of the global circulation

In this case study, we compare various scenarios of the global circulation of a desktop personal computer (PC) thrown away in Japan. While detailed data and simulation conditions are described in the reference (Kishita 2006), Table 6.1 summarizes the scenarios. As shown in Figure 6.3, we take Japan and coastal and inland areas in China respectively as target regions that have different labor costs, electricity charges, and unit CO2 emissions of electricity. Note that we model these regions in a simplified manner; in other words, omitting certain legal and cultural circumstances to pursue the future possibility of global circulation. We consider product reuse, part reuse, the material recycling of metals, and that of plastics in each region. Here we assume that plastics are not recycled in Japan, while they are recycled in China. Metals, however, are recycled in the same kind of facilities with equivalent recycling rates in both Japan and China.

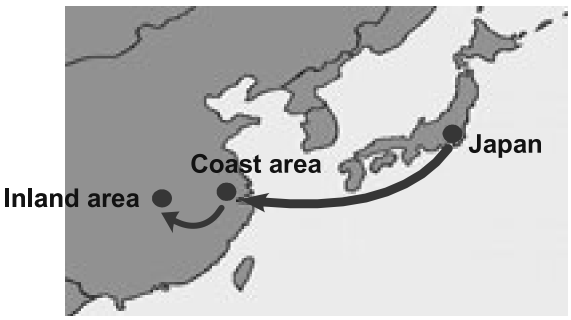

Figure 6.3 Global circulation in the case study

The advantages of reuse and recycling are modeled as follows in this simulation. In material recycling, the difference in CO2 emissions between the production processes of a virgin material and the recycling processes of the recycled material is subtracted from total CO2 emissions as an environmental advantage. Moreover, the market price of the extracted material is added to the sales amount as an economic advantage. Likewise, in reuse circulation, the difference in CO2 emissions between the production processes of a new product (in product reuse) or a new part (in part reuse) and their reuse processes is subtracted from overall CO2 emissions. In addition, the market price of the secondhand product or part is added to the sales amount.

The simulation starts when a PC is discarded in Japan, and while it has no secondhand value in Japan, it can still be sold in the secondhand market in China.

Modeling uncertainty

The largest obstacle for conducting the simulation is the uncertainty of the model; namely, actual international flows of disposed PCs remain clear and we are unable to obtain sufficient practical data. Therefore, we represent such uncertainty in the simulation model via two methods. One involves representing unexpected events as risks; examples include theft, PCs going to illegal channels, failure in customs clearance, and unexpected environmental pollution. A risk is defined as the mathematical product of the probability of an event and the impact of the same (ASME 2003). We represent the impact as a monetary loss when the event occurs. The other involves representing uncertainty in data as a data width; *e.g.* the labor cost in a region is 10-20 (yen/day).

Simulation results

The objective of this simulation is to determine conditions for successful global circulation. Here, we assume that “successful” means the circulation has economic and environmental merits; in other words, profit should be greater than zero and CO2 emissions, as representative of environmental loads, should be less than those of domestic material recycling in Japan.

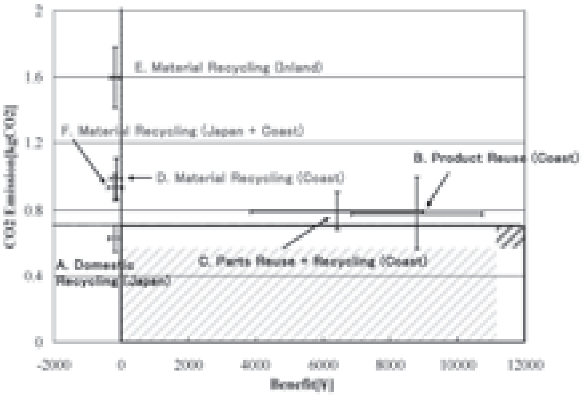

Figure 6.4 Simulation results

Figure 6.4 summarizes the simulation results. The results include the risks discussed in the previous section and the uncertainty in data, which is represented as the width of the result, as shown in this figure. In Figure 6.4, scenario A (domestic recycling) is the reference, hence the rectangular area in the bottom right (hatched area) is that indicating *successful* circulation, as discussed above. Unfortunately, there are no fully successful circulations in this simulation, but the reuse scenarios B and C are promising.

CO2 emissions of all global circulation scenarios B-F are higher than the domestic recycling equivalents (scenario A), because of additional CO2 emissions during overseas ship transportation. For example, in scenario D, the CO2 emission of overseas transportation accounts for 70 % of its total CO2 emission and is 16 times the CO2 emission of transportation in Scenario A. Because the reduction of CO2 emissions in reuse is larger than that in recycling, total CO2 emissions in scenarios B and C are smaller than those in recycling scenarios D-F. However, reuse scenarios are still larger than or on the border of the *successful* area. Among the recycling scenarios D-F, CO2 emissions in scenario E are largest, because of the additional transportation from coast to inland. Scenario F is slightly better than scenario D, however, since preprocessing in Japan in this scenario reduces CO2 emissions during overseas transportation.

Economically, reuse scenarios B and C are more profitable than the recycling scenarios, because of the higher market price of the secondhand products and parts. However, the uncertainty in profit (*viz.* the data width) is larger than that of the material recycling because it seems that the fluctuation of their market price is larger than that of the extracted material to be recycled.

We can summarize the simulation results as follows. The environmental bottleneck of global circulation is the overseas ship transportation, although this is obvious. The reuse scenarios are hopeful candidates for sustainable global circulation. By executing sensitivity analyses of the reuse scenarios, the “yield rate” turned out to be a critical factor. The yield rate here means the rate of correctly working products and parts to be sold in the secondhand market relative to the total number of products shipped to China. On the other hand, the recycling scenarios are not hopeful, either environmentally or economically. However, it seems there global recycling circulations of PCs do exist in the real world, for economic rather than environmental reasons. We can cite two reasons for this inconsistency. Firstly, costs exceeding actual levels come from the assumption that all processes, including those in China, are well managed so as to be compliant with Japanese legislation. Secondly, although the global circulation has higher risks than domestic recycling in general, the actual balance sheet does not take such risks into consideration.

The simulation results imply that better global circulation requires the assurance of traceability especially in reuse circulation and risk management throughout the circulation. Moreover, a positive combination with domestic recycling may improve the global recycling circulation.

At the end of this section, let us highlight two issues for modeling and simulating global circulation. First, as mentioned several times, the largest obstacle to the simulation is a lack of information; *viz.* lack of practical data and invisible flows. Therefore, the accumulation of practical data is vital for discussing global circulation. Secondly, the current model is insufficient to evaluate the effects of ensuring a traceability system and life cycle management. This is one of our future works.

CONCLUSION

This paper discussed the issues and possibilities of global circulation. The main driving force of global circulation is the economic and legal disparity between developed and developing countries and prerequisites for sustainable global circulation include full care of the environmental loads, traceability, and equity. Under current Asian circumstances, it seems the only possibility is a global circulation system owned and managed by a reliable global company.

This paper also described the simulation of a global circulation of a personal computer. The simulation results indicated that reuse circulation is a hopeful candidate for sustainable global circulation, while recycling circulation requires improvement.

The global circulation of disposed products should not be ignored and seems indispensable, both for developed as well as developing countries. We should strive to transform it into an environmentally aware and, therefore, sustainable form by ensuring the prerequisites mentioned above. At the least, the accumulation of practical data is indispensable for scientifically discussing global circulation.

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Sustainable Management of Food, Biomass and Water Resources

7. Key obstacles to Sustainable Agriculture in Hokkaido

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ABSTRACT

Presently, agriculture in Japan faces many difficulties: the ever-rising price of petroleum has led to increased farming costs in the form of costlier agricultural machinery, pesticides and fertilizers. The movement towards international free trade via the World Trade Organization (WTO) and Free Trade Agreement (FTA) has also rendered the cost-benefit balance so deleterious for Japanese farmers that many must now rely on farm subsidies from the Japanese Government to survive. A more serious problem is that of aging farming communities. Although many retired urban dwellers continue to move to rural areas to work on farms as a lifestyle change, this trend has basically been disrupted by private management allodial tenure systems. Under such circumstances, we anticipate several additional agricultural difficulties being triggered by global warming: changes in pest fauna may cause sudden pest outbreaks, due to the expected time delays until natural enemies can adapt. There is no need to pretend that we can survive without food produced from agriculture, since it is very apparent that we cannot continue indefinitely importing the majority of our food from overseas. In this paper we presented an idea to establish a new type of agriculture in Hokkaido, one able to overcome present as well as expected future difficulties.

Keywords: Agro-sphere, Biological control, Self-sufficient society, Simulation, Rural city

INTRODUCTION

Agriculture in Japan was maintained in a sustainable form up until approximately 140 years ago, namely the end of the Edo Period (King 1911; Diamond 2005). The re-utilization of the waste excreted by big cities in the form of agricultural fertilizers in adjacent farming areas provided many occupations involved in maintaining such cycles. The self-seclusion policy of the Tokugawa shogunate was perhaps the most important factor during the Edo period causing people to maintain a basically self-sufficient society mostly dependent upon sustainable (recycling and reutilizing) agriculture. Whether people's lives during this era were comfortable, healthy or happy is another matter, but at least 30 million people could be sustained for 250 years (1603-1867).

A considerable time has elapsed since Japanese agriculture was transformed into a monocultural system requiring considerable inputs of artificial fertilizers, pesticides and machinery. Hokkaido in particular, was a pilot region where North American-style agriculture could be introduced, as it was almost completely undeveloped at the time. Soon after the Meiji Restoration, our foregoers at Sapporo Agricultural College, later to become Hokkaido University, promulgated a somewhat unsustainable form of agriculture in order to achieve higher food productivity, because politicians strove for the short-term affluence of the people (or mostly for national wealth). Furthermore, the development of synthetic chemical compounds for agricultural use soon after World War II, enabled large-scale monocultural crop production, and saw productivity improve tremendously in Hokkaido. Moreover, in order to pursue the rational agricultural systems of the time, the government actively encouraged the formation of large-scale farming enterprises in Hokkaido.

However, constant supplies of cheap chemical compounds and sufficient energy, both of which originate from imported fossil oil, are needed to sustain such activities. It is clear that if we are unable to drastically reduce our dependence on imported fossil fuels, Japanese people's lives will no longer be sustainable.

So, should we try to return to the Edo era? This is quite evidently impossible. The Japanese population is now 4 times larger than it was during that period, and the magnitude of the present economy is incomparably larger. Instead, we have to learn from the agriculture of the Edo era to overcome the problems – namely the depletion of agricultural activities, and of petroleum, etc - that we now face. We believe that many, but not all of the features of that era may be applicable to future Japanese and Asian agriculture, if we choose to re-evaluate such "low-technologies" based on contemporary advanced scientific knowledge.

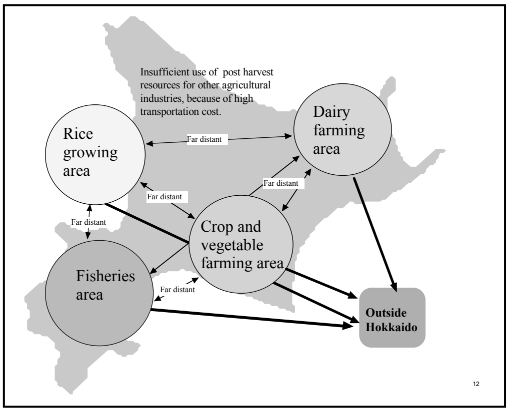

Figure 7.1 Spatial separation of farming areas of Hokkaido agriculture

In this article, we would like to precisely address the nature of the problems and how we can solve them in our program, the "Hokkaido University Sustainable Governance Project (SGP)" so as to establish sustainable agriculture in Hokkaido.

WHAT ARE THE DIFFICULTIES IN JAPANESE AGRICULTURE?

Japanese agriculture presently faces several serious problems: the relative escalation of farming costs, because of rising petroleum prices; and long-term pollution by pesticides and fungicides, etc. Because of the movement for international free trade (e.g. the WTO and FTA), the cost and benefit balance has now become so deleterious to many Japanese farmers that they now depend heavily on Government subsidies. Perhaps an even more serious problem is the aging of rural farming communities. This is partly due to three reasons, symbolized by three Ks in Japanese, namely Kitanai (dirty), Kibishii (hard work) and Kakkowarui (not fashionable). On the other hand, there is the absurdity that aged (retired) people living in big cities intend to work on farms in order to change their lifestyles. However, this trend is basically disturbed by private management systems with allodial tenure. Furthermore, over-investment in chemical fertilizers and pesticides is also a serious problem, as it has resulted in polluted environments, soils and foodstuffs themselves.

If we restrict the scope to agriculture in Hokkaido, there are several other specific problems hampering the establishment of sustainable agriculture. Hokkaido Prefecture now contains approx. 25% of Japan’s (utilized) agricultural land and its food self-sufficiency rating (calorie-based) is 201% (MAFF 2004). The separation of Hokkaido into several large areas where only a few specific bio-products are produced (Fig. 7.1), is a serious problem. If sufficient supplies of cheap petroleum are available, the costs of transporting agricultural products to markets are negligible. However, rising petroleum costs are expected to rapidly render cheap transportation a thing of the past. In fact, it is already impossible to transport unused bio-products (including industrial waste from dairy farming and fishing, which can be converted to excellent organic fertilizers) to distant farming areas where demand is high, because the transportation costs outweigh any agricultural benefits.

Another underlying problem is the seasonality of agriculture activities. Other than dairy farming, there is little work for farmers during the winter in Hokkaido. In the growing and harvesting seasons, however, Hokkaido farmers face serious labor shortage problems. Thus we must solve the temporal labor uncertainties of northern agriculture, in order to establish economically viable and sustainable agriculture in the region.

From a global perspective, food is in chronic short supply. We cannot survive without the food produced by agriculture, and we cannot continue indefinitely to import large amounts of it from other countries. Therefore, we must now begin to (re)create a new system of agriculture, one which can overcome the present and anticipated difficulties.

WHAT WE HAVE TO DO

Under these circumstances, Hokkaido University began its Sustainability Governance Project (SGP) this year in order to propose a new future for the agricultural industry, as well as a new urban lifestyle that promote environmental conservation. This project is part of the Integrated Research System for Sustainability Science (IR3S) alliance. For these purposes, we integrated many scientific activities, which to date were conducted in fragmented scientific fields. In this project, we have established 5 themes that need to be addressed (Fig. 7.2). Hereafter, we will introduce the activities of the first theme and address what we intend to do during the 3-year research period.

NORTHERN AGRO-SPHERE SIMULATOR

In recent times, both agriculture and society have undergone rapid development. Human activities to obtain food and living space were the first requirements, and the rationalization was the second. Therefore, if we, as scientists, attempt to address the rationality of such systems, we need to know exactly what the systems are. In other words, our present knowledge and understanding of such systems is quite insufficient.

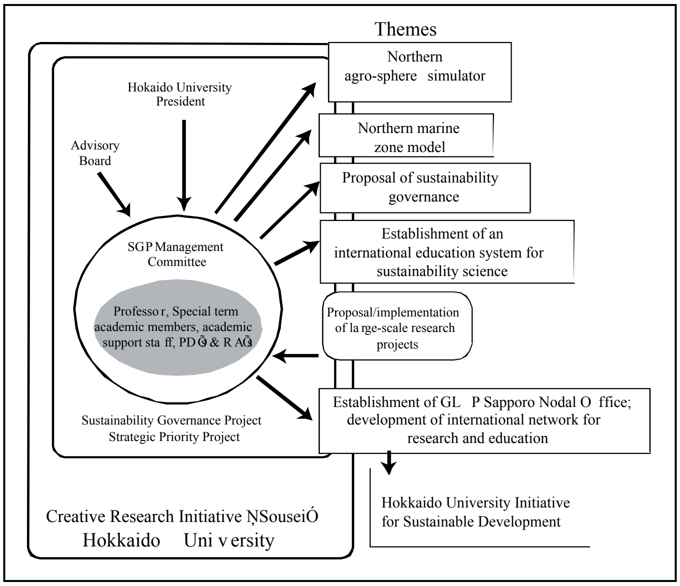

Figure 7.2 Implementing agencies for the Sustainability Governance Project (SGP) in Hokkaido University and its main themes

If we intend to propose a plan for a sustainable rural city in Hokkaido, it is essential to investigate the real state of the present aspects and activities (functions) of that model city. Under such circumstances, we have begun to investigate Furano, a rural city in Hokkaido as a case study for a sustainable rural city model.

Furano is a rural city with about 26,000 residents, located in the Furano basin in central Hokkaido. Within the Furano basin, three local governments, Furano City, Kami-furano Town and Naka-furano Town, have developed, alongside the Sorachi River. Furano is about 130 km from Sapporo (pop. 1,800,000) and 53 km from Asahikawa (pop. 360,000), the 2 largest cities in Hokkaido. Tourism (sightseeing in summer and snow sports in winter) and agriculture are the two main industries and a resource recycling rate of over 90% has been attained. This attempt is now underway, and the first step of the systems simulation is shown below in Figure 7.3.

In order to compose the systems model for Furano city and the Furano basin, we must first have a detailed understanding of the energy, material and money flows of the main industries. Secondly, we need the same such information for hotels, stores and private homes. Using this information, we will then develop a computer model simulating a rural city. Based on the systems model, we will then be able to discuss how Furano and its neighboring towns can be maintained as rural cities in Hokkaido.

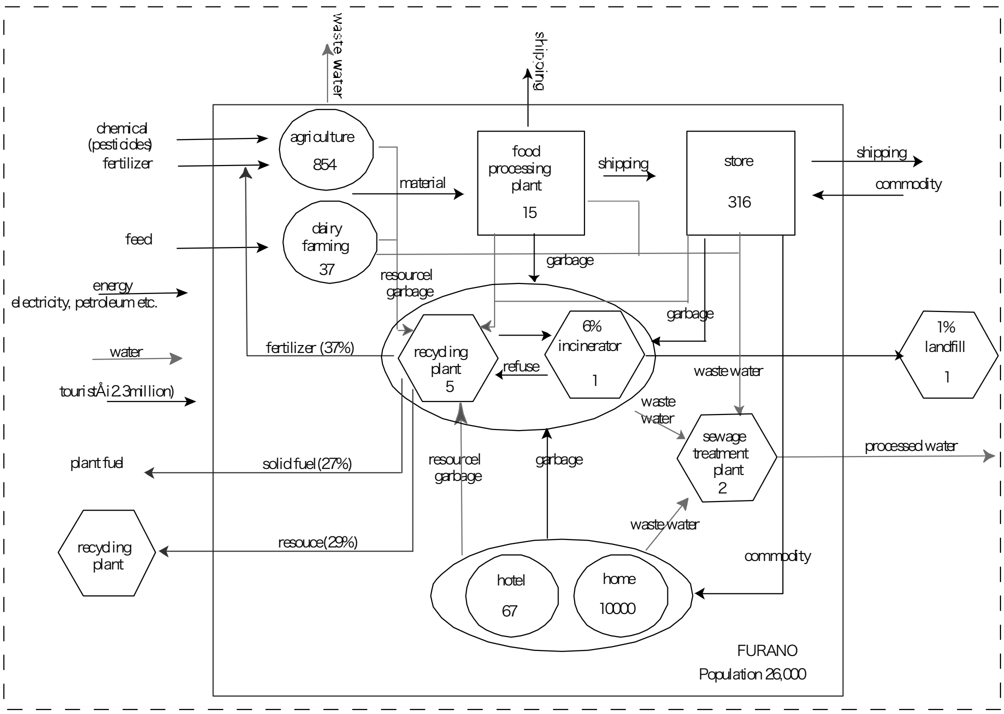

Figure 7.3 Brief sketch of the systems flow in Furano city

Continuing on this theme, we also plan to establish a new, small-scale integrated agricultural industry. Initially, we settled a “virtual” area (10~20 ha) near the Sorachi River, as the site for such an industry. We are presently attempting to integrate several agricultural activities in Hokkaido into this area by simulation. Through trial and error processes, we intend to propose some rational and sustainable combinations, and are hopeful that the integration of agriculture should lead to environmental and socio-economic sustainability.

RELATED RESEARCH FOR SUSTAINABLE AGRICULTURE

The sustainability of human society, agriculture and environment is our target. However, the primary reason why such a concept has now become necessary is mostly in response to the anticipated deterioration of the Earth by human industrial activity. The alert to global warming (Lischak 2006) is mostly sensationalist. In relation to this problem, however, there are two opposing views within Hokkaido agriculture. Rice farming in Hokkaido has long faced the threat of damage from long periods of cold weather. Actually, in 1993 the rice harvest was devastated, because of an extraordinarily cool summer in Hokkaido. Therefore, the recent trend of warmer weather is considered to be a welcome phenomenon. Is this true?

Several differing opinions exist on this trend. Some entomologists and pathologists warn of an ecological disaster through such warming. Hokkaido is the northernmost region in Japan, meaning that the amounts of pesticide, herbicide and fungicide applied are relatively low in comparison to the other more southerly regions. This is one of the important commercial traits of Hokkaido produce, namely the fact that it is safe and clean. If average temperatures in the growing season continue to rise, we must expect invasions and/or outbreaks of pests and diseases to occur in Hokkaido. If the costs of chemical compounds continue to rise, we may face great difficulties in maintaining safe food production. Under such circumstances, we must focus on the forecasted environmental conditions under which we will conduct sustainable agriculture.

The idea of augmenting bio-diversity for pest management in agriculture is not a new one (Huffaker 1971). In European and Chinese agriculture, the polyculturing of several crops simultaneously and the preservation of natural vegetation in fields and orchards have both been stressed as important elements of agriculture (Brookfield 2001). As mentioned previously, Japanese agriculture has pursued high productivity with reduced labor, such that little diversity remains in the fields of Hokkaido. Monoculture enables farmers to introduce big machinery to reduce labor costs, and this prompted the introduction of North American style agriculture into Hokkaido. As addressed previously, large-scale, monocultural agriculture will inevitably become increasingly difficult in future due to energy shortages, and is extremely vulnerable to pest outbreaks. Thus, we should consider other means of pest management, such as the introduction of polyculture and the preservation of biodiversity.

Hereafter, we will present a recent success in biological pest management using biodiversity in order to show a potential means to establish sustainable and safe food production.

BIODIVERSITY AS A KEY OF SUSTAINABLE AGRICULTURE

Outbreaks of pest mites on Moso bamboo (*Phyllostachys pubesense*) have occurred since the late 1980's, and many bamboo forests have withered in Fujian province, China. We have launched a Japan-China joint research project to restore the Moso bamboo forests and have revealed that the pest outbreaks on bamboo were triggered by a change from polycultural to monocultural bamboo cultivation, which inevitably decreased arthropod (pests and their natural enemies) diversity (Zhang et al. 2004a). Furthermore, we discovered that a phytoseiid mite, *Typhlodromus bambusae*, common to the Hokkaido dwarf bamboo forests, is the most important predator species of the pest mites of Moso bamboo (Zhang et al. 2004b). However, monocultured Moso bamboo forests have no nursery plants (banker plants) to sustain predator populations during the winter defoliation periods (which occur at 2-year intervals). Therefore, we could recommend that farmers plant a banker plant, *Miscanthus* spp., on which another prey species for the predators occurs year-round (Fig. 7.4). In addition, we determined that an introduced predator species, *Amblyseius cucumeris,* also provides effective control of pest mites and several small insect pests (Zhang et al. 2003) and were thus able to prove that bio-diversity can provide effective pest regulation. This is the story in a nutshell story, but finally, we will add an epilogue to this success. Moso bamboo has largely destroyed traditional Japanese forests, or Sato-yama, because poorly maintained bamboo forests often trigger landslides. Cheaper imported bamboo shoots from Fujian province, China also discourage efforts to maintain Japanese bamboo forests. Thus there is a conflict between Chinese and Japanese bamboo plantations. We have learned that the establishment of sustainable agriculture in one country can sometimes cause unexpected problems for sustainability in another. This is only a small example, but we must pay attention and be prepared for such possibilities.

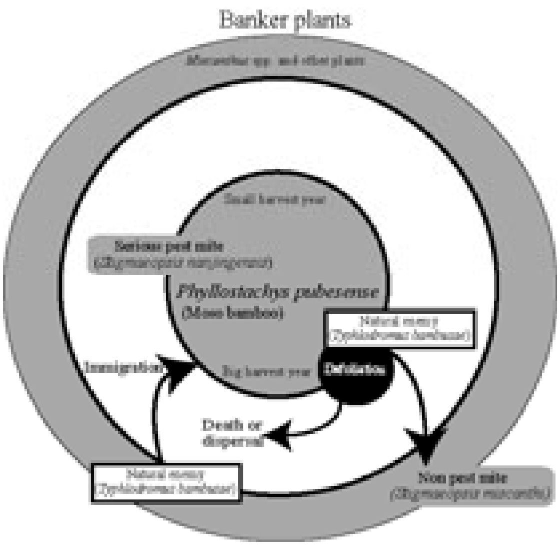

Figure 7.4 An example of restoring damaged Fujian bamboo forests through biodiversity

CONCLUSION

We must now remember that a sustainable nation could be established during the Edo era when there was no means of obtaining any food or energy from overseas. If transportation costs increase, we have to realize that we will be unable to survive by depending upon imported food. Car exports presently play a great role in supporting Japan's economy, but for how much longer we will be able to get money from such industries, if there is no power source to drive cars? Of course, technological developments may resolve such problems in future, as optimistically pointed out by Choen (1995), but another question that will continually arise is whether these technological developments THEMSELVES will be sustainable from the Earth's perspective.

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8. Integrated Water Resources Management Strategies towards Sustainable Development in Vietnam

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ABSTRACT

Vietnam has experienced both qualitative and quantitative deterioration of its water resources in recent years mainly due to rapid economic development. All efforts to manage these valuable resources in a sustainable fashion have failed. To attain sustainable development, it is necessary to shift from the traditional end-of-pipe approach to an integrated approach of water resources management. One of the main barriers towards this goal is that currently the value of water is not reflected in its price. This article outlines the management of water resources based on financial mechanisms and the application of economic instruments in Ho Chi Minh City (HCMC). Being the largest city in Vietnam, HCMC provides an important case for studying the pricing system.

Keywords: Water resources management strategies, Ho Chi Minh City, Water pricing, Sustainable development, Vietnam

INTRODUCTION

The growing population and pressure on natural resources impair the natural processes of the water cycle resulting in shortages and declining quality of water resources. Finding a practical approach to address this important issue is among the most pressing that the world faces in the early 21st century.

The Asia Pacific Region accounts for 36% of global run-off water. Even though water scarcity and pollution are key issues, the region has the lowest per capita availability of freshwater: renewable water resources amounted to 3,690 m^3 per capita/year in mid-1999 for the 30 largest countries in the region for which records are available (UNDP, UNEP, World Bank and WRI 2000 and United Nations Population Division 2001).

Water scarcity, lowered quality and inadequate wastewater systems are serious threats to the development of the Asia Pacific Region. Water is an essential resource for the region's growth, but current water and wastewater related problems are increasing and will limit the region's development options for the future. Traditionally, government policies and strategies on water management have aimed at expanding the supply services in order to meet the increasing water demand from domestic, agricultural and industrial sectors. The largely fragmented approach that has traditionally been applied has allowed conflicts and competition, and has led to over-exploitation of water resources.

The current challenge for many countries in the region is to overcome fragmented sub-sector approaches and to design and implement integrated water resources management strategies, particularly for the implementation of projects that transcend sub-sectors.

ENVIRONMENTAL RESOURCES AND INTEGRATED WATER RESOURCES MANAGEMENT

The concept of an integrated environmental-economic system is an approach for integrating water management, which in turn may serve as a point of departure for promoting the process of sustainable development. According to Dasgupta, environmental resources are renewable as long as the environment in which they are nurtured is maintained appropriately, but they may be depleted when they are misused. Environmental resources have the following features: (i) uses of environmental resources often conflict; (ii) environmental resources are limited; and (iii) environmental resources not only in the form of flow but also the actual stock affect people's welfare.

In the environmental-economic system, environmental resources are inputs derived from the environmental system and used in the economic system. The framework of environmental resources set out by the Environmental Agency of Japan from this perspective identifies the following three categories of environmental resources:

- Pollutants: seven major pollutants defined by law;
- Physical and ecological resources: lithosphere, atmosphere, aquasphere, biosphere, natural landscape, local energy, etc; and
- Amenity environmental resources: neighborhood pollutants, space and aesthetic resources, historical and cultural resources, services, disasters, etc.

Environmental resources may also be classified in accordance with the uses to which they are put, namely: (i) natural/ecological environmental resources; (ii) productive activity-oriented environmental resources; (iii) urban activity-oriented environmental resources; and (iv) social-cultural-environmental resources. Figure 8.1 shows a model of integrated water resources management.

INTEGRATED WATER RESOURCES MANAGEMENT STRATEGIES IN VIETNAM

Features of Vietnam water resources

Due to the humidity and tropical monsoon climate, Vietnam has abundant rainfall, which greatly supports the river network. There is a river mouth for each 20 km of coastline, and around 2,360 rivers that are more than 10 km long. Eight of these rivers are large basins with a catchments area of 10,000 km^2 or more. Many of the rivers flowing through Vietnam cross international boundaries. The total catchment area in Vietnam and internationally is close to 1.2 million km^2 which is approximately 3 times the size of Vietnam itself. The total annual runoff is 835 billion m^3 but the shortage of water is aggravated in the 6-7 month dry season, when the runoff is only 15 to 30% of this total (World Bank 2002).

Vietnam's water resources are not sustainable. According to the National Water Resources Strategy report, the surface water that flows into the country's territory accounts for 63% of the total volume and over 70% of the river basin. This makes Vietnam vulnerable to water resource decisions made by countries upstream.

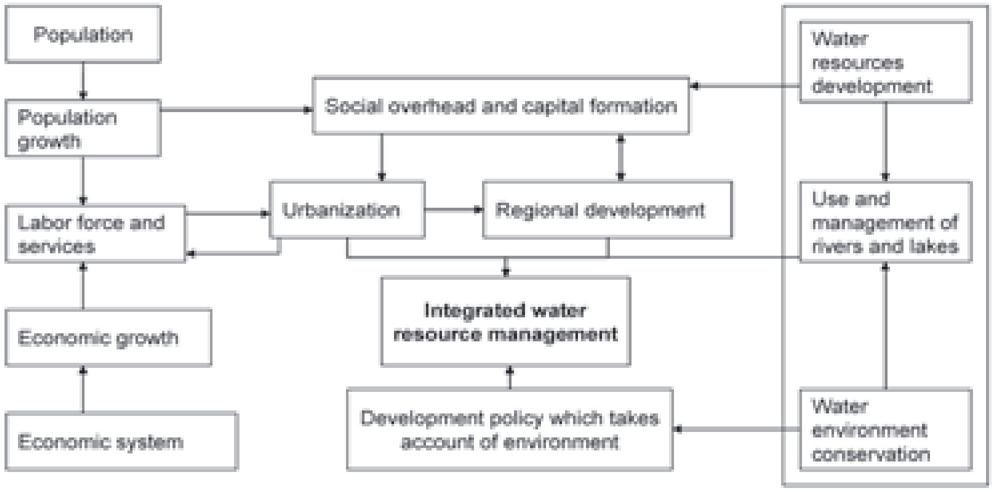

Figure 8.1 Integrated water resources management

Changes in the global climate are causing a considerable decline in water resources. It is forecasted that in the next 20, 50, 100 years from now (2006) the total volume of surface water will be around 96%, 91% and 86% of today's quantity respectively.

The current average per capita surface water availability from the total volume of water in rivers within Vietnam is about 3.840 m^3 per year. If water inflows from outside the country are included, the average per capita river water availability is 10.240 m^3 per year. Taking the population growth into consideration, by 2025 the average per capita surface water availability will be 2.830 m^3 per year, and this figure would be 7.660 m^3 per year if water flows from outside the country were taken into account. According to the standards of the International Water Resources Association, nations with average per capita water availability lower than 4000 m^3 per year are considered to have inadequate water supply. Thus, if we only count the volume of surface water generated within the territory, Vietnam is already a water deficient nation and will face many challenges with water resources in the near future. Furthermore, in Vietnam, water resources are not evenly distributed over different regions over different times of the year or over different years. The rapid speed of urbanization and development has led to pollution of the water resources, which will make the matter worse (Vietnam National Water Resources Strategy towards the year 2020).

Balance between protection and development of water resources: ensuring an adequate supply of water and water security for socioeconomic development

Vietnam will face many significant challenges regarding water resources in the near future unless public awareness is raised. Major challenges include:

- Shortage of water in the dry seasons is occurring with higher frequency and with severer impact, especially in the Centre and Central Highlands;
- Obsolete infrastructure and wasteful, inefficient use of water has not been improved;
- Degradation and exhaustion of groundwater is occurring in some areas and has not been controlled;
- Lack of an integrated and multi-purpose approach in water exploitation and use;
- Population growth, economic development and poverty will directly affect the water resources; and
- The accession of Vietnam to the WTO will on the one hand bring opportunities for the national economy but on the other hand affect domestic business. Whether they can compete internationally, depends on their ability to improve their management practices.

Major water resources strategies and policies

In the 1992 UN conference on Environment and Development (UNCED) in Brazil, Vietnam reported that its environmental management had been limited because of its largely piecemeal. Vietnam also reported that it faced various constraints including the fact that the government had higher priorities in national economic development. Also there was a general lack of awareness regarding environmental issues, the legislative framework and the information base were weak and incomplete and the resource base was severely limited.

In the 1982 Directives of the Council of Ministers, environmental protection was recognized as a major issue to be given top priority in all governmental branches and localities in Vietnam. In 1985, with the promulgation of Resolution 246 of the Council of Ministers on the survey and rational use of natural resources and environmental protection, environmental protection was established as a concern of the entire population. In June 1991, the National Plan on Environmental and Sustainable Development 1991 - 2000 was approved by the Council of Ministers. Considering these and other initiatives, Vietnam has had major policies on environmental protection from the early 1980s.

The broadest level of national policy and strategy development is provided in the "Socioeconomic Development Strategy for 2001-2010". In regard to water resource management policies, a number of objectives have been formulated: The Water Resources Development Plan to the Year 2000 and the Tentative Development Plan to the Year 2010 (MARD 1998), the Direction and Duties of Water Resources Development to the Year 2010 (MARD 1999), Strengthening Environmental Protection in the Period of National Industrialization and Modernization (Communist Party of Vietnam, Directive No. 36/CT-TW, 1998), the Strategy for Rural Agriculture Development in the Industrialization and Modernization Period to the Year 2010, the Agriculture and Rural Development Plan (2001-2005) (MARD 2000), the National Strategy for Rural Water Supply and Sanitation (NRWSS), the Second National Strategy and the Action Plan for Disaster Mitigation and Management in Vietnam 2001 to 2020 (MARD and the Central Committee for Flood and Storm Control 2001). In 1998, the Law on Water Resources was passed and came into effect in January 1999. The Law on Water Resources is a flexible legal framework to which a number of decrees have been added subsequently. These decrees define the responsibilities and duties of the institutional bodies for implementing the Law on Water Resources.

Although the Vietnamese government has formulated many strategies and policies regarding water resources, water resources are being used unsustainably and the needs of the people are not being effectively satisfied. Management of water resources based on a financial mechanism and application of an economic instrument is the most important task for integrated water management. This means that water should be treated as an economic good, the subsidized mechanism should be eliminated; and the costs for utilizing water should be fully reflected in the price of water. The water pricing issue in Ho Chi Minh City (HCMC) is considered in the case study below.

PRICING URBAN WATER IN HO CHI MINH CITY

Since July 2004, the water price has increased in HCMC. However, the average price is still lower than the cost of production, resulting in financial loss for the water supply company. Since the price continues to be subsidized, the current water price has not encouraged efficient use of water. The use of water is still wasteful and large quantities of water are still being discharged. The water resource has been over-exploited to meet the increasing water demand. In order to protect and encourage efficient use of the water resource as well as to ensure a healthy financial system for the water supply company, we must reconsider the current water pricing structure.

Water demand and supply in Ho Chi Minh City

Water supply

Currently, a state-owned company called The Saigon Water Supply Company (SAWACO) is responsible for providing water to the city. Private companies are not allowed to do business in this sector. SAWACO is presently using water from Thu Duc, Binh An and Tan Hiep Water Utility and from Tan Binh Groundwater Utility and other groundwater supply sources.

Table 8.1 Water volume supplied in Ho Chi Minh in recent years (Saigon Water Supply Company)

Year	2002	2003	2004	2005	2006
Supplied Water volume (1000m^3/day)	940	965	1058	1028	1121

Table 8.1 shows the water volume produced per day in each utility since 2002. In June 2006, the water supply capacity of the city reached 1,121,570 m^3/day (Table 8.2). Although the water volume supplied has been increasing significantly; it is still insufficient to meet the water use demand in Ho Chi Minh City.

Water demand

In recent years, the demand for water use has increased significantly, as a result of expansion of the city and the appearance of newly established districts and industrial zones. The water supply system in the city cannot meet this increasing demand. The demand growth rate is increasing faster than the supply growth rate. According to Saigon Water Supply Company data, in 2003, water demand was 1.4 billion m^3 and the capacity of water companies only met 70% of use demand. Compared with the first six months of 2005, water consumption in the same period of 2006 increased to approximately 2,819,000 m^3 (or equal to 18,700 m^3/day on average). Thus, although there was a significant increase in water volume supplied, just 75.5% of the population had access to clean water through the water supply company's network. By 2010, water demand will be 2,374,094 m^3/day while water supply will be approximately 413,093,000 m^3/year (or 1,147,480 m^3/day) (Saigon Water Supply Company 2004). This means that there will be a water demand shortage of 1,226,614 m^3 per day (see Table 8.3).

Table 8.2 Water volume supplied in June 2006 (Saigon Water Supply Company, 2006)

Water utilities	Designed capacity (m^3/day)	Water volume supplied (m^3/day)
1. Surface water resource	**1.150.000**	**1.045.566**
Thu Duc Water Utility	750.000	698.463
Binh An Water Utility	100.000	100.572
Tan Hiep Water Utility	300.000	246.531
2. Groundwater resource	86.000	**76.004**
Tan Binh Groundwater Utility	60.000	53.568
Other groundwater utilities	26.000	22.436
Total	**1.236.000**	**1.121.570**

Table 8.3 Water Demand and Supply in Ho Chi Minh City (Saigon Water Supply Company, 2006)

Year	Population	Water demand (m^3/day)	Water Supply (m^3/day)
2000	5.576.000	1.250.000	850.000
2005	6.325.000	1.960.032	1.028.000
2010	7.320.000	2.374.094	1.147.480

Water pricing reform

Legal basis for setting the current urban water price

The State issued guidelines on the principles and methods for defining the clean water tariff in 1997. On June 6, 1999 the government assigned the Ministry of Construction and the Government Pricing Board to issue circular 3/1999/TTLT/BXD-BVGCP stipulating a common water tariff framework for the whole country. This circular superseded Circular 2 issued in 1997. After four years of its implementation, limitations and problems were found. Consequently, on August 11, 2004, the Ministry of Construction in coordination with the Ministry of Finance jointly issued Circular 104/2004/TTLT/BTC-BXD on the guidelines, principles and methods for defining the water tariff framework replacing that of Circular 3 for the whole country. Similar to Circular 3, Circular 104 provided only the guidelines for defining the water tariff and it was not a command with which the provincial committee must fully comply.

Analysis of the existing problems with the current water price

HCMC, like other cities in Vietnam, uses average cost pricing for water services. Table 8.4 shows the current water price in HCMC and the percentage of water use for each group of residents in 2005. According to the water supply company, the average cost per $1m^3$ was 4500 VND in 2005. With the proportion of water use as shown in Table 8.4, the average price is $4090VND/m^3$, which means the company will suffer from a financial deficit: 4500 – 4090 = 410 VND/m^3. Since the Water Supply Company is still state owned, the government has to subsidize this deficit.

Table 8.4 The percentage of water usage of each user's group at different block rates (Water Supply Company, 2005)

Category	Price (VND)	Percentage
Domestic (DU)		
Below 4 m^3/capita/month	2.700	55%
Above 4 m^3/capita/month	5.400	9.48%
Above $6m^3$/capita/month	8.000	5%
Industry (Production)	4.500	17%
Business and commercial units	8000	6%
Public Administrative organizations	6000	7%
		Total :100%

This is a burden on the government's budget. At the same time, as the water price is still subsidized, it creates a habit of using water at a low price, and thus it does not send the right message about the value of water to users and does not promote water efficient use and conservation.

The government plans to shift the water supply company to the private sector. In order to do so, the water price should be re-considered carefully and calculated accurately and adequately to ensure that the water supply company can operate stably based on self-finance and it must also have sufficient financial accumulation to upgrade and expand the system.

Although setting different prices for different water usage groups with corresponding coefficients is reasonable for the current situation in Vietnam, the pricing system has other problems. In the water pricing structure in HCMC in particular and in Circular 3 issued in 1999 in general, it is stated that when the water price is set, the affordability of residents should be taken into consideration. However, there have been no guidelines for "affordability". So far, in Vietnam there has been no standard to regulate the percentage monthly cost of using water to take account of the total monthly average income of residents. In fact, in Vietnam the monthly domestic water expense varies greatly among cities. For example in 2002, the cost of monthly water use in the total average income per capita was 3.5% in Ha Giang, 3.2% in Cao Bang, 0.8% in Da Nang, 0.6% in HCMC and 0.8% in Ha Noi (World Bank 2006).

In HCMC and other cities as well, the decision to set the price according to affordability has resulted in either inaccurate or insufficient calculation of production costs especially in the asset depreciation calculation. According to the recommendation of the Asian Development Bank (ADB), the affordability of consumers for clean domestic water in developing countries is about 3% of GDP per capita. In 2005, the average income in HCMC was more than 1.8 million VND/month. Meanwhile, the monthly expenses for water use only accounted for about 1% of this income. Consequently, there is no reason to impose a low water price that does not reflect its real value.

CONCLUSION

Integrated water management is important for achieving sustainable development in a multi-component-market economy with a rapidly growing demand for water. Reform in the current pricing system is necessary and these changes will not only improve the financial situation of the water supply companies and the quality of services but will also support the efficiency of integrated water management, aiming at its sustainability.

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9. Biomass Asia Partnership

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ABSTRACT

Biomass is unique in terms of its renewability and carbon neutrality. When biomass is combusted for energy conversion, carbon dioxide is released into the atmosphere. However, the net concentration of carbon dioxide in the atmosphere remains constant provided the same amount of carbon dioxide is fixed by photosynthesis. If biomass is efficiently and wisely utilized through sustainable management, it can replace fossil fuels such as coal, oil, and natural gas. Energy conversion technologies are divided into two major categories, namely, thermo-chemical conversion, including power generation, gasification, pyrolysis, liquefaction, and trans-esterification as well as biological conversion, including ethanol fermentation and anaerobic digestion. Among these technologies, the importance of technology to produce liquid transportation fuel from biomass wastes will be emphasized in this article. In Asia, fossil fuel consumption, especially petroleum, is increasing due to rapid economic growth and remarkable motorization. As a matter of course, carbon dioxide emissions will also increase. R&D for the environmentally-friendly production of liquid transportation fuels from biomass is thus highly anticipated. Biomass is gasified to produce synthesis gas and can then be converted to alternative transportation fuels such as methanol, di-methyl ether, and F-T diesel. The energy situation in Asia will also be analyzed in this article.

Keywords: Biomass, Energy, Conversion, Liquid fuel, Carbon dioxide

INTRODUCTION

The characteristics of biomass

In general, biomass refers to a substantial number of bioorigin resources that can be utilized as a source of energy and raw materials. Wood, grass, marine algae, agricultural waste, forestry waste, and municipal waste all fall into this category. Energy crops form one part of promising biomass that may enable large scale energy plantation, though this has not yet been commercialized at present. Biomass forms its own body by photosynthesis utilizing solar energy. If biomass is burnt and carbon dioxide is emitted into the atmosphere, the net concentration of carbon dioxide remains unchanged provided carbon dioxide can be photochemically fixed into biomass as demonstrated in Figure 9.1. This is called the carbon neutrality of biomass. Energy sources capable of replacing fossil fuels are derived from this cycle, namely, energy utilization by combustion, and carbon dioxide emissions, and carbon dioxide fixation by photosynthesis, for example, by reforestation. We can thus safely say that carbon dioxide emissions can be reduced by substituting fossil fuels for biomass.

Biomass is the only organic source among other forms of renewable energy. In other words, ethanol, methanol, dimethyl ether, and hydrocarbons can be produced only from biomass among renewable energy sources. This means that biomass can be transported, stored, and transformed in the form of material. It should be emphasized that wind, photovoltaic, tidal, wave, and geothermal energy can produce heat and power but not chemicals and fuels. However, carbon dioxide emitted from the utilization of biomass will accumulate irreversibly into the atmosphere in a manner similar to that discharged by fossil fuel utilization unless the fixation of carbon dioxide is conducted. Sustainable biomass management is essential for the long-term stable supply of bioenergy.

Biomass has disadvantages compared with oil, coal, and natural gas, in the sense that although it is widely abundant, its energy density is low. If a good supply of biomass is required at one site, the cost of collection may be excessive due to the long distance of transportation. In general, biomass has high moisture content and its heating value is lower than those of fossil fuels.

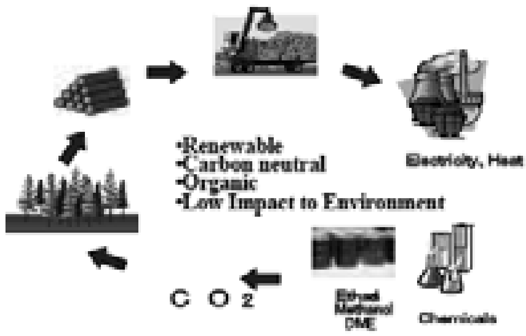

Figure 9.1 Characteristics of biomass

Biomass energy potential

With regard to domestic biomass energy potential, according to the report made by the Japan Institute of Energy in 2002, the amount is estimated to be 1,757PJ/y (41 million TOE) including woody biomass, forestry waste, agricultural waste, food waste, animal waste, and sewage sludge, etc. and the available energy potential is 1,327PJ/y (31 million TOE). This is almost equivalent to 5.7% of the primary energy supply of Japan in 2000 (JIE 2002).

From a global perspective, biomass energy accounts for nearly 15% total global energy consumption. Particularly in developing countries, biomass is the dominant source of energy (38% of total energy consumption). In most rural areas of the world, biomass is non-commercial and held in low esteem as an energy source. The role of biomass in the global energy economy remains unclear. Official data on biomass consumption collected by the Food and Agricultural Organization (FAO) of the United Nations indicate that biomass is burnt at a global rate of about 20EJ/y, which represents less than 6% of total primary energy consumption. However, detailed surveys in many countries indicate a much larger role. Best estimates suggest that biomass is consumed globally at a rate of 55EJ/y, which represents some 15% of the total primary energy consumption (Johansson et al. 1993). Biomass is a major energy source which is consumed globally at nearly the same rate as natural gas. Biomass could play an even larger role in future if we can find eco-efficient technologies to convert it into liquid, gas or electricity.

CONVERSION TECHNOLOGIES

Technologies for biomass conversion have a much wider range than those for wind, photovoltaic, and geothermal energy. This is because biomass is quite different in its chemical and physical properties. Figure 9.2 shows biomass energy conversion technologies. Combustion, gasification, and liquefaction through gasification are suitable for dry biomass such as wood. Animal waste and sewage sludge, meanwhile, with their high moisture content are suitable for anaerobic digestion to produce methane. In the case of starch and sugar, the best technology is fermentation to produce ethanol. In the case of waste food oil, crude palm oil, and rape seed oil, biodiesel production is the best choice through trans-esterification using methanol. In many countries, considerable biomass is already being used for power generation. Cogeneration is in use in Scandinavian countries and huge quantities of ethanol are being produced in the United States and Brazil. Biodiesel fuel produced from rape seed oil is also being used in some European countries, while methane produced by anaerobic digestion has been used for power generation or as an alternative to natural gas for vehicles. In developing countries, charcoal is in broad use for cooking and wood pellets are gradually penetrating society.

Regarding power generation from biomass, the biggest capacity on a single unit in the world is about 50MW. The Hokkaido and Tohoku regions represent good candidates to introduce a cogeneration system on such a scale, as heating is indispensable in winter. In order to operate a plant on a scale of 10MW, nearly 80,000 tons of wood may be needed per year, although this depends on the efficiency of power generation, and operational rates, etc. This scale is, however, not always economical. In recent years, there has been remarkable development in power generation technology through gasification on a small scale.

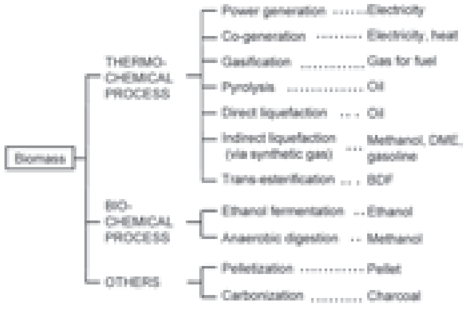

Figure 9.2 Biomass energy conversion technologies

According to a recent news report (Asahi newspaper 2005), the Chugai Ro Company has been developing power generation technology at a test facility to exploit gases generated from wood waste by using a rotary kiln type gasifier. It uses methane and other flammable gases obtained by burning biomass fuel to propel turbines to generate power. This company succeeded in generating electricity from wood waste for 500 consecutive hours.

In order to make biomass fired power generation economically feasible, a cheap supply of biomass and a reasonable price for the sale of electricity are two important factors. In Japan, the RPS (Renewable Energy Portfolio Standard) was enforced from April in 2003, which activates the business of the biomass fired power generation. To ensure the further penetration of biomass into our society, it seems that preferential policy and measures may be necessary.

Methanol, dimethyl ether (DME), and diesel alternatives can be chemically synthesized from synthesis gas (a mixture of hydrogen and carbon monoxide) which is produced by the gasification of biomass such as lignocellulosic materials (wood and grass). However it currently remains in the phases of development and demonstration. Mitsubishi Heavy Industry Co. is conducting research for the production of methanol through biomass gasification with the financial support of NEDO. If methanol is synthesized, DME can also be easily produced by the dehydration of methanol. Since both methanol and DME are promising fuels for fuel cells, an economical process is strongly anticipated. The importance of Fisher-Tropsch diesel (FTD) production from synthesis gas from biomass will be described later.

Biodiesel fuel (BDF), resembling diesel oil, can be used to drive diesel engine motor vehicles. As vegetable oils such as crude palm oil, crude rape seed oil are usually viscous, they are trans-esterified to reduce viscosity. Glycerin co-produced as a by-product of trans-esterification should be properly treated in a large scale plant. In Japan, BDF is mainly produced using waste food oil and rape seed oil in Kyoto, Shiga, and Hiroshima, etc. The quantity of BDF produced is limited (less than 10,000 kl/y) and a substantial amount of vegetable oil may be necessary if larger scale production is expected. Since the consumption of diesel oil is about 40 million kl in Japan, 2 million kl of BDF is needed, if 5% of BDF is blended. In order to supply such a large quantity of vegetable oil, Japan must rely on other Asian countries. In this case, a mutually beneficial strategy is essential for both sides.

Ethanol can be used as gasoline alternative. In Brazil, motor vehicles fueled with nearly 100% ethanol are in common use, and in the United States as well as Brazil E-10 (10%

ethanol blended with gasoline fuel) is used as motor vehicle fuel. In Japan, E-3 (up to 3% of ethanol blended with gasoline fuel) is permitted for use in motor vehicles which are not specially modified for E-3.

The research and development of ethanol production from lignocellulosic feedstock, including woody and herbaceous biomass, is in progress and has reached the production stage. Private industry in the United States, in cooperation with the US Department of Energy (DOE), has developed a process in which lignocellulose is saccharized using sulfuric acid and ethanol fermentation is carried out using genetically modified enzymes. Based on the basic technology supplied by the United States, private industries in Japan are now undergoing further development in readiness for commercialization.

PRODUCTION OF TRANSPORTATION FUEL

In Asia, energy consumption is rocketing due to economic growth and the pursuit of higher amenities in social life. Particularly in China and India, such trends are outstanding and environmental impacts are becoming obvious due to the vast populations of the two countries.

First of all, in Asia the weight of the industrial sector is larger compared with transportation and domestic sectors because energy-consuming industries, such as the heavy chemical industry, have been driving the economy, meaning energy consumption has been augmenting alongside economic growth. Secondly, in the transportation and domestic sectors, electrical appliances, including those for lighting, cooking, and air conditioning, have been prevailing and automobiles have been also increasing.

It is important to consider that traditional or non-commercial fuels, such as fuel wood, charcoal and animal dung, are shifting to fossil fuels including kerosene, light oil, LNG, natural gas, and electricity due to rising incomes, even in developing countries.

In 2003, the primary energy consumption was 2,774 MTOE (million ton oil equivalent) and primary energy production was 1,953 MTOE in the Asian region. The deficiency was compensated for by net imports amounting to 822 MTOE, which represented twice the figure of 1993. As for coal and natural gas, their import dependencies were 10.2% and 13.5% in 2003, respectively. On the other hand, oil consumption was 1,004 MTOE and production was 349 MTOE. About 65% of oil is imported as shown in Figure 9.3 (Koyama 2004). Although China, Indonesia, Malaysia, and India are oil producing countries, consumption exceeds production and oil is constantly deficient in these countries as well.

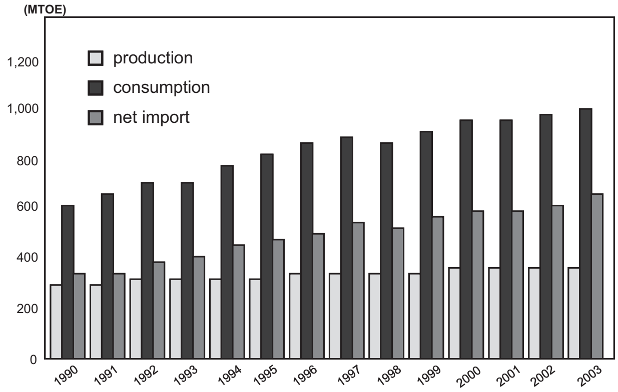

Figure 9.3 Oil supply and demand in Asia

It is interesting to focus on biomass utilization for the production of oil alternatives. Electricity and heat can be produced from coal, natural gas, and renewable resources. However, liquid fuels can only be produced from biomass. This is because biomass is organic or carbonaceous as described in the introduction.

One example is given in Figure 9.4. The production of crude palm oil is about 20 MTOE both in Malaysia and Indonesia. Usually crude palm oil is trans-esterified using methanol for the production of BDF (bio-diesel fuel). However, crude palm oil is utilized for food, chemicals, and other industrial applications. Basically, biomass for energy use should avoid competition with food or other valuable use. Waste palm trunks, which are cut down every 20 or 25 years when the palm trees are replanted for better production, will be good candidates for the use of energy or fuel. According to the statistics, the amount of waste trunks will be 8 million tons on a dry basis per year in Malaysia, most of which will be left unused.

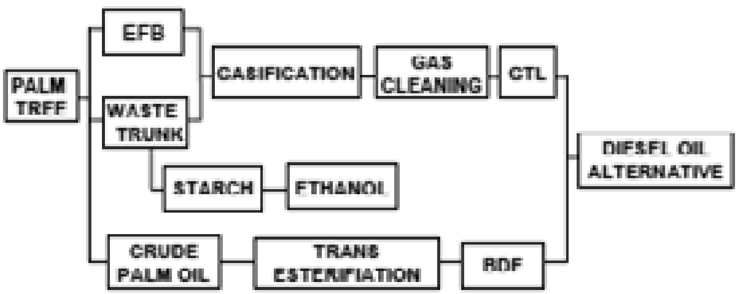

Figure 9.4 Example of whole biomass utilization system

As shown in Figure 9.4, waste trunks are gasified to produce synthesis gas (a mixture of hydrogen and carbon monoxide), from which liquid fuels can be produced. Depending on the reaction conditions and catalyst, methanol, DME, Fishcer-Tropsch diesel etc. can also be synthesized (Tsubaki 2002). Waste trunks contain starch of about 15% which can, if efficiently extracted, be fermented to produce ethanol. Ethanol is used for the tarns-estrification of crude palm oil instead of methanol. The process for the production of liquid fuel applies not only to waste trunks but also to many other woody biomass and agricultural waste. To meet the future demand for oil, particularly for transportation fuels, it is vital to develop these technologies.

BIOMASS ASIA STRATEGY

The Japanese government proposed the “Biomass Japan Strategy” in cooperation with six governmental organizations and this was approved in cabinet in 2002. In addition, Japan must build a master plan that includes Asian countries. These countries have a vast amount of unutilized biomass resources as well as human resources and technologies. If our country and Asian neighbours collaborate and integrate their efforts, there will be great benefits for both sides.

Figure 9.5 depicts the Biomass Asia Strategy. Fossil fuel consumption will be reduced if the products are imported, energy security will be achieved, greenhouse gas emissions will be reduced, greenhouse gas emission trading will be possible, and international cooperation through technology transfer will be enabled for our side. Furthermore, primary industries will be fostered, employment will be secured, new energy and chemical business will be introduced, fossil fuel consumption will be reduced, a CDM (clean development mechanism) will be applied, and capacity building will be made for Asian countries.

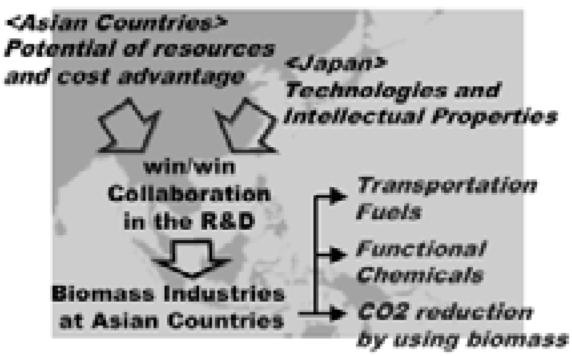

Figure 9.5 Image of Biomass Asia Strategy

For this purpose, a three year project starting in 2004 was organized by the research institutes of the Ministry of Agriculture, Forestry, and Fisheries and AIST (Agency of Industrial Science and Technology), together with the University of Tokyo, RITE, and Mitsubishi Corporation. The main objectives of this project are to investigate biomass resources in great detail, to establish a network of researchers and policy makers, and to propose a master plan or grand design of international collaboration for the efficient utilization of biomass in accordance with environmental protection. It is strongly expected to establish a substantial collaboration that will bring mutual benefits.

CONCLUSION

- In Japan, the biomass energy potential accounts for several percent of primary energy consumption.
- Appropriate conversion technology should be chosen for respective biomass.
- Biomass is the only carbonaceous material among renewable resources. Fuels and chemicals are preferential products.
- Taking the energy situation in Asia into account, oil is deficient and 65% of oil is import-dependent. The production of motor fuel alternatives from biomass is strongly anticipated.
- R&D is important for the production of methanol, ethanol, DME, and FTD from waste biomass instead of food or valuable materials.
- The establishment of a Biomass Asia Strategy, which is mutually beneficial for both sides, is needed to drive this scenario.

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10. Conservation of Biological Productivity Supporting Sustainable Biomass Utility

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ABSTRACT

In order to promote sustainable biomass production and utility, it is important to understand in what way the biomass product yield is obtained and what risks to biomass production exist. Net primary productivity (NPP) is the foundation of biomass production and climatically defined NPP can be used as the potential productivity in product yield estimation and systematic production planning. Common risks to the sustainable biomass production in South East Asia are summarized in this article. The potential of GIS (Geographic Information Systems) to assist in the management of biomass production as well as environmental conservation is also shown. The article also outlines the results of a case study, in which a forest ecosystem model was combined with GIS and where the wood yield and soil organic matter were calculated as an indicator of land failure protection and the potential habitat of an endangered animal based on different regional forest management strategies respectively.

Keywords: Net primary productivity, Biomass production, Product yield, GIS

INTRODUCTION

The rapid economic growth of emerging countries in South Eastern Asia is leading to a correspondingly rapid increase in energy demand. In this context, the introduction and promotion of a stable and clean energy supply has become vital. Developing biomass utility for energy supply is one possible solution. However, biomass produced in rural agriculture and forestry regions has already been highly utilized for various purposes, including heat and cooking fuel, fertilizer, livestock litter etc. in traditional ways, meaning the additional demand for biomass may affect the balances of production and utility. This article summarizes a few aspects to conserve biological productivity that supports sustainable biomass utility. The potential of Geographic Information Systems (GIS) to assist in the management of biomass production as well as environmental conservation is also shown with results of a case study.

BIOLOGICAL PRODUCTIVITY AND BIOMASS PRODUCT YIELD

Biological productivity is defined as annual biomass growth within a unit area of an ecosystem. NPP (net primary productivity) is the common indicator of production in natural vegetations, and is adaptive to forestry and agriculture production, which is defined as the annual net biomass growth of autotrophic organisms (*i.e.* green plants) in a unit area, having the unit of tdw ha^{-1} y^{-1} or tC ha^{-1} y^{-1}. Figure 10.1 shows the global NPP map illustrated by Efimova (1977). NPP is strongly dependent on climatic conditions, especially temperature, radiation and precipitation. Certain NPP models were proposed based on the relationships between NPP and the climatic factors. For example, the Miami model (Lieth 1975) estimates NPP by means of its dependence on air temperature and precipitation by the following equations:

$$NPP_T = 30/\left[1+\exp(1.315-0.119T)\right]$$
$$NPP_P = 30\left[1-\exp(-0.000664P)\right] \qquad (1),$$

where NPP_T and NPP_P are the temperature and precipitation controlled annual NPP (tdw ha^{-1} y^{-1}), respectively, T is the annual mean temperature (°C) and P is the annual precipitation (mm). The NPP of a site is the smaller of NPP_T or NPP_P. Uchijima and Seino (1985) developed their Chikugo model, which estimates NPP as a function of net radiation and radiative dryness index as follows;

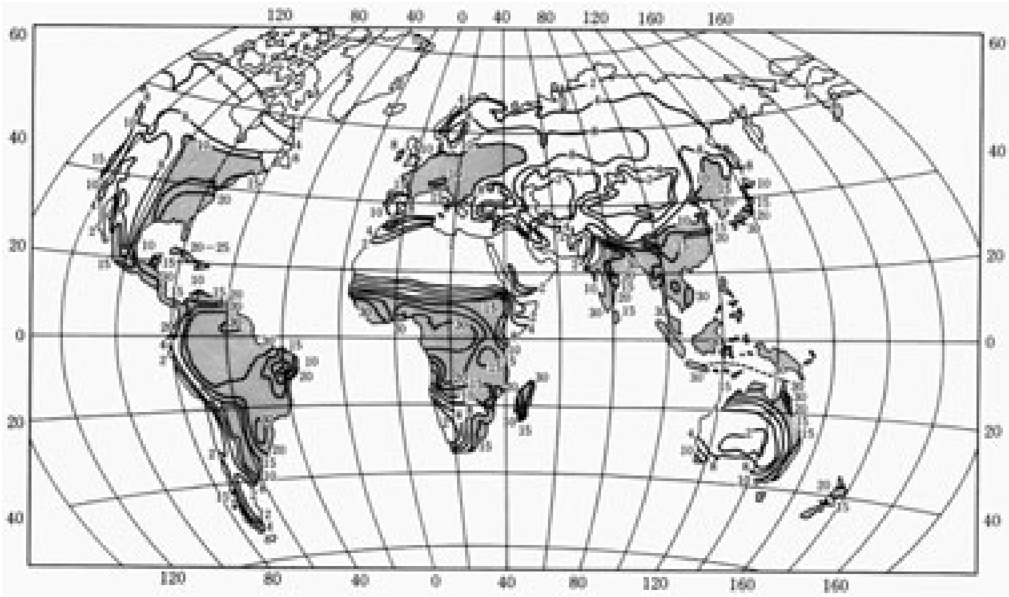

Figure 10.1 Global NPP map (Efimova 1977). Unit is tdw ha^{-1} y^{-1}

$$NPP = 0.0069\left[\exp(-0.216 RDI^2)\right]R \qquad (2),$$

where, NPP is in tdw ha^{-1} y^{-1}, R is the annual net radiation (MJ m^{-2} y^{-1}) and RDI is the annual radiative dryness index, defined as the ratio of net radiation to the equivalent evaporation energy of annual precipitation,

$$RDI = R / lP \qquad (3),$$

where, l is the latent heat of evaporation (MJ kg^{-1}). These two models only modeled the climatic control of NPP and did not consider actual vegetation and other environmental factors. Recent studies have proposed more detailed models. For example, Melillo *et al.* (1993) modeled the effects of leaf area, carbon dioxide and water vapor concentrations, and soil nutrient availability on NPP, and SimCYCLE by Ito and Oikawa (2002) estimated NPP based on the production structure of vegetation and the environmental control to NPP. Satellite images also provide useful information on vegetation and environmental factors and are used in routine NPP monitoring (NASA 2003).

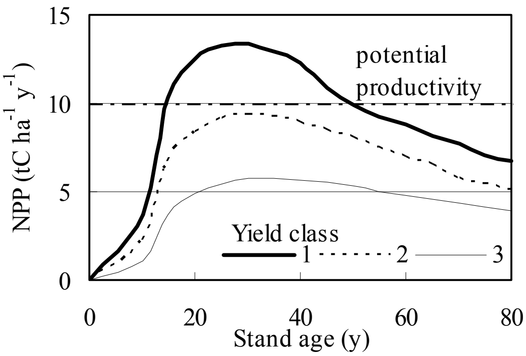

Figure 10.2 Actual NPP of Japanese cedar (*Cryptomeria japonica*) plantation of different yield classes in Hyogo prefecture, central Japan

The NPP, determined by its relationship to climate, can be considered as natural average productivity and has the meaning of potential productivity. On the other hand, actual productivity also depends on various site factors, including soil, topography, and water availability etc. Anthropogenic treatment factors, such as plantation and thinning in forestry, and crop selection, irrigation, fertilization and multiple cropping in agriculture also affect actual productivity. Figure 10.2 shows the actual productivity of the Japanese cedar (*Cryptomeria japonica*) plantation of Hyogo prefecture, located in central Japan. The curves were calculated from a standard yield table for this region, and the horizontal line, denoted as potential productivity, represents the climatically defined NPP by means of the Miami model. This figure indicates that actual productivity largely varies depending on the stand age, and the yield class, which is a total site quality reflecting environmental factors, including soil, nutrients, water, slope, altitude etc. Actual productivity also changes based on tree species, and that of Japanese cedar in the highest yield class exceeded the climatically defined potential productivity (namely, that thought to be of a species typical for the climate zone) during the ages of high growth rate. The ratio of actual productivity to the potential value is the total factor of the site and treatment, and can be estimated statistically if datasets of a variety of site quality, treatment and observed yield are available.

The biomass product yield can be calculated by the product of potential productivity, site and treatment factors described above, and conversion efficiency, which represents the fraction of product yield to total biomass, for example the ratio of timber volume to total wood biomass. This calculation can easily be applied to the yields of byproducts (*e.g.* straw and wood chips) and secondary products (*e.g.* livestock), and furthermore, it is applicable to the biomass yield model for the selection of crop species, which is used to assist in the regional planning of biomass production and utility (Fig. 10.3). The use of a simple climatically modeled NPP is suitable to estimate biomass product yield in such applications, because it can be treated as the potential value of biological productivity.

CONSERVATION OF BIOLOGICAL PRODUCTIVITY IN SOUTH EAST ASIA

South East Asia is one of the world highest biological productivity regions, with high temperatures and considerable precipitation (see Figure 10.1). However it also belongs to the monsoon climate zone, which is characterized by clear wet and dry seasons, and its productivity is variable depending on the inter-annual change in climate.

This region faces common risks on biomass production and environmental issues for natural and anthropogenic reasons: the surface soil organic layer of tropical and sub-tropical forest is generally very shallow and easily lost by erosion after deforestation, especially on steep slopes. In irrigated croplands, meanwhile, special care is needed to avoid soil salinization caused by high potential evaporation. A monocultural wood plantation provides a high yield and easier management, however is also associated with increased risks of pest and insect damage than natural or mixed forests. Forest fires frequently occur during dry seasons in this region, especially during El Nino years. Meanwhile, the loss of biodiversity caused by changing land-use and water pollution by the improper use of fertilizers and chemicals should be prevented. Maintaining a proper intensity of biomass utility balanced with productivity is indispensable for a high yield. For example, in the case study of a cropland in Khon Kaen Province, Thailand (Fig. 10.4), about half of the nitrogen loss by harvest is compensated with chemical fertilizer and the remaining half with crop residuals and livestock manure (Matsumoto and Paisancharoen, 2005). This suggests that the high utilization of “unused” biomass, such as crop straw and cattle manure for energy production, may lead to soil nutrient shortages and reduced productivity.

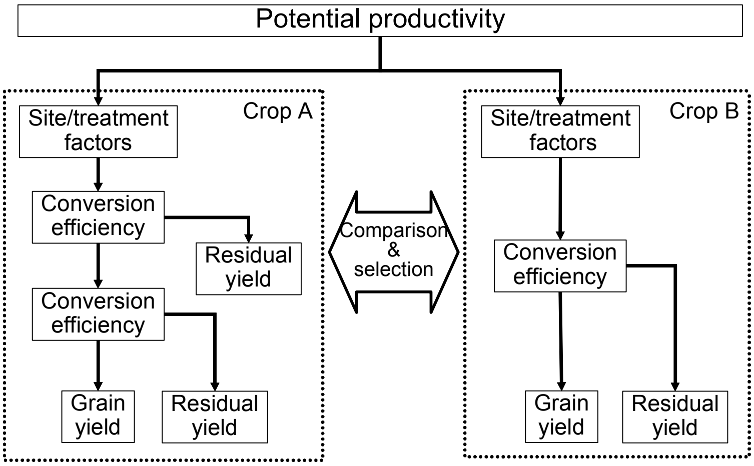

Figure 10.3 Concept of systematic biomass products selection based on potential productivity and product pathways. Potential productivity is defined climatically and is common to all crop species; however, the grain yields of crops A and B differ because they have different site and treatment factors, conversion efficiencies, and process pathways. They also provide different by-products. Comparison of total product yield among candidate crop species can assist decisions concerning regional biomass production strategies.

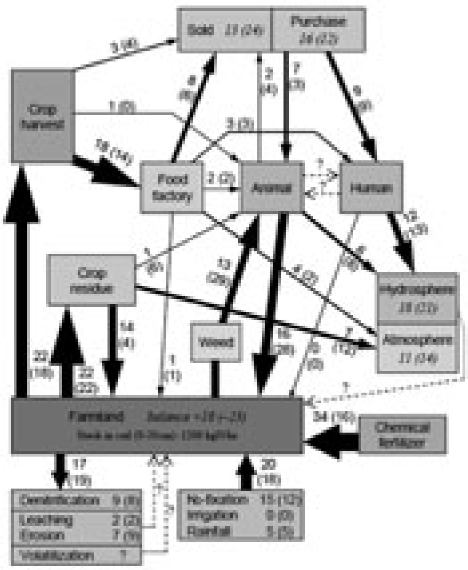

Figure 10.4 Nitrogen cycle related to agriculture activity in 1990–92 and 2000–02 in Khon Kaen Province, Thailand (kgN ha^{-1} y^{-1}). Values outside parentheses indicate the nitrogen flow in 2000–02, and values inside parentheses indicate the nitrogen flow in 1990–92. Values in italics are calculated by subtracting output from input (Matsumoto and Paisancharoen 2005).

POTENTIAL OF GIS FOR THE MANAGEMENT OF SUSTAINABLE BIOMASS PRODUCTION

GIS are useful tools for the regional management of biomass production and utility. They can combine regional information related to consumption (e.g. population, industry, transportation etc.) and biomass production as well as the models described above. A case study by Ooba et al. (2006) shown below effectively indicates their potential.

A forest ecosystem model was used to estimate biomass growth under different conditions of site yield class, wood species and stand age on a GIS for the evaluation and future estimation of forest ecosystem services in the Yodo River basin. The Yodo River basin is located in central Japan and has an area of 8,240 km^2 mainly comprising a highly developed urban area, cropland, and mountainous forest that occupies 63% of the basin area. Two forest management strategies by means of different re-plantation treatments were compared through the simulations lasting 30 years; one aimed to promote wood production and planted Japanese cedar, which is the most rapidly growing tree species among those common in this region after deforestation, and the other aimed to protect land failure and biodiversity loss by reforesting mixed broad leaf species, which supplied considerable organic matter to the underlying soil. The common treatments for both strategies involved clearcutting the oldest remnants of any species and replanting selected species, in which the annual treatment area was 1% of the total forest area, and natural preserves and special purpose stands were not managed. Soil carbon storage was used as the indicator of land failure protection. In order to evaluate the effect of forest management on biodiversity conservation, the potential habitat of a few endangered animal species was estimated by linear discriminant analysis based on distribution survey data and the environmental factors stored and calculated in the GIS.

Figure 10.5 shows the calculated forest productivity distribution in the Yodo river basin 30 years after beginning management, which is indicated in terms of the wood volume yield in order to display the long-term accumulated production. The productive (productivity promotion) management used to develop Japanese cedar monocultural plantations saw the active promotion of tree biomass production and wood yield far larger than the protective (land failure protection and biodiversity conservation) management, especially in the southern part. The average wood yields were 322 m^3 ha^{-1} and 241 m^3 ha^{-1} for the productive and protective management, respectively, while the latter promoted soil organic matter accumulation in 30 years (Fig. 10.6).

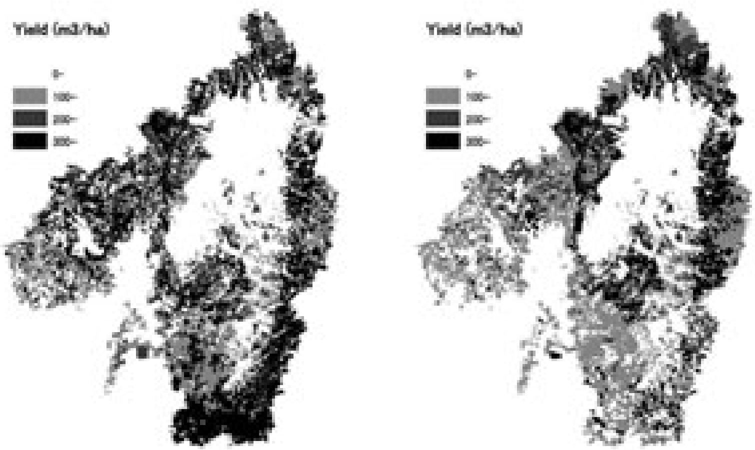

Figure 10.5 Wood volume yield distribution in the Yodo River basin, 30 years after beginning forest management in units of m^3 ha^{-1}. The left and right panels indicate the productive and protective management strategies in which Japanese cedar and broad leaf species were replanted, respectively.

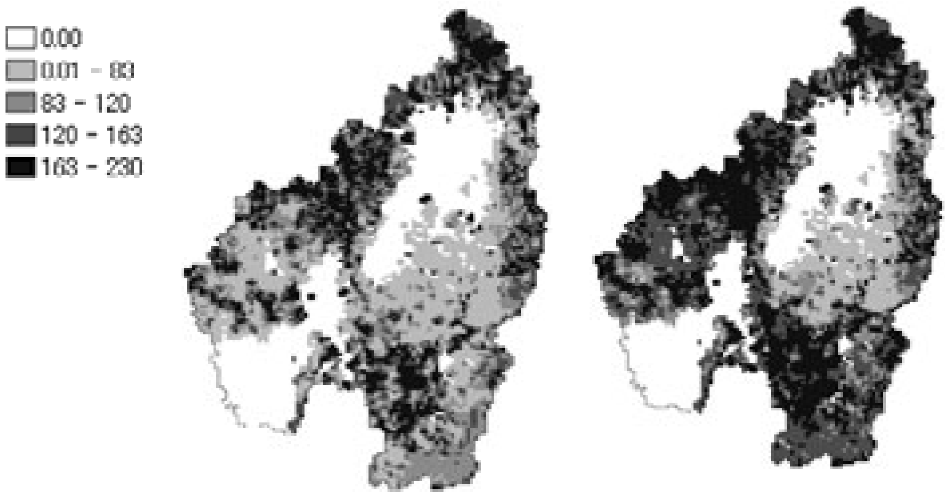

Figure 10.6 Soil carbon storage distribution in the Yodo River basin in units of tC ha^{-1}. The left and right panels indicate the state during and 30 years after the beginning of the protective forest management, respectively.

Figure 10.7 shows the potential habitat distribution of the Japanese black bear (*Ursus thibetanus* japonicus) during and 30 years after the beginning of the protective management program, as estimated by linear discriminant analysis. The potential habitat of the Japanese black bear was expanded by 30% over 30 years by planting broad leaf species.

The above case study has not introduced any zoning plan to classify stands according to their functions (wood production, land failure protection, water reservour, biodiversity conservation, recreation, sightseeing etc.) yet. The application of this zoning strategie is indispensable in the practice of regional forest management to achieve a high and sustainable biomass production, well balanced with environmental conservation, and GISs are capable of assisting in the planning of the same.

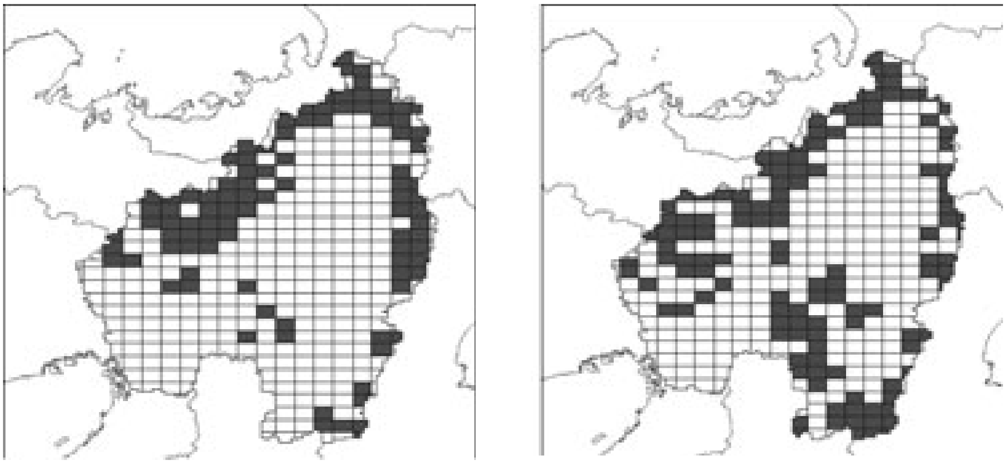

Figure 10.7 Estimated potential habitat of the Japanese black bear (*Ursus thibetanus* japonicus) in the Yodo River basin by means of linear discriminant analysis. The left and right panels indicate the period at and 30 years after the beginning of the protective forest management, respectively.

CONCLUSION

This report summarized a few aspects to conserve biological productivity in terms of the utility of potential biological productivity and common environmental issues in South East Asia. It also illustrated the potential of GISs to assist in the management of biomass production and environmental conservation. It is important to understand in what way the biomass product yield is obtained and what risks exist on biomass production to plan sustainable biomass production. Practical studies of the planning, management and evaluation of environmentally sound and sustainable biomass production and utility are now expected, based on the concepts discussed in this report.

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Policy Measures towards Sustainability at Different Scales

11. Multiple Approaches to Asian Sustainability

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ABSTRACT

It is crucial to achieve sustainability in the Asian region, where 60% of the world population lives and consecutive industrialization and rapid economic growth are expected. Several approaches to achieve a sustainable society have been proposed and implemented. These initiatives aim at ensuring resource protection, environmental protection and change in consumption and production patterns. These approaches also include those for creating a sound material cycle society, focusing on the sustainable use of natural resources, a de-carbonized society focusing on sustainable energy use, and sustainable cities to harmonize urban development and the environment. There is no single optimal way to achieve a sustainable society and various approaches should be taken simultaneously. From the implementation perspective, the 3Rs approach represents an effective tool to achieve sound material cycles based on a closed loop economy. The sound material cycles may be created at different levels and scales, though the basic unit should be considered at national level. However, some end-of-life products that cannot be recycled or disposed of in environmentally sound and economical feasible manners in discarding countries may require regional consideration for appropriate recycling. On the contrary, biomass waste could be used for energy recovery at the level of cities and neighboring villages, which involves realizing sustainable agriculture in suburban areas of large cities as well as conservation of natural environment in the area, and a renewable energy supply to cities, which can be applied to countries in the Asian monsoon region.

Keywords: Sound material cycle society; 3Rs; Regional approach; Urban-rural cycle

INTRODUCTION

Asia, home to around 60% of the world's population, occupies about a quarter of the global area. As of the year 2000, Asia had 48% of the world urban population, which makes it less urbanized than other regions. Energy consumption in Asia accounts for 32% of the global total (2000), while per capita energy consumption is less then 1/3 the average of other regions. The GDP in Asia accounted for 28% of the world total in 2000, with per capita GDP about 25% that of other regions. The geographical features and cultural characteristics of this region considerably differ between the eastern sub-region (Northeast, Southeast and South Asia) and western sub-region (Middle East and Central Asia). Eastern Asia is where the majority of the population and economic activities are concentrated. Currently 90% of Asian people live in Eastern Asia, from where 87% of Asian GDP comes. Eastern Asia, including several big and populous countries, such as China, India, and Indonesia, is rapidly industrializing and expanding its economy, resulting in the large consumption of natural resources and increasing imports of such resources and scraps into this region.

This paper introduces some approaches for achieving a sustainable Asia, based on the Japanese experience, and proposes some basic ideas that could be applied to countries in the Asian region where policies and measures for enhancing sustainability are necessary.

CHANGING ASIA AND THE RESOURCE ISSUES

Though Asia is currently less urbanized and less developed than the global average, the continuous economic growth in this region is altering its global status. According to estimates by international organizations, due to economic growth and improving quality of life in the region, the percentages of population of the whole Asia in 2030 will decrease to 54% of the world from the current figure of 60%, whereas Asia will come to share 54% of the world urban population, 45% of the world GDP and 43% of the world energy consumption[)], as shown in Table 11.1 (UNPD 2005; UNS 2005; EC 2005).

Consequently, in the future, Asia will become a region where the economic performance will be balanced with the population size. At that time, the Asian countries will come to consume more than half the global energy and natural resources and also discharge proportionate volumes of air and water pollutants and solid waste. It is thus clear that Asian sustainability is vital in order to achieve global sustainability.

Table 11.1 Asia among the world

Parameter	Y2000	Y2030
Population	60%	54%
Urban Population	48%	54%
GDP	28%	45%
Energy Consumption	32%	43%
CO2 Emissions	-	46%

Despite the very rapid industrialization, Asia lacks sufficient natural resources to cover even domestic use in the region, and some rapidly industrializing countries are facing a shortage of both natural and energy resources for expanding their industrial production. At the same time, this economic growth and the consequent changes in consumption patterns mean Asia will generate a large amount of solid waste, including end-of-life products in the near future. Some Asian countries are trying to conserve scrap metals, waste plastics and waste papers as materials for industrial production from foreign countries, including non-Asian countries. Under these circumstances, some countries are suffering from illegal imports of waste materials, particularly E-waste and other hazardous waste, which pose a threat to human health and the environment. At the same time, most developing countries in the region are urged to implement the environmentally sound disposal of municipal waste, including household waste, hospital waste and E-waste, which are generated in their own territories.

APPROACHES TO A SUSTAINABLE SOCIETY

The concept of a sustainable society has been discussed repeatedly since the Rio Summit and could generally be defined as a society where the following objectives are achieved:

(a) Poverty eradication,
(b) Sustainable consumption and production,
(c) Protection of natural resources,
(d) Protection of the environment,
(e) Economic and social development, and
(f) Protection and promotion of human health.

Among these, the second, third and fourth objectives are considered particularly important from the viewpoint of material sustainability for this region where industrialization, urbanization and economic growth will continue. The concept of a closed loop economy (CLE) is recognized as a basis to support the achievement of these objectives, mainly through the creation of sound material cycles (SMC).

Several approaches have been proposed to achieve a sustainable society. One of them proposes the design of sustainable cities, which has been implemented under the initiative by the International Council for Local Governmental Initiatives (ICLEI). ICLEI introduced the Local Agenda 21 campaign which promotes a participatory, long-term, strategic planning process that helps municipalities identify local sustainability priorities and implement long-term action plans (ICLEI homepage). This initiative was endorsed in the Rio Summit, which called upon efforts for sustainable development by all relevant sectors at all levels, including local governments and municipalities.

Sustainable cities are sometimes interpreted as environmentally sustainable cities. The Urban 21 Conference held in Berlin in July, 2000, defined the concept of sustainable cities as such cities to improve the quality of urban life, including ecological, cultural, political, institutional, social and economic components, without burdening future generations (World Commission Urban 21 2000). Efforts to limit waste generation, prevent pollution, maximize the conservation of a healthy ecosystem and promote the efficiency of resource utilization are needed to reach sustainable cities, the latter of which also require economic and financial considerations, and the development of infrastructures and social systems to support these activities. Today many cities are participating in a movement to make cities sustainable worldwide, but the considerable variation in the scale, development stage, and socioeconomic circumstances of cities mean the major concerns of the respective cities should be considered individually. Actually some cities are interested in sustainable traffic systems but others are focusing on environmentally sound waste management. This approach aims at achieving sustainability in a city scale with very flexible targets, according to the situation of each city.

In addition to this movement for sustainable cities, Japan has tried certain other approaches towards a sustainable society. One of these involves creating a sound material cycle society (SMCS) or recycling-based society, where 3Rs (reduction, reuse and recycle) and the environmentally sound disposal of solid waste are expected to drastically reduce the excessive use of natural resources and also minimize the environmental impacts.

Another approach is to create a de-carbonized society, where people are not suffering from the adverse effects of global warming, such as extreme temperature rises, drought and flooding, and ecological destruction, etc., by tackling climate change including the mitigation of greenhouse gas emissions and adaptation measures against global warming.

The approach to achieve a de-carbonized society focuses on energy sustainability, such as improving energy efficiency and conversion to renewable energy sources, whereas an approach to SMCS focuses on sustainable material cycles.

In addition to these, a zero-emission approach is also proposed in order to ensure environmental protection and the conservation of natural resources, which is a similar concept towards SMCS.

These approaches have the common aim of achieving a sustainable society and their methodologies partly or mostly overlap. For example, waste recycling, which is a key component in achieving SMCS, is also meaningful in achieving a de-carbonized society by improving energy efficiency, and the energy recovery from solid waste, which is also considered a new energy source. However, the focal points vary slightly from the others as shown in Figure 11.1. The de-carbonized society approach mainly targets energy conservation and environmental protection, particularly against climate change, whereas SMCS mainly targets resource conservation and sustainable consumption and production. The sustainable city initiative, on the other hand, targets environmental protection and sustainable consumption and production.

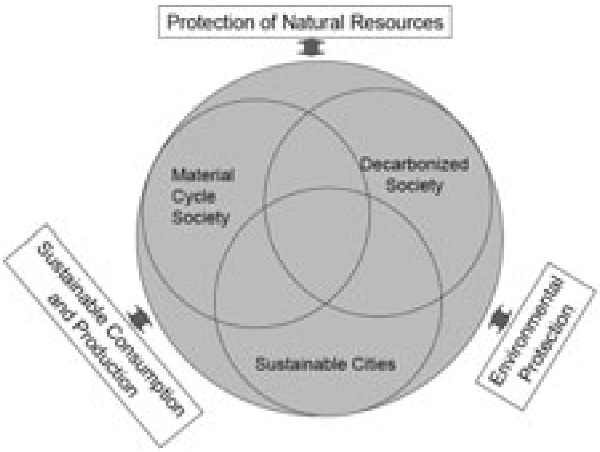

Figure 11.1 Several approaches towards a sustainable society

It is useless to discuss which approach is better or worse because all these approaches try to achieve a sustainable society by taking different paths, and a variety of approaches to sustainable society should be taken simultaneously. Considering the critical situation we are facing in Asia concerning natural resources and waste management, we are particularly urged to create an SMC in this region that is supported by the concept of CLE.

3Rs FOR RESOURCE CONSERVATION

After the industrial revolution, societies have dramatically increased their consumption of natural resources via the exploitation of metals and energy sources among others. For example, iron and steel production increased 15fold over the twentieth century. Copper has also been a useful metal for human society since ancient times and has become more important in modern industrialized societies because it is essential for producing present-day electrical and electronic appliances. Through industrialization, its consumption has been increasing rapidly worldwide and its production increased 25 times over the twentieth century (U.S. Geological Survey 2006). Copper consumption has particularly rocketed in the Asian region due to recent rapid industrialization.

Copper ore, which is extracted from the lithosphere, is transformed to a copper cathode, which is fabricated and manufactured to copper containing products such as electric wires, electrical and electric appliances, or used for construction materials. Copper is not literally consumed by human society but is stored in anthropogenic sites in the form of construction materials of buildings and other infrastructures, parts of various machines in factories, and electrical appliances or other copper containing products in households. At the end of their lives, these copper containing products are discarded, some of which are collected as copper scraps and the recovered copper is used again in production. Today about 60% of obsolete copper is estimated to be recovered from waste and demolition scraps and the remaining 40% is land-filled (Graedel et al. 2004).

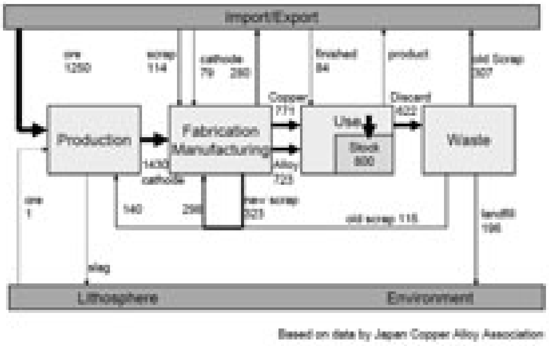

Figure 11.2 Copper material flow in Japan (2003)

Figure 11.2 shows the copper material flow in Japan (JCBA 2003). Because Japan has no big copper mines, most of the copper ore is imported from foreign countries, such as the Philippines and Chile. Copper scraps from end-of-life products recovery accounts for about 70% in Japan. This figure has risen to around 75%, the highest level in the world, after the enforcement of the Home Appliances Recycling Act in 2001, which provides for mandatory recycling of refrigerators, TV-sets, washing machines and air-conditioners under the responsibility of manufacturers.

In order to protect natural resources while minimizing the environmental impact, there are many technical measures, including improved efficiency from exploitation to utilization processes, reduction of material use and increased recycling.

The Government of Japan is taking the leadership on 3R initiatives among developed nations to realize SMC. The “3Rs” originally meant (a) the reduction of waste and by-products generation during the production and manufacturing stages, (b) the repeated reuse of materials in the consumption stage, and (c) the recycling of materials in the waste management stage. Now the reduction means not only reducing waste generation but also reducing the raw materials and natural resources used for production. Under the concept of 3Rs, Japan is implementing a variety of policies to encourage the creation of SMCS in Japan For example, during the product manufacturing stage, designs for easily recyclable products and less material use, as well as efficient resource use are encouraged. In the marketing stage meanwhile, simple packaging, the use of returnable containers, eco-labeling, and the collection of packaging materials are encouraged, and during the consumption stage, green purchasing and source separation of household waste are promoted.

SCALE OF MATERIAL CYCLES

National and regional scale

Though metals and other natural resources are generally traded in world markets and are continuously on the move worldwide, the material cycles should be primarily examined at a national level because the nation is a definite and basic unit of economic activity and management of natural resources. Therefore each nation is encouraged to implement the necessary policy and measures for creating SMC or CLE in the territory, with its own economic and social circumstances in mind.

However, there are some waste materials that require regional consideration for achieving a better SMC or CLE. Today, it is common for waste generating countries to differ from product manufacturing countries under the globalization of the economy. Consequently, an increasing number of industrial products which cannot be recycled or disposed of in an environmentally appropriate and economically feasible manner are increasing (Fig. 11.3).

Mobile phones, which are rapidly expanding worldwide, pose a major threat to the environment, since they are disposed without appropriate controls. Although mobile phones contain valuable metals, such as copper and aluminum, their recycling is neither easy nor profitable without the appropriate facilities and technology in some developing countries. However, there is an advanced form of technology developed by one Japanese recycling company (Dowa Ecosystem Corporation) which can recover traces of gold contained in mobile phones in an economically profitable and environmentally sound manner (Naka 2006).

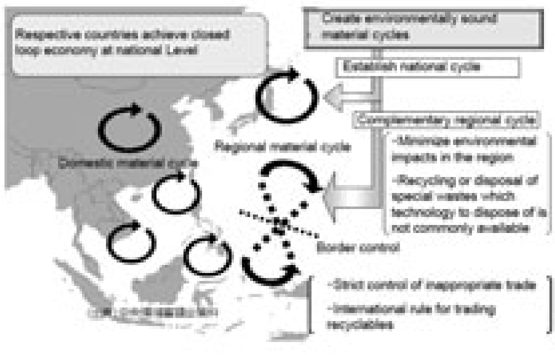

Figure 11.3 National and regional cycles (MOE 2005)

Eco-efficient recycling technologies like that mentioned before should be introduced to increase recycling levels while protecting the environment. However, sometimes such technologies cannot be applied in developing countries. If sufficient scraps cannot be collected due to market limitations, the recycling business would not be profitable, and it may be difficult to hire qualified engineers for operating these technologies. In some cases, a regional collection and recycling system should be considered to promote the maximization of resource efficiency and minimization of environmental impacts. In particular, as several countries in the Asian region are now suffering from environmental pollution and health hazards caused by inappropriate E-waste recycling and disposal methods, material cycles at a regional level should be considered as a supplementary scheme to national recycling systems.

Regional material cycles would be also effective when an EPR-based recycling scheme for some specific end-of-life products is introduced under regional cooperation. Fuji Xerox Corporation, based in Japan, built its own recycling facility for photocopying machines in Thailand, where end-of-life machines used in 9 countries of the Asia-Pacific region are collected and recycled. Recovered materials from the process are then used as alternative resources by the Thai industry. Before this facility commenced operation, end-of-life photocopy machines were recycled and disposed in each country and between 5 to 50 % of materials were land-filled. Now, nearly 90% of materials are recovered and only 0.4% is land-filled (Watanabe, 2006). This is a good example that shows that a regional recycling scheme made it possible to reduce the environmental impact and also recover more valuable materials for industrial use. This experience suggests that a future model of regional material cycles for specific products could help achieve regional sustainability.

City scale

There are several material cycles at different levels and scales. Some material cycles are formed at a city level, but others at an inter-city or area level and some on a nationwide scale. The scale of material cycles generally depends on their nature, value, marketability, the location of waste generation sites and consumption sites of recovered materials, cost and mobility of raw materials, and availability of technology, etc. However it is desirable to create smaller material cycle systems near to waste-generating sites, even if natural resources move world-wide, based on the viewpoint of reducing environmental loads by transporting waste materials and on the availability of recovered materials.

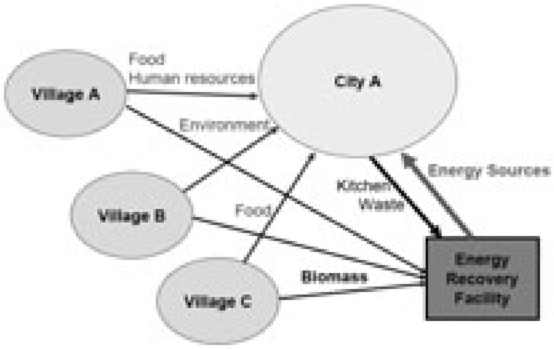

Figure 11.4 Urban-rural material cycle

Some material could be cycled at the level of cities and neighboring villages and one example is organic waste. Cities generate vast amounts of organic waste from households, restaurants and food processing industries, while neighboring villages also generate agricultural waste. These organic wastes could be efficiently collected and recycled at a local level, covering cities and neighboring villages.

Traditionally organic waste has been recycled as compost or animal food and such efforts are still underway in some areas in this region. However, an alternative concept for the material cycle on this scale is to recover bio-energy, such as in the form of methane, ethane or alcohols from this organic waste. Due to the need to expand renewable energies as well as diversify energy sources, under the likely scenario of energy shortages and price hikes, as well as the forthcoming threat of climate change, energy recovery from organic waste could be a useful option for waste recycling, particularly in this region, where many countries are likely to face energy limitations and environmental deterioration (Fig. 11.4).

The University of Tokyo is now conducting a research program under an IR3S flagship project on CLE, towards creating a closed loop system over the area between the urbanized city and its neighboring villages, where bio-mass is collected to produce energy. This research seeks a new sound relationship between cities and villages, maintaining sustainable agriculture while conserving the traditional landscape of farmlands. Cities have been closely connected to surrounding rural areas through trade in agricultural products, and receiving labor and recreation services, but bio-mass recycling systems in combination with the energy supply could establish a new relationship between cities and their surrounding areas. In Asia, it is said that cities have been developed in a mixed form of urban land use and farmland use, which is considered a unique but common factor of Asian cities. In addition, this region is characterized by the Asian monsoon climate where agriculture depends on rice crops. These characteristics may make it easy to collect bio-mass from cities and neighboring farmland to supply recovered energy for consumption in the area.

CONCLUSION

CLE-based SMC is an essential key to achieve a sustainable society. There are several ways to do so and it is both necessary and effective to use multiple approaches to reach the goal because sustainability is a comprehensive concept, with many aspects that must be implemented. Regarding material cycles, there must be different SMC at different scales and levels. With careful consideration of material flows and the other factors concerned, SMC should be built at an appropriate level.

CLE is an economic concept to realize SMC through efficient material use and maximum recycling. However, it is impossible to build CLE and SMC without environmental-friendly lifestyles and cultures. CLE, linked with an environmental-friendly lifestyle, is supported by several factors, such as technology, legal systems, education, and policy, etc. Technology is particularly important for encouraging CLE, and technological innovations will make it possible to launch new recycling systems and more efficient operation. Policy and education are also crucial for creating an environmental-friendly culture, which encourages the purchase of environmentally-friendly or green products and contribute toward improving resource efficiency and encouraging recycling activities.

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12. Current Environmental Issues in South Korea and Policies toward a Sustainable Society

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ABSTRACT

For decades, South Korea has indulged in developing a growth- and supply-oriented economy while paying little attention to the environment. Although such development worked for a time, it has not been as economically efficient as was hoped and indeed instead poses a dangerous threat to the land and people. The ultimate goal of the nation's policies should target environmental sustainability, rather than economic indices. Our economic activities should not be allowed to exceed the land's carrying capacity and land use should be planned from an ecological perspective, in order to preserve its productivity and stability. In that sense, there should be a clear goal concerning where and to what extent to preserve the three important ecological bases in the Korean Peninsula, namely, forests, coastal wetlands and agricultural farms. The forest is the base for terrestrial ecosystems like flood control, water resources, climate and others; the coastal wetland for the marine ecosystem and farmland for producing food. Within that goal, limits should be set on the extent to which the land can be utilized for activities like urban development, manufacturing, recreation and others. Moreover, the limits imposed on pollution generated by such activities should be set so as not to irreversibly damage the environment. Economic development should be planned to minimize the use of energy and resources only after satisfying these constraints. Energy efficiency should be upgraded and an efficient recycling system should be established to save energy and resources and reduce waste volume. The industrial structure should be reformed to make it environmentally friendly and pollution should be cleaned up. Korea's environmental problems cannot be fundamentally solved without first solving those of the wider Northeast Asian region, such as trans-boundary air pollution, marine pollution, and the conservation of endangered species, all of which need to be solved through international cooperation.

Keywords: Traditional environmental policy, Environmental degradation, Land-use planning, Management policies

TRADITIONAL ENVIRONMENTAL POLICY

Traditionally, Korean people, as pantheists, used to revere nature and had very strict environmental ethics. They did not regard nature as a resource for human use but regarded human beings as members of nature, and sought to live in harmony with it. They regarded acts like destroying or polluting nature or the wasteful use of resources as crimes which would incur divine wrath. During the Chosŏn Dynasty (1392-1897), environmental crimes were punished under the constitution. For example, illegal logging, destruction of forests, dumping of wastes such as ash and manure and the pollution of rivers used to be severely punished. According to the constitution, for example, the penalty for illegal logging in the Forbidden Mountains, designated to protect green areas and equivalent to the present Green Belt system in England, was 90 lashes plus restoration of the damaged trees. However, the actual penalty enforced under ordinance was harsher: the penalty for illegal logging of a pine tree used to be one hundred lashes, that for two trees or more one hundred lashes plus lifetime military service and that for ten trees or more one hundred lashes plus deportation to Manchuria (Ministry of Interior 1978). Dumping of ash or manure was punished with thirty to eighty lashes and damaging forest by loosening cattle with a hundred lashes (Ministry of the Environment 1990).

Houses and towns were built so as to minimize environmental damage and the use of energy and resources. Houses were usually built south-facing with mountains to the north to fence off the cold wind and maximize the use of sunlight. The Korean ondol is a good example of the thrifty use of energy: it is a heating system which warms up the house using exhaust-gas channels built under the earthen floor, connected to the cooking fireplace in the kitchen. Simply cooking twice a day was enough to warm up the house all day long. It is considered one of the most efficient heating systems in the world. Villages and cities were carefully located to minimize the environmental impact, especially the water pollution, within the watershed. Villages were usually built on the foothills of mountains below thick forest, such as bamboo forest, with fenced off soil erosion and avalanches. Down from the villages were agricultural fields, facilitating the use of human waste as fertilizer. Rice paddies, efficient wetland to treat wastewater, were also located down from such places. Since the runoff waters were further filtered by vegetation strips before entering the water channels, the majority of surface waters were drinkable. The Han River water, which flows through Seoul, used to be drinkable throughout the Dynasty, even until 1960.

Cities were formerly not built on fertile plains, since these were saved for farming. The population of Seoul was also controlled: it reached 200 thousand people in 1660 and remained at that level until the end of the 19th century (Seoul Metropolitan Government 1988). This was probably regarded as the maximum number which could sustain the forest of Seoul, utilize waste as fertilizer in nearby farms and conserve the water quality. This is now widely regarded as the ideal population for an ecological city worldwide.

People were frugal in their use of resources and did their utmost to avoid pollution. All resources were recycled and there was no waste to be disposed of. Vegetable gardens and domestic animals were used to recycle food waste. Night soil and ashes were used for compost. Dishwashing water was used to boil straw for cattle fodder. Even pouring hot water on soil was regarded as sinful because people thought it would kill the soil. Villagers used to establish financing clubs to plant trees in the mountains.

The number one priority policy for government throughout history used to be the "management of mountains and waters." This may explain why Korea was long known as "the land without flood and famine with rich forests," "the land with clean water and fertile soil," or "the land embroidered with silk". However, this policy became ineffective when the Dynasty weakened at the end of the 19th century.

ENVIRONMENTAL DEGRADATION IN KOREA

Japanese environmental exploitation

The Korean environmental ethic was deeply shaken after the Japanese invasion. Japan, which gained power over Korea in the late nineteenth century, began to exploit Korea`s forest resources. Japan murdered Queen Min, who opposed its intervention in Korea in 1895, and eventually won the Russo-Japanese War in 1904. The Japanese Government never released data concerning the exploitation during this period. However, in 1910, when Korea was formally annexed to Japan, it began to openly survey forest resources on the Korean peninsula and ship timber to Japan. According to the Japanese survey, by 1910 our forests had already been reduced to 700 million m3, which is equivalent to 46 m3/ha in density. This was further reduced to 200 million m3, 13 m3/ha in density in 1945: a fall of almost 70% in 35 years (Kim Ŭn-sŏn 1988). Elderly people recall that the Yalu river (Amnokkang) and the Busan Harbor used to be full of log rafts to be shipped to Japan.

The deforestation activity became extremely severe during the final stages of the Pacific War. Koreans were forced to supply charcoal to Japan for energy to wage war, since Japan lacked sufficient energy sources at the time. This meant people had to cut down every available tree, thus leaving mountains near villages completely bald. Korean tigers were known to have become extinct during this period. Any remaining forests were further devastated during the Korean War (1950-1952). In 1952, when the war ended, the forests had been reduced to 36 million m3 in South Korea, which is equivalent to 5.6 m3/ha in density. Likewise, such deforestation used to be regarded as a sin in the Western world as well. The Old Testament says,

"When thou shalt besiege a city a long time, in making war against it to take it, thou shalt not destroy the trees thereof by forcing an axe against them: for thou mayest eat of them, and thou shalt not cut them down (for the tree of the field is man`s life) to employ them in the siege (Deuteronomy 20: 19)."

During the Seven Years` War in the seventeenth century, Friedrich of Saxony was known to issue a decree to his forces to take particular care to avoid any damage to wooded areas and trees (Green 1991).

The deforestation had an enormous impact on Korea`s environment. The land could no longer control flood and drought. Numerous small dams had to be built to supply irrigation water during Japanese rule, while in recent years many large-scale dams have been built to control flood and drought.

There has also been considerable soil erosion: river bottoms have been heavily deposited with eroded soil and raised to such an extent that river banks have had to be elevated to control flooding. In some rivers the bottoms have become even higher than the nearby crop fields. These streams are called "ceiling streams." Korea, fearing foreign invasion, did not develop good road systems until the last century. Instead, rivers and streams used to serve as the media for transporting agricultural products and other goods. It is known that large Japanese barges used to sail along the Han`gang river up to Yŏngwŏl, about 200 km from the West Coast, to build a thermal power plant. Nowadays, however, the Han`gang river has become too shallow for navigation. Moreover, large-scale reclamation projects on the West Coast were made possible because of the vast load of eroded soil deposited in the area and many sandy beaches on the West Coast have been spoiled with clay deposits. Based on these and other factors, it seems that our environment has still not recovered from the deforestation shock.

Japan also forced Korea to change its traditional method of farming. Korean farmers used to practice mixed-culture and crop rotation to control pests and preserve soil fertility. However, Japan forced the mono-culture of rice. As a result, chemical fertilizers and pesticides had to be introduced and the soil began to degrade rapidly (Korean Catholic Farmers Association 1990).

Environmental degradation during industrialization

When the South Korean Government launched the first 5-year economic development plan in 1962 to industrialize Korea after Western countries, the environmental ethics completely changed and even mentioning the environment was regarded as national treachery. For example, Prof. Won Jong Hoon of the Busan National University of Fisheries was abducted by the KCIA and tortured after publishing data on the environmental pollution levels of fishery farms, while the dean of the university was fired. Prof. Won died a few years later, allegedly due to the injuries sustained from torture. By that time, industrialized Western countries had experienced serious environmental problems, especially during the 1950s and 1960s. Metropolitan cities and industrial areas experienced casualties resulting from environmental pollution. In Japan in particular, a variety of serious illnesses such as Minamata disease, Itai-itai disease, Yokkaichi asthma, and others began to emerge, marking the urgent need to eliminate pollutive industries.

However, the government encouraged rather than restricted environmental pollution. There used to be an environmental law called the Pollution Prevention Law, but it was so lax that industries, even those not operating treatment facilities, were unhindered by the same. Even in cases where the law was violated, this was seldom penalized. Such loose environmental policy inevitably attracted pollutive industries to Korea from abroad.

Mr. Lawrence Summers, former secretary of finance of the USA, once circulated a memorandum to his colleagues while he was a chief economist at the World Bank. He insisted that pollution should be exported to developing countries. He listed three reasons. Firstly, the cost of health-impairing pollution is lower because the labor cost is cheaper in developing countries. Secondly, the impacts of pollution are less pronounced in developing countries because they are under-polluted. And thirdly, the demand for a clean environment is lower, because of the reduced life expectancy in developing countries, reducing the likelihood of pollution-related diseases, such as cancer, being inflicted on them (Foster 1993). Such an idea is clearly shown in the following example. A rayon (a synthetic fabric) plant, infamous for toxic gas called CS2, used to operate in the USA, where it harmed employees. When the compensation became expensive, the plant was exported to Japan. The plant was later exported to Korea and finally to China, leaving serious health damage, including mortality, affecting employees and neighbors in each country.

During the early stage of industrialization, foreign investments were the main source of capital, meaning transnational corporations (TNCs) played a very important role in shaping the industrial structure in South Korea. Among the Ulsan/Onsan Industrial Complexes, the first and largest industrial estates established in South Korea, the majority of highly pollutive industries turned out to be TNCs. Initially based on these pollutive TNCs, the overall structure of the South Korean industry has also been shaped to be pollution-intensive. In the export-oriented Korean economy, exports generate far more environmental pollution than economic contribution.

The South Korean industrialization policy was successful and this success turned Korea turned into a resource-wasteful and environmentally-pollutive society. The energy consumption per GNP in South Korea is the highest among OECD countries: about 50% higher than average. The industrialized countries have also succeeded in drastically reducing pollution emissions since the 1970's, unlike those in South Korea, which have been increasing well in excess of those in industrialized countries. Although the size of the South Korean economy is only 1/12 that of Japan, the population 1/3, and the area 1/4, emissions of sulfur dioxide are twice that of Japan, while Korea's per-capita energy use exceeds those of Japan and Germany. The pollution growth rate has far exceeded the economic growth rate for decades. Only in recent years have there been some signs of relief: sulfur dioxide emissions began decreasing from 1991 and municipal solid wastes from 1992. Other pollutants are still increasing but at a much slower rate (Kim 2002). Consequently, the quality of the environment has been continually deteriorating in South Korea. The earliest environmental problems observed since industrialization were the damage inflicted on farmers and fishermen around industrial areas, like Ulsan/Onsan and Yeocheon Industrial Complexes. In 1985, the Government decided to remove about 37,000 inhabitants in Ulsan/Onsan Industrial Complexes from the area for fear of health problems as well as damage to agricultural and fishery crops. The victims engaged in violent demonstrations demanding compensation, but the public had to stay away from their pains under the dictatorship. However, this episode helped trigger public awareness of the environment.

The environmental conflicts, which were formerly limited to industrial areas, began to disperse into areas surrounding metropolitan cities or industrial estates and even into rural areas, as waste disposal sites or other environmentally-susceptible facilities were built in those areas.

In Korean society, like many other oriental cultures, individual citizens are usually supposed to tolerate inconveniences inflicted on them for the good of society. Within such an environment, the complaints of the minority suffering from environmental pollution in limited areas are easily overlooked, which may be very dangerous when it comes to environmental issues. When environmental problems become those of the majority, they may be too late to solve. A good example is the case of Nakdong River pollution. It was reported that Doosan Electronics had long secretly discharged industrial waste into the river. Such secret practice resulted in a major spill of phenol in March 1991, which caused tremendous turmoil among over 10 million inhabitants along the river basin. Ever since, it has been impossible to improve the water quality of the river, despite massive investment totaling trillions of won. Consequently, 99% of Korean people do not trust tap water as safe (Ministry of the Environment 2003).

The air pollution level of Seoul City also ranked top among OECD countries, ahead of Mexico City: the annual average level of PM10 in Seoul in 2003 was 76 μg/m3 while that in Mexico City was 53 μg/m3 and the NO2 level in Seoul was 36 ppb while that in Mexico City was 27 ppb (OECD 2004). It was estimated that the air pollution in the Seoul area might be responsible for 11,000 deaths in the area and other respiratory diseases which might cost up to 10 trillion won each year (Yu 2004).

The dangerous state of the South Korean environment is well expressed in the environmental sustainability index reported by the World Economic Forum. South Korea ranked 136th among 142 countries in 2002 and 122nd among 146 countries in 2005. The overall pollution load of South Korea ranked 146th among 146 countries (Jang 2005).

FUTURE ENVIRONMENTAL RISKS

Domestic threats

The South Korean government has continued its planning of growth-oriented economic development without giving the environment much thought. Such plans, if implemented, would put Korea in danger of further environmental risk. However, since the economic crisis that significantly battered the country in 1997, it is doubtful whether the implementation of all such economic plans is feasible, given the fact the public became very critical about the plans. However, since the government has not stated any intention to change the plans, they remain in effect. These plans are highly supply-oriented and resource-wasteful, and they will turn the country into a high-cost and low-efficiency economy.

The population of South Korea is expected to reach 50 million in 2020 from the present 46 million, which has been a major burden on the environment. The population density of South Korea is also the second highest in the world. The government expects per-capita income to reach US$ 30,000 by 2020 from the present US$ 12,600; while the number of vehicles will increase to 25 million from the present 10 million (Government of the Republic of Korea 1992) and the total energy demand 330 MTOE (million tons of oil equivalent) from 190 MTOE in 2000 (Wang et al. 2002).

To support such growth, many large-scale land development projects are under construction, many of them termed ‘National Policy Projects’ and many supply-oriented, lacking full consideration of ecological efficiency and the environmental impact. Such projects are anticipated to further lower the productivity of the land and aggravate the environment.

The government plans to reclaim most of the mudflats in the West Coast, which many scientists cited as a valuable source to support the marine ecosystem and wetland birds and clean up pollution. The quoted purpose is to supply farmlands, industrial sites and commercial towns. However, it is claimed that the rapid decrease in fishery products, the aggravated water quality and the receding sand beaches in the West Coast in recent years are all attributable to the large-scale reclamation projects. The Shihwa reclamation project, completed in 1995, aroused people`s attention because of the serious polluting of a freshwater lake. The lake was supposed to be used for both irrigation and industry, but pollution has left it fit for neither. The lake turned black and its odor became offensive to nearby inhabitants; hence a dyke had to be opened to let seawater in. The Saeman`gŭm reclamation project, the biggest of its kind ever in the world, is now under construction, with many concerned scientists predicting it will become another Shihwa. It is jeopardizing one of the few remaining estuarine tidal flats in South Korea (Citizen-Government Joint Investigation Committee for Saeman`gŭm Project 2000). The Government has a plan to reclaim most of the West Coast, reducing the coastline by half.

Incheon International Airport, constructed on a reclamation site in the West Coast, is scheduled for expansion to accomodate 100 million passengers a year, twice the size of O'Hare Airport in Chicago, which is currently the busiest airport in the world. There are also claims that this will seriously damage the tidal flat ecosystem in the West Coast. Since this airport is located at the northwest end of South Korean territory, where no utilities such as electricity, water, gas and transportation existed, it has also aggravated the land use efficiency as well as the environment, aspects which will further deterioriate when the airport is fully constructed.

The Seoul-Busan High Speed Train, which links the two cities in two hours, is under construction and set to take 300,000 passengers a day. However, the current total is only 70,000 passengers, which were the main target of the train, and the reduction in automobile trips has been insignificant. This high speed train uses about twice the energy of existing trains (Krewitt 1999) and increases energy consumption, necessitating the construction of another nuclear power plant.

The so-called ‘7x9 highway’ network (7 highways running north-south and 9 east-west) is under construction, to connect all places in the peninsula to any other place within 6 hours. Many urban highways are also being constructed, so that access to these highways will be possible from anywhere in the country within 30 minutes. When completed, the highway density of South Korea will reach over 60 m/km, the largest in the world (Min 2002). The well developed highway system will encourage automobile trips and discourage the use of mass transit. The roads in Korean downtown cities are very wide, often exceeding ten lanes; some are 16 lanes with a width of over 100 meters. Moreover, cheap public parking spaces are available in downtown areas, since major downtown buildings are required to provide parking spaces for visitors by law. Korean cars run an average of 26,000 km/year while American cars run 19,000 km/year, French cars 12,000 km/year and Japanese cars only 10,000 km/year (Kim et al. 1999). This is the major cause of the air and noise pollution in Korean cities.

The Government`s land-use plan in relation to transportation is paradoxical: it plans to promote automobile trips by constructing the densest highway network in the world and at the same time to promote train trips by building the High Speed Train, and promote air travel by building large airports nationwide, including the Incheon International Airport, the largest in the world, all of which must be in a trade-off relationship. This will make the land more energy-intensive and pollutive.

The Government is also planning to build 20 further multi-purpose dams, mainly in order to supply water and control flooding and drought. There are already 10 such dams, which have been regulating the flow of all of South Korea`s major rivers. Even though Japan has a similar rainfall pattern, it does not have such big dams. In 1996, the collapse of the Yŏnch`ŏn dam due to unprecedented flooding brought disaster to the downstream communities. If Soyang dam, the largest in South Korea, failed, it would be catastrophic for Seoul. In September of 1990, the whole nation was on alert, watching as the rising water level of the dam was covered live on television, following record rainfall in the area. Although these dams are very effective in controlling small floods and droughts, they could trigger a major catastrophe should they fail to control any disastrous flood.

In order to supply the energy demand forecasted, the government has built 8 further nuclear power plants since 1997, in addition to the twenty plants currently in operation, many of which were constructed while the economy was receding. Seven more nuclear power plants are planned by 2015 and a further six by 2030 (Byrne et al. 2004). In Yeongheung-do island, to the west of Seoul, the largest coal power plant complex in the world is under construction. In order to dispose of surplus electricity overnight, the government encouraged the use of 'midnight electricity' for heating homes and water, which is very energy-inefficient compared to direct heating. This night time surplus electricity is the result of over-supply from nuclear power plants, Due to this policy, peak energy demand shifted to winter nights from summer afternoons.

All of the above plans encourage the wasteful use of energy and resources which will have a tremendous impact on the environment. None of the economically feasible environmental technologies will ever be able to reduce the emissions from such development.

Threats from the Northeast Asian region

More serious environmental threats may originate from the Northeast Asia region, which includes Siberia, Mongolia, China, Korea and Japan. The wind pattern in this region is such that air pollution from one country can be easily carried to regional neighbours. In particular, due to the prevailing northwest wind in this region, the air quality in Korea is heavily affected by air pollution from China. For example, yellow dust originating from deserts in China can be carried to Korea within just three or four days (Kang 1993). In recent years, China has achieved the world`s highest economic growth, meaning it will rise to become an economic superpower early this century (Time 1993). Alongside economic growth, China is expected to produce enormous amounts of air pollutants. The amount of SO2 generated in China was estimated to be 16 million tons in 1988, but it increased to 17.5 million tons in 1990 and 21 million tons in 1993, which is about 14 times that of South Korea (Woo 1999). At current rates, China`s emissions may reach 200 times those of South Korea before its per-capita income reaches US$ 10,000, which may be achieved within a few decades. The air pollution in China is projected to be worse than that of South Korea, because China depends mainly on low-quality coal, while South Korea uses refined oil. It is estimated that about 1 to 2% of the sulfur dioxide generated in China will be deposited onto the Korean peninsula, either in wet or dry form (Kim 1993), which is disastrous for both countries.

The Siberian environment is also reported to be in bad condition. For example, a complex of smelters in Norilsk in central Siberia, the largest single source of air pollution in the world, was reported to produce 2 million tons of sulfur (4 million tons of sulfur dioxide) per year, which is two and half times the total amount produced in South Korea (Time 1995).

While information about North Korea is very limited and of questionable accuracy, the environment in North Korea is also reportedly poor. Total emissions of five major air pollutants (sulfur dioxide, nitrogen oxides, carbon monoxide, hydrocarbons and total suspended particulates) was estimated to be 10,816,000 tons in 1994, 2.4 times that of South Korea (4,526,000 tons), even though its energy consumption is 1/5 that of South Korea (Kang and Chŏng 1996). However, the actual air quality data measured in some parts of North Korea showed very low levels compared with those of South Korea. The NO2 level in Pyongyang was almost equivalent to rural areas in South Korea and the air quality in Keumho area, a rural area along the East Sea, was below those of South Korea's rural areas (Kim and Lee 2005). It is well known that the North Korean forests are very badly destroyed from farming and logging for wood fuel, which has been blamed for the frequent floods and drought in recent years. North Korea's environmental sustainability index ranked 146th among 146 countries in the world in 2005.

Another threat in the region is the polluting of the Yellow Sea. The Yellow Sea, surrounded on three sides by China, Korea and Japan, is so shallow, with an average depth of only 44 meters, and so stagnant that its capacity to tolerate water pollution is very limited. Presently, China mostly uses human manure as fertilizer, but when flush toilets are popularized and chemical fertilizers replace human manure, the Yellow Sea may be placed in serious jeopardy. The removal of mud flats and the construction of industrial bases along the coast, in both Korea and China, will further aggravate the situation.

The East Sea is encircled by the Korean peninsula, the Russian continent, Sakhalin, and the Japanese islands, and has very limited access to the Pacific Ocean. Accumulation of waste in the Sea, as evidenced by the dumping of radioactive waste by Russia, can also affect all countries along the seacoast.

Newly developing countries tend to import more pollutive industries from richer countries. Although South Korea`s environment is far worse than those of Japan, U.S.A. or Western European countries, China`s environment is worst of all. In this respect all countries in the Northeast Asia region except Japan are very likely to accept pollutive, leftover industries from richer countries. If China, Russia, Mongolia and North Korea continue to accept accepting pollutive industries from the rest of the world, the environment in this region will become highly vulnerable.

POLICY RECOMMENDATIONS FOR A SUSTAINABLE SOCIETY

As shown above, growth-oriented economic development which encourages wastage of energy and resources and which neglects the environment can bring disastrous results. Besides, as shown by the recent economic collapse in East Asia, such plans cannot succeed in the long term because of additional inefficiency in the economic sense. The South Korean public is well aware of the danger of the current policy. In public surveys conducted in 1995 and 1996, 57.1% of the respondents responded that environmental problems represented the most dangerous threat to their future and 75.9% believed that the environment would get worse. In response to the question concerning the priority of policies for the twenty-first century, the environment came top (44.8%), followed by security (19.1%), information/media (16.9%) and others (Kim et al. 1997). Since the present development policy, which demands a continuous supply of resources and sacrifices the environment, is destined to fail, we must look for new ways of development.

Environmental land-use planning

Land use should be planned from an ecological perspective so as to best preserve the land`s productivity and stability. In that sense, there should be a definite goal on where and to what extent to preserve the three important ecological bases in the Korean Peninsula, namely, forests, coastal wetlands and agricultural farms. The forest is the base for terrestrial ecosystems like flood control, water resource, climate and others; the coastal wetland for the marine ecosystem and the farmland for producing food. Within that goal, limits should be set the extent to which the land can be utilized for activities like urban development, manufacturing, recreation and others. Moreover, the limits of pollution loads resulting from such activities should be set so as not to irreversibly damage the environment. Economic development should be planned to minimize the use of energy and resources, only after these constraints have been satisfied.

The Korean Peninsula is separated from China, Japan and Russia by seas, rivers and mountains, which form a relatively independent ecological unit. Therefore, it is relatively easy for Korea, as a unified country, to set out ecologically-sound land-use planning, such as that concerning the conservation of forests, wetlands, animal habitats, farmlands and others as well as on limits of economic development.

Local communities should be established in conformity with ecological principles and within the framework of the national environmental plan. Cities in California like Los Angeles used to be set as ideal models to follow in South Korea. Web-like networks of highways and roads are built in such cities to facilitate the flow of people, energy and resources between sects, which eventually encourages the wasteful use of energy and resources and dumping of waste on poor neighboring sites. Local communities should be established so as to minimize the use of energy and resources and maximize the recycling of materials as in natural ecosystems. Each local community should be established as an efficient ecological unit.

The current centralized energy system in South Korea is inefficient and the energy efficiency of large power plants located in remote areas can only reach thirty percent because the heat generated cannot be utilized. Including loss during distribution, this falls way below the thirty per cent figure. If the electricity is used for heating, the overall efficiency is below 15%. Conversely, if small-scale energy plants are located near the demand sites (distributed energy system), efficiency can be elevated to over 80%. In order to achieve energy security, we have to depend less on oil and nuclear fuel, which are governed by only a few global powers. Global political instability will seriously jeopardize our energy security; hence renewable energy, which can be produced with technology only, should be promoted. The current share of renewable energy in South Korea is below 0.1%, which is far lower than other developed countries.

The automobile-oriented transportation system cannot solve the traffic problem. Trains should be the main means of transportation between cities and for mass transit within cities. Many cities in South Korea are not connected by railroads while numerous highways are being built to link cities. The High Speed Train does not help much: it is currently posing a serious problem for traffic to and from small cities in South Korea. The number of parking spaces in downtown cities must be reduced and parking fees raised to solve the problem of heavy urban traffic. The current parking fees are too cheap compared with the expensive land prices.

Until the end of the Chosŏn dynasty, each local community in Korea was believed to have functioned as a sustainable ecological unit: energy was supplied from nearby forests without creating irreversible damage, and waste from urban areas was returned to farms without polluting the water systems. In a healthy ecosystem, renewable energy is used to make the system function and materials are completely recycled. Human settlements should be restructured so as to maximize the efficiency of energy use and material cycle, and minimize the environmental impact. We cannot turn back the clock, but we can learn the ideas and principles of sustainability based on our traditions.

Environmental management policies

The present path of economic development in South Korea, which is energy/resource wasteful and environmentally pollutive, is destined to fail because it is inefficient in the economic sense, and the pollution which accumulates from using so much energy and so many resources will degrade the productivity of the land. All the inputs to economic activity, such as energy and materials, must come out of the system as outputs, in whatever form and in whatever time frame. Those outputs are called waste. No matter how clever the technology we employ in treating this waste, it never disappears, but simply changes its form. The surest way of reducing environmental pollution, therefore, does not lie in treating waste, but rather in reducing the input. Therefore, the first priority in controlling environmental pollution should be given to reducing the use of energy and resources. Only then can we concentrate on treatment technologies changing the waste into a less harmful form.

Energy prices in South Korea have been kept much cheaper compared with industrialized countries. For example, the price of electricity in South Korea is less than half that in Japan. That has been possible because less money has been spent on treating pollution arising from energy use. However, the total energy cost remains more expensive in South Korea, as evidenced by the total energy use, because no serious efforts are made to save energy and more energy is needed to restore the damage created from using cheap, pollutive energy. Ultimately, so-called cheap energy is not at all cheap. To save energy, we have to use clean energy, meaning renewable energy, such as solar, wind, tidal, biomass and other forms should be developed.

An efficient recycling system should be established to save energy and resources and reduce waste volume. It was estimated that about 6 to 7% of the total energy demand in South Korea could be saved if the recycling rate of paper were raised from 43.3% to 65%, iron and steel from 26.4% to 70% and plastics from 16% to 50% (Kim and Choe 1994). Recycling campaigns mainly directed toward the public should be extended to manufacturers whose volume of industrial waste amounts to twice that of household waste. Industries should target zero-discharge technology, which is truly sustainable.

Next, the industrial structure should be reformed to make it environmentally friendly and pollution should be cleaned up. Substances never disappear but only change their form, and move from one place to another. Therefore, environmental problems should be solved using a “holistic” approach. Damage to the ecosystem, air pollution, water pollution, solid waste, soil pollution and other environmental problems should not be seen as independent problems, since they are all inter-related. Moreover, priority should be established between sectors. Environmental problems which are impossible or difficult to resolve should be given higher priority. The first priority should be given to the ecosystem, and subsequently the atmospheric environment, soil/water and solid waste. All domestic environmental policies should be in conformity with national environmental planning.

Environmental standards need to be upgraded, and penalties for violating laws should be stricter and heavier. In addition, adequate funding should be invested in the environment. Saving energy and resources does not mean doing less work and investing less money, contrary to the beliefs of most growth-oriented developers. Rather, it requires investment and efforts to make industries and urban structures function with less energy and resources.

Korea`s environmental problems cannot be fundamentally solved without first solving those of the Northeast Asian region, such as trans-boundary air pollution, marine pollution, and the conservation of endangered species, all of which need to be solved through international cooperation.

CONCLUSION

For decades, South Korea has indulged in developing a growth- and supply-oriented economy while paying little attention to the environment. Such development worked for a time, but has not been as economically efficient as was hoped and instead poses a dangerous threat to the land and people. The Korean ancestors provide a good example on how to pursue harmony with nature. The ultimate goal of the nation`s policies should target environmental sustainability, rather than economic indices. Our economic activities should not be allowed to exceed the land`s carrying capacity and land use should be planned from an ecological perspective to best preserve its productivity and stability. In that sense, there should be a definite goal concerning where and to what extent to preserve the three key ecological bases in the Korean Peninsula, namely, forests, coastal wetlands and agricultural farms. The forest is the base for terrestrial ecosystems like flood control, water resources, climate and others; the coastal wetland for the marine ecosystem and farmland for producing food. Within that goal, limits should be set on the extent to which the land can be utilized for activities like urban development, manufacturing, recreation and others. Moreover, the limits of pollution loads resulting from such activities should be set to avoid irreversibly damaging the environment. Economic development should be planned to minimize the use of energy and resources only after these constraints have been satisfied. Energy efficiency should be upgraded and an efficient recycling system established to save energy and resources and reduce waste. The industrial structure should be reformed so as to be environmentally friendly and pollution should be cleaned up. Korea`s environmental problems cannot be fundamentally solved without first solving those of the Northeast Asian region, such as trans-boundary air pollution, marine pollution, and the conservation of endangered species, all of which need to be solved through international cooperation.

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13. Environmental Problems and Strategies in China

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ABSTRACT

Rapid economic growth and industrialization in China is bringing higher living standards to its people. However, in the absence of a sustainable development scheme, such economic growth has also brought very severe environmental problems, such as air pollution, water resource depletion and pollution of water bodies, ecological degradation, soil erosion and pollution, desertification, acid rain, sandstorms, forest depletion, pollution of seawater and red tides, etc. Since such environmental conditions are expected to worsen, China urgently needs a new sustainable development pattern and strategy. In order to promote both economic development and environmental improvement, the Chinese government is enhancing its environmental management policy. In this paper, the author analyzes the environmental problems of China based on the environmental evolvement process over the past 15 years. From a sustainable development perspective, the author has explored the relationship between economy, society and the environment and proposes a new model of sustainable development. This model is an integrated socio-economic environmental system that aims to solve the main environmental issues of China.

Keywords: Environmental problems, Environmental strategies, Sustainable development, Socio-economic environmental system, GGDP

INTRODUCTION

The rapid economic growth of developing nations is bringing welfare and higher living standards to people. This economic growth, however, is accompanied by natural resource depletion, ecological degradation, environmental pollution, and biodiversity loss. Ecological and environmental problems are affecting human health, safety and security, and sustainable development.

In the past two decades, the Chinese economy has grown rapidly, bringing higher living standards to its people. However, in the absence of a sustainable development scheme, such economic growth has also triggered very severe environmental issues, such as air pollution, water resources depletion and pollution of water bodies, ecological degradation, soil erosion and pollution, desertification, acid rain, sand and dust storms, forest depletion, pollution of seawater and red tides. Since such environmental conditions are expected to worsen, China urgently needs a new sustainable development pattern and strategy. In order to promote both economic development and environmental improvement, the Chinese government is enhancing its environmental management and financial investment in environmental science and technology.

The objectives of this paper are:

- to address the environmental problems China is facing in the process of economic development;
- to analyze the environmental evolvement processes of China;
- to explore the relationship between society, economy and environment based on sustainable development;
- to present the current patterns of sustainable development, and
- to propose strategies towards solving the environmental problems of China.

ENVIRONMENTAL PROBLEMS OF CHINA

According to data from the State Statistical Administration of China, the GDP of China reached 18.2321 trillion RMB Yuan and 13,943 RMB Yuan per capita in 2005. The population of China is 1.3076 billion people. Even though this economic growth has been significantly increasing over the past two decades, it has also been accompanied by many environmental problems.

Water pollution of the main rivers in China

According to the Chinese Environmental Protection Communique, there is severe water pollution of China's main rivers, with 59% of all river water bodies said to be polluted. Based on the long-term measurement of water quality, good water qualty has decreased and that of polluted water increased, as shown in Figures 13.1 and 13.2. The volume of wastewater discharged into surface water bodies also increased yearly from 1989 to 2005 (Fig. 13.3).

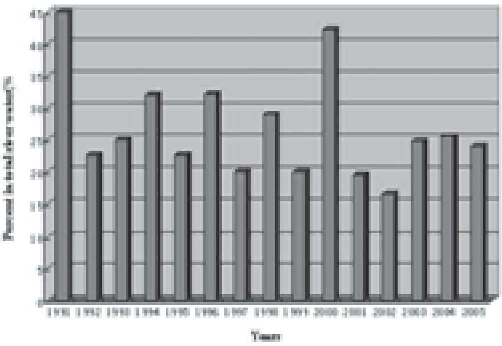

Figure 13.1 3-type water quality of China's main rivers

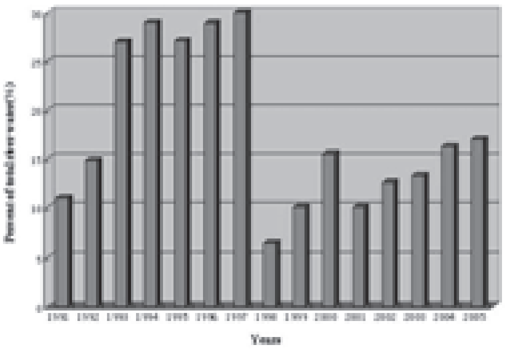

Figure 13.2 4-5 types water quality of China's main rivers

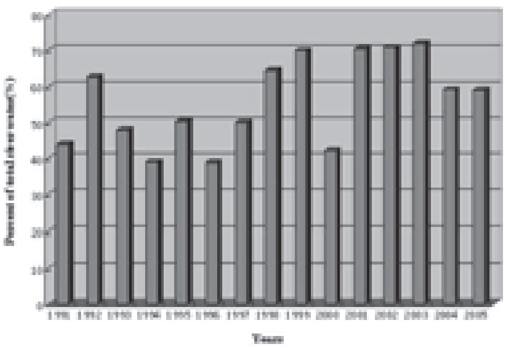

Figure 13.3 Wastewater discharged into surface water bodies from 1989 to 2005

Air pollution of China

The air quality of China has been improving slowly since 1997 where it reached its worst level. The volumes of soot and industrial dust discharged into the atmosphere have yearly decreased from 1997 to 2005 due to central government management, as shown in Figures 13.4 and 13.5 respectively. However sulfur dioxide emissions have been increasing as shown in Figure 13.6 and acid rain distribution has extended from 1989 to 2005.

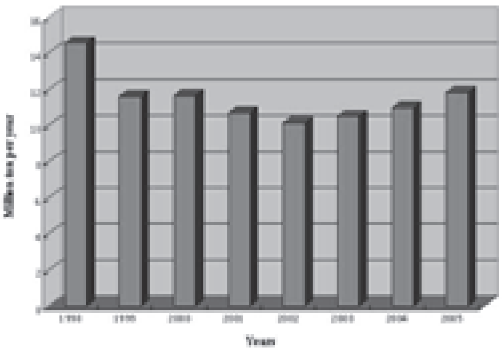

Figure 13.4 Soot discharged into the atmosphere of China from 1989 to 2005

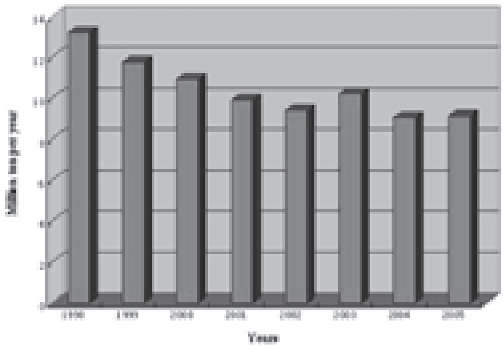

Figure 13.5 Industrial dust discharged into the atmosphere of China from 1989 to 2005

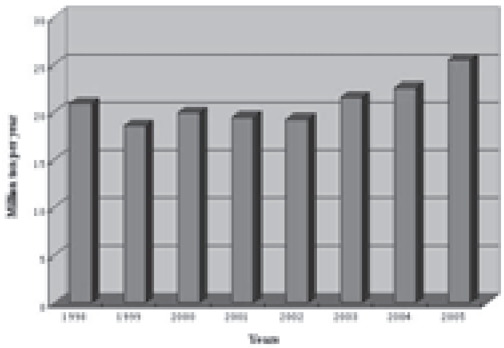

Figure 13.6 Sulfur dioxide emissions of China from 1989 to 2005

Inshore seawater pollution of China

The marine environment of the China inland sea has changed over the past decade due to human activities. Its water quality reached its worst level in 2001 (where polluted seawater occupied 49%). After 2002, the water quality of the inland sea has improved gradually as shown in Figure 13.7.

The frequency of red tide occurrence decreased in the China inland sea region, but the area of red tide occurrence extended gradually, as shown in Figures 13.8 and 13.9 respectively.

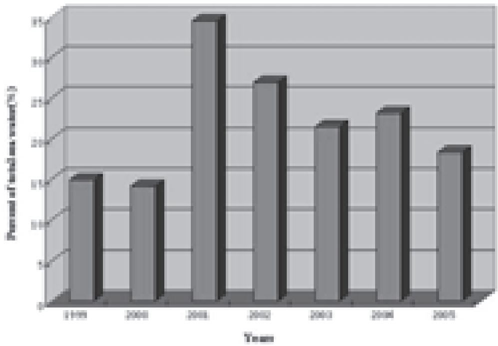

Figure 13.7 5- type water quality of China inshore sea from 1999 to 2005

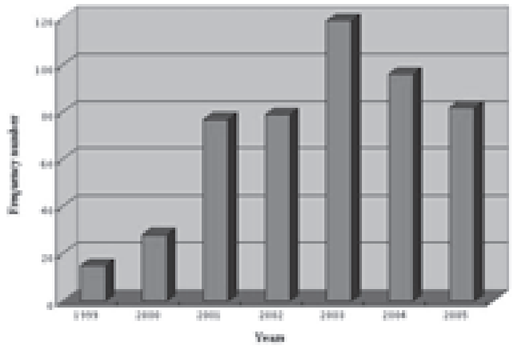

Figure 13.8 The frequency of red tide occurrence in the China inland sea region

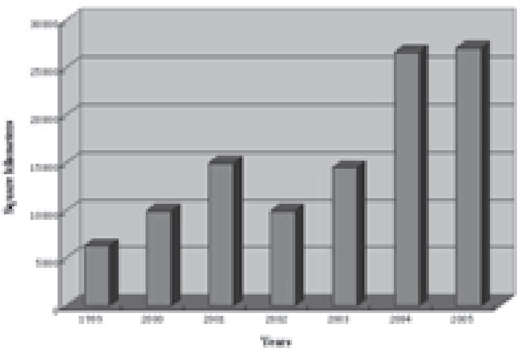

Figure 13.9 The area of red tide occurrence in the China inland sea region

Industrial solid waste production of China

In addition to huge consumption of material and energy resources, industrial waste production has also been increasing yearly from 1989 to 2005, due to rapid industrial development (see Fig. 13.10).

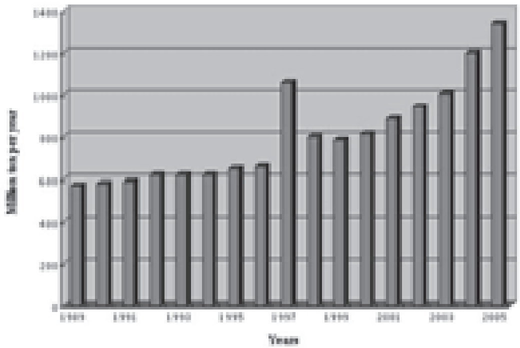

Figure 13.10 Industrial solid waste production of China from 1989 to 2005

To sum up, industrial development has brought economic growth and environmental degradation. Figure 13.11 outlines the environmental effects of human activities.

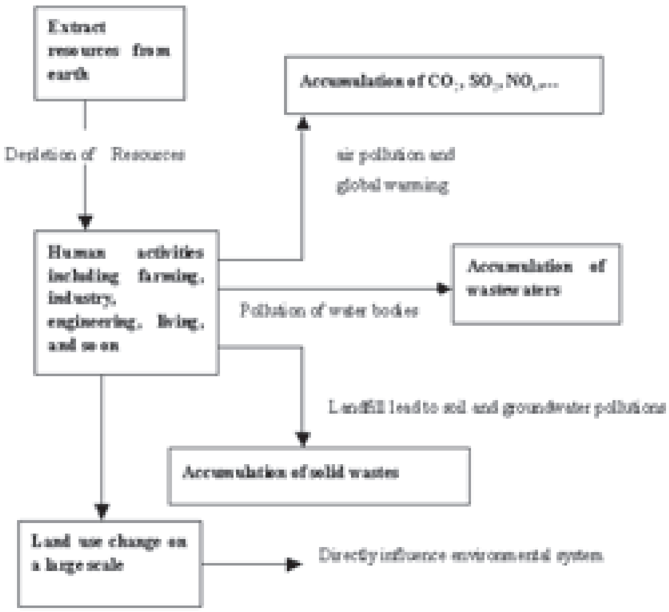

Figure 13.11 Environmental effects of human activities

CONSIDERATION OF SUSTAINABLE DEVELOPMENT

In the early stages of economic growth, societies paid little attention to the environment. Environmental degradation caused by rapid economic growth, however, was one of the catalysts for the introduction of environmental policies. Sustainable development is perhaps the most challenging policy concept ever developed. Sustainable development is defined as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. Definitions of sustainability must consider intergenerational equity, resilience or the carrying capacity of the earth system, environmental maintainance and consumption or welfare maintainance (Clarke and lslam 2004).

Sustainable development requires a harmonious relationship among environment, economy and society. ICLEI (1996), du Plessis (2000), and Barton (2000) proposed this model as shown in Figure 13.12. This model has some limitations. It assumes the separation and even autonomy of the economy, society and environment from each other. The separation distracts from or underplays the fundamental connections between the economy, society and the environment and also prompts assumptions that trade-offs can be made between the three sectors. The result will produce weak sustainability. In order to unify economy, society and the environment, Giddings, Hopwood and O'Brien (2002) proposed the nested model for economy, society and the environment, as shown in Figure 13.13. This indicates that the economy is nested within society, which, in turn, is nested within the environment. The nested model integrates different actions and sectors and overcomes barriers between disciplines. However this model also incorporates internal boundaries, a problem which hinders system optimization and also leads to weak sustainability.

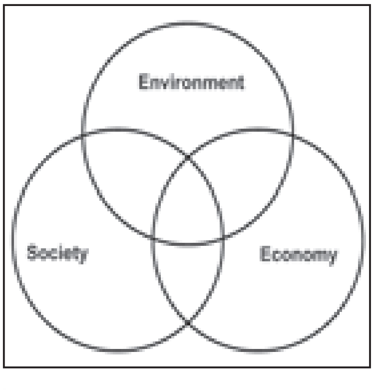

Figure 13.12 Common three-ring sector view of sustainable development

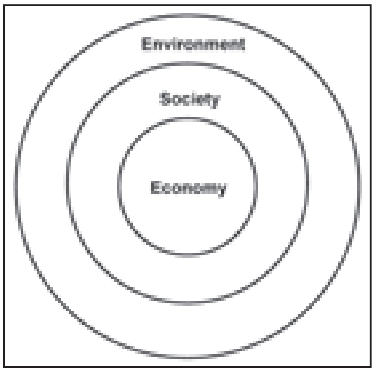

Figure 13.13 The nested model for sustainable development

The boundary between the environment and human activities remains unclear and poorly defined, namely fuzzy. There is a constant flow of materials and energy between human activities and the environment and both constantly interact with each other (Giddings et al. 2002) as shown in Figure 13.14.

The model in Figure 13.14 merges society and economy which can be measured in terms of human activity and well being. Although this model of sustainable development intends to show strong linkages between human activities and the environment, it still shows a separation between human activities and the environment and strengthens the central human position within the natural system. Since natural resources are finite and given the limited nature of the environment, economic growth cannot last forever. Humans must be included within the ecosystem. Based on this, a reasonable model of sustainable development should be a socio-economic environmental system, merging society, economy and the environment, as shown in Figure 13.15.

The proposed model of sustainable development is an integral borderless system. The quantification analysis of the socio-economic environmental system can use optimization theory.

The model also provides an optimal solution (strong sustainability). The model tells us that the environment and human systems are not contradictory and should be treated as a unified system. Harmonious Society is basic for human life and also requires healthy economic development that respects the environment. Sustainable development requires a harmonious relationship among environment, the economy and society.

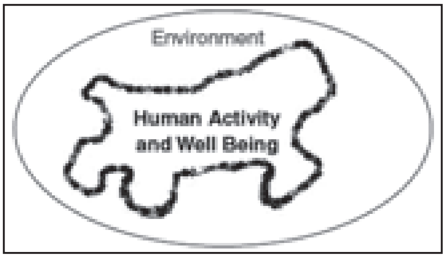

Figure 13.14 Fuzzy boundaries: merging society and economy and opening up to the environment

Figure 13.15 A model of sustainable development merging society, economy and the environment

CONCLUSION

Strategies to solve environmental problems require the theory and practice of sustainable development. Such strategies should consider the following measures:

- to change both living and production patterns, as well as traditional natural views of humans being at the centre of the natural world, and to establish a developmental view of harmoniousness between humans and nature;
- to construct "eco-cities" and "eco-industries" and promote a closed-loop economic system (waste material repair, reconditioning, remanufacturing, reduce, recycle, and reuse);
- to integrate environmental laws and environmental management, and extend GGDP (Green Gross Domestic Product), considering environmental and ecological services, and environmental and ecological damage within a national account system instead of a GDP account system, GGDP=GDP+ECS+ES-ECD-ED, where GDP is the Gross Domestic Product, ECS is the Ecological Service Values, ES is the Environmental Service Values, ECD is the Ecological Service Damage Values, and ED is the Environmental Service Damage Values;
- to intensify interdisciplinary research between human-cultural science and natural science-technology and increase investments in environmental science field research and environmental remediation;
- to educate the common people to enhance environmental awareness, so that they become wider participants in this task; and
- to design mechanisms for global environment assessment and increase international cooperation in the environmental field.

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14. On the Circular Economy Legislation of Shanghai City Guided by the Ideal of a Circular Economy Society

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ABSTRACT

The Chinese government introduced a new strategy which aims at changing the current economic system into a system that meets the requirements of a circular economy i.e. a sustainable closed-loop economy. Shanghai City is taking the lead in the development of a circular economy as the largest industrial and commercial city and the engine of the Chinese economy. In this paper, the authors elaborate the general strategy for developing a legal system favoring the development of a circular economy in Shanghai. Historically, Shanghai has adopted many local laws and regulations related to waste control and reuse. They constitute a good basis for the development of a legal system that meets the requirements of a circular economy. The authors suggest a legislation system of circular economy for Shanghai and elaborate the major tasks of municipal legislation for promoting a circular economy in the city.

Keywords: Circular economy, Circular Economy Society, Theory basis, Legislation, Shanghai

CONCEPT OF THE CIRCULAR ECONOMY

Circular economy is the abbreviated form of the name ‘Closing Materials Cycle Economy’ (Qu 2001). A circular economy is an economic growth model, where the core idea is the effective utilization and recycling of resources. This model is based on the ‘Reduce, Reuse, Recycle’ principle and targets low consumption, low discharge and high efficiency. The circular economy conforms to the sustainable development ideal and represents a revolution to the traditional economic growth model characterized by ‘mass production, mass consumption, and mass waste’.

Although people hold different opinions concerning the nature of the circular economy, a consensus on the following content has been reached:

- The circular economy is a reflection and achievement of the sustainable development strategy. Sustainable development requires the integration of economic development and environmental protection. As circular economy characterizes resources use as ‘Resources – Products – Recycled Resources’, it successfully embodies the harmonization of development and environmental protection, and is an effective approach and model toward achieving sustainable development.
- The circular economy is an ecological economy that follows ecological laws, while the traditional model of economic development is a straight and one-way linear process of resource flow – ‘Resources – Products – Pollution Discharge’. During this process, economic growth is achieved through a one-way linear process, turning materials and energy into waste. The circular economy, however, differs from the traditional economic model in that it is a closing cycle of material and resource flows – ‘Resources – Products – Recycled Resources’. The circular economy regards the various economic activities of human society and the resource elements of nature as a closely connected and integrated body, takes them into consideration while making economic development plans, requires that natural resources and environmental capacity be utilized in an environmentally friendly way, minimizes the impacts of economic activities on the natural environment, and achieves harmonious development of economic growth and environmental quality improvement (Liu 2004).
- The ‘3R’ principle - ‘Reduce, Reuse, Recycle’ is the basic principle of the circular economy. The “Reduce” term means to reduce the quantity of materials used in production and consumption processes, as well as the waste generated. The “Reuse” term

refers to using products as many times and ways as possible and preventing products from becoming waste at an early stage. Finally, the "Recycle" term means to recycle waste, turning it into regenerated raw materials. The sequence of the 3R principle is reduce – reuse – recycle, because the ultimate objective of the circular economy requires the systematic prevention of waste and its reduction during the economic flow process, and recycling waste is merely a means of reducing the quantity of waste to be finally disposed of (Zhu 1998, 2003).

- The basic characteristic of the circular economy is low exploitation, high utilization and low discharge, in contrast to the traditional economic model of high exploitation, low utilization and high discharge. The circular economy requires that targeted production and consumption objectives be achieved with minimum material input, production and technology chains be prolonged and expanded, waste digested within enterprises, and pollution discharge reduced; products and packages be made available for future reuse in their initial forms; waste generated during production, circulation, consumption and other stages being recovered and recycled for other uses after being treated with technologies; waste that cannot be disposed of by enterprises themselves is recovered and treated centrally, reducing resource exploration, non-renewable resource utilization and waste discharge (Niu 2004).
- There are three types of circular economy. They include the circular economy within enterprises, the circular economy among enterprises and the circular economy in a society as a whole. The circular economy within enterprises is characterized as the recycled use of materials and energy within an enterprise and is formed through ecological industry chains. Various enterprises are organized as a combination of industries sharing resources and exchanging by-products, where the waste of one enterprise becomes the resources of another. This type of circular economy often exists in some advanced industrial parks. A circular economy in society as a whole closes the loop of 'Resources – Products – Recycled Resources' throughout society as a whole by developing cleaner production, green consumption and resources recovery industries (Liao 2003; Zhu 1998).

In addition, differences exist between the broad and narrow perceptions of the circular economy. The narrow understanding mainly refers to minimizing waste, emphasizing cleaner production and whole-process management, while the broad interpretation covers all social production activities, and is equivalent to the proposal of the 'Circular Economic Society'.

THEORY BASIS OF CIRCULAR ECONOMY

One of the theory bases of the circular economy is ecology. An ecosystem is composed of both organisms and non-organisms; all of which co-exist and influence each other within the system, forming countless connected food chains, from low to high and simple to complex. “Energy and materials are passed on in food chains, from low to high, and again vice versa, forming a connected and mutual organism chain, thus maintaining the ecological balance between various materials in nature, and ensuring continuous natural development” (Xu 2003).

As for human society, although the division of labor between social production sections is becoming subtler and cooperation between human economic sections is being reinforced, the economic model of human society remains a linear pattern, based on exploring large amounts of resources from the nature, and then throwing all kinds of waste back into the latter. This model of economic development fundamentally violates ecology laws, seriously destroys the natural environment and ecosystem, and is unsustainable.

Faced with serious environmental problems, people have realized that it is necessary to restructure the economic regime in accordance with ecology laws, reorganize human economic activities in light of ecological principles, dramatically reduce resource consumption, achieve full materials recycling, and thus guarantee a sustainable future for human society.

The second theory basis of the circular economy is the latest development of economics – ecological economics. In the late 1960s, the American economist Kenneth Boulding officially proposed the concept of ‘Ecological Economy’ in his important essay *Ecological Economics as a Science*. Since then ecological economics has made great progress.

The most important contribution of ecological economy is that it proposes and proves the concept of the overall scale of human economic activities; it highlights what should be the priority for traditional economics – effective resource allocation and fair distribution of wealth, and include the prerequisite that the overall scale of economic activities cannot exceed the supporting capacity of the earth ecosystem. The resource reserve of the earth is limited, likewise its environmental capacity. The scale of human economic activities should remain within the bounds of the supporting capacity of nature, and the means of human economic development should comply with the restricted mechanism of the ecosystem, taking full consideration of ecological parameters in the economic development model. Since the industrial revolution, the economic development of human society, however, has never fully considered the ecological prerequisite. Even economists neglected the ecological limit. Ecological economics identifies this critical drawback of the traditional development model and traditional economics, and highlights the importance of this prerequisite. It further proposes that the foremost task of economics is to study the relation between the overall scale of human economic activities and the supporting capacity of the earth ecology, and this takes precedence over studying effective resource allocation and the fair distribution of wealth. Ecological economics requires that ecological principles be the basis of economic policies. “The relationship between ecologists and economists is like the relationship between architects and builders, ecologists should provide economists with blueprints” (Brown 2001).

Ecological economics advocates ecological economy; it applies ecology laws as well as those of traditional economics to guide human economic activities, and integrates the objectives of human economic activities with ecosystem improvements. Traditional economics separates the economic system of human society from the ecosystem, and treats the latter merely as an external element utilized by the human economic system. However, humans have never lived outside the ecosystem; since human society is part of the Earth ecosystem, and must exist under the laws of nature.

Ecological economics holds that public resources, such as air and water, although previously considered unlimited and free to use, should be counted as costs in human economic activities. The forerunner of ecological economics, Daly Herman pointed out that our world “has ended the era of which human-made capital (‘non-existent’ substances) represents the restricted element of economic development, and entered into a new era in which increasingly scarce natural capital (‘real’ substances) replaces its status”. With the continuous expansion of human development, the products and services provided by the earth ecosystem are increasingly declining, meaning natural capital becomes the restricted element (Daly 1993).

Ecological economics emphasizes ecological efficiency, although this efficiency is not the same as that under traditional economics. In traditional economics, the environment and natural resources are terribly neglected in the production function and the term efficiency refers only to the value created by laborers. Ecological efficiency means that the national economy should achieve constant growth on the basis of increasing the utilization efficiency of natural resources and reducing environmental pollution. On the one hand, it increases the productivity of energy, minerals and other raw materials, mainly measured by reducing energy and materials consumption per GDP; on the other, it minimizes external non-economic losses caused by pollution, mainly measured by reducing environmental pollution load per GDP (Huang et al. 2004).

These views held by ecological economics represent important revisions and supplements to the traditional economics. Together with the basic principles of traditional economics, they constitute the theory basis of the circular economy. The circular economy recognizes the limits of the earth supporting capacity, and is based on the fact that the overall scale of human economic activities cannot exceed that limit. The circular economy recognizes the integration of the human economic system with the natural ecosystem, and accepts the fact that ecosystem laws should guide human economic activities. The circular economy regards natural capital as a cost of implementing human economic activities, recognizes its economic value, and incorporates it into the balance sheet of human economic activities. The circular economy stresses ecological efficiency, namely reducing energy consumption, materials consumption and pollution load per GDP.

The legislative activities of the circular economy should be guided by the above-mentioned basic views of ecological economics, implement these guiding thoughts while setting rules and regulations for human economic activities, and reflect theses basic views of the circular economy in legal rules.

NEED TO DEVELOP A CIRCULAR ECONOMY IN SHANGHAI CITY

Shanghai is a mega city with a high population density and relatively deficient resources. It is an alluvial plain, located downstream of the Yangtze River, and facing the East Sea, with a flat topography and limited resources. The city is 6,340 square kilometers, housed 15.6 million permanent residents in 2002, and the population density was 2,460 people/square kilometer. In the central city area, within the external ring line and occupying 670 square kilometers, the population has reached 9.11 million, a density much higher than that of New York, Paris and London (Wang 2005).

This high population density and fast pace of city development has left Shanghai confronting land deficiency. If the current pace of development is maintained, available land will be used up in the following 10 to 15 years, let alone considering reserve land and “land for future generations” (Wang 2005).

Deficiency of drinking water resources is another severe problem in Shanghai. According to monitoring results of cross sections of the main rivers of Shanghai, conducted by environmental agencies, only 1 percent of surface water in Shanghai meets the national standards of drinking water sources, while water of quality below V Class accounts for 68.6%. Although Shanghai has water, it lacks quality water. Its water quality is both influenced by upstream water pollution, and also damaged by local pollution sources. Shanghai is a typical city that lacks quality water, and is currently listed by the United Nations, as one of the six cities in the world seriously lacking drinking water in the 21st century (Wang 2005).

In respect of energy consumption, industrial energy consumption accounted for 63% of the city energy structure in 2002, while this proportion was only 7% in New York. The total energy consumption increased from 31.91 million tons of standard coal in 1990 to 67.5 million tons of standard coal in 2003, more than doubling the 1990 figure. Calculating the energy consumed to produce a value of 10,000 RMB, it is 0.583 (ton/10,000 RMB) in Shanghai, while only 0.18 in Japan, less than one third the unit energy consumption in Shanghai (Wang 2005). In addition, the fast economic growth means that the use of both industrial and domestic electricity is rocketing; meaning neither the installed capacity nor power generation can meet the electricity consumption needs. In the short term, Shanghai cannot achieve electricity self-supply, nor can she depend wholly on external electricity provision (Wang 2005).

In 2002, the discharge rate of wastewater was 78.73%; and although a substantial drop from the 86.25% discharge rate in 1998, a gap still remains when compared to developed countries. Taking industrial waste water as an example, the water reuse rate was 81.7% in Osaka in 1981 and 92.7% in Yokohama, Japan in 1982 (Wang 2005).

In respect of domestic garbage, taking 2003 as an example, the quantity of domestic garbage generated in the whole city reached 6.45 million tons; of which 600,000 tons were diverted through waste recovery systems, and 5.85 million tons were cleaned, transported and disposed of by the environmental sanitation sector (4.34 million tons in the urban district, and 1.52 million tons in the suburbs). Currently, the classified collection capacity for domestic garbage is poor, and there is insufficient disposal capacity, which results in a low level of reducing, harmlessly treating and recycling domestic garbage. Among the 14,000 tons of domestic garbage generated daily in Shanghai, about 10% cannot be transported to the Lao Gang landfill site, and is simply piled up in the suburbs (Wang 2005).

Over the past decades, the GDP of Shanghai has escalated, but this has come at the cost of consumption of water resources, energy and raw materials, and increased domestic garbage and urban waste water, and waste air. Currently, resource consumption and waste discharge tends to be over-hasty. For instance, since 1990, the GDP per capita in Shanghai has been increasing at an annual rate of 12%, while domestic garbage has also ascended at an average annual rate of 7% (Zhu 2004).

In conclusion, the economic growth in Shanghai, based upon high material consumption and pollution discharge, is definitely unsustainable. This development model does not conform to the strategic objective of constructing Shanghai to be an international economic, financial, trade and shipping center, and also a socialist modern metropolis. Shanghai shall fully develop a circular economy, reducing material consumption and pollution discharge, while ensuring economic growth. Only by doing so can Shanghai remain competitive in the international market in future.

GENERAL STRATEGY AND MAIN TASKS OF DEVELOPING THE CIRCULAR ECONOMY IN SHANGHAI CITY

Relevant agencies in Shanghai have reached initial consensus on the general strategy and the main tasks of developing the circular economy. The following are the main points of the strategy:

- Reducing energy consumption through the reform of industrial structure, technology and management systems, aiming to determine a fundamental resource saving method.
- Promoting the construction of closing materials circle systems at levels of small, middle and large circles.
- Implementing whole-process management, namely from the input end through processes to the output end, with a view to achieving the integration of the reduce, reuse and recycle principle.
- Forming a cooperation mechanism for the forces of market, society and government to promote the circular economy.
- Strengthening the coordination with neighboring provinces/cities, such as Jiangsu and Zhejiang, with a view to building up a regional circular economy regime (Jiang 2005).

Relevant agencies in Shanghai have put forward the following eight key sectors and tasks for developing the circular economy:

- Further promoting industrial structural adjustment, developing resources and environmentally friendly industries;

- Promoting all in society to save energy, controlling the growth of energy consumption;
- Improving the level of land intensive utilization, and reducing land consumption caused by socioeconomic development and urban construction;
- Accelerating the construction of a water saving city through reasonable development and effective utilization;
- Promoting cleaner production, and reducing the industrial pollution discharge;
- Developing ecological recycled agriculture, and controlling agricultural non-point pollution;
- Strengthening the recovery and reuse of renewable resources, and improving resources utilization level at the exiting end; and
- Promoting appropriate product packaging, reducing packaging waste (Jiang 2005).

The proposal for the above-mentioned general strategy and main tasks reflect the guidance function of the basic principles of ecology and ecological economics in developing a circular economy in Shanghai. The view of ecology, namely that natural things are mutually connected and co-existent, and the views of ecological economics on the ecological limit of human economic activities, and the human economic system being part of the ecological system, natural capital and ecological efficiency, are all clearly reflected in the general strategy and main tasks. The proposal of the general strategy and main tasks not only highlights the direction and objective of developing a circular economy, but also includes an important meaning of guidance for the legal system construction of the circular economy. The legal system construction of the circular economy in Shanghai should follow the general strategy and center on the main tasks.

LEGISLATION OF THE CIRCULAR ECONOMY IN SHANGHAI GUIDED BY THE IDEAL OF A CIRCULAR ECONOMY SOCIETY

Current status of the legal system of the circular economy in Shanghai

Shanghai has prioritized the comprehensive utilization of resources, environmental sanitation and environmental protection. In 1985 Shanghai formulated the *Interim Rules of Energy Conservation of Industrial Enterprises in Shanghai* (these Interim Rules were abolished after the issuance and implementation of Regulation on Energy Conservation in Shanghai), in 1987 the *Administration Methods of Waste Paper Recovery in Shanghai* (these Interim Administration Methods were abolished), and the *Interim Administration Methods of Comprehensive Utilization of Coal Ash* (these Interim Administration Methods were abolished after the issuance and implementation of Administration Rules of Comprehensive Utilization of Coal Ash).

To date, current local regulations and rules concerned with the circular economy are as follows: *Regulation on Energy Conservation in Shanghai* (passed at the 5th meeting of the Standing Committee of the 11th People's Congress of Shanghai on Sep. 22, 1998, implemented since Oct. 15, 1998), *Administration Rules of the Comprehensive Utilization of Coal Ash in Shanghai* (issued by Decree No. 89 of the Shanghai Municipal Government on Dec. 5, 1994, revised and reissued by Decree No. 53 of the Shanghai Municipal Government on Dec. 14, 1997), *Interim Administrative rules on Disposal Plastic Lunch- Boxes in Shanghai* (issued by Decree No. 84 of the Shanghai Municipal Government on Jun. 14, 2000, implemented since Oct.1, 2000), *Administrative rules of Waste Paper Recovery in Shanghai* (approved by the Shanghai Municipal Government on Nov. 24, 1987, implemented since Dec. 1, 1987), and *Opinions on the Implementation of Law on Cleaner Production Promotion in Shanghai* (issued by the Decree No. 41 of the Office of the Shanghai Municipal Government in 2003). In addition, other regulations also include certain stipulations on reducing and recycling waste, such as the *Rules on Pollution Prevention and Control of Hazardous Wastes in Shanghai* (1985), and the newly issued *Plan and Administrative Rules on Domestic Garbage in Shanghai* (2005) and *Administration Rules on Restaurant Garbage Disposal* (2005). Recently, the city has also issued several other related regulations, including *Administrative Rules on Building Energy Conservation* (issued by the Shanghai Municipal Government on Jun. 13, 2005) and *Provisional Rules on the Subscription and Sales of Green Electricity* (transmitted by the Office of the Shanghai Municipal Government on Jun. 14, 2005).

Relevant agencies in Shanghai are amending *Regulations on Energy Conservation in Shanghai*, *Administratve Rules on Water Saving in Shanghai*, and planning to issue *Administrative Rules on Electricity Saving in Shanghai*, *Administrative Rules on Central Heating Supply in Shanghai*, *Administrative Rules on Key Energy Consumption Organizations*, and other government rules.

Some local regulations or rules in Shanghai have been well-implemented. Take the *Interim Administrative Rules on Disposal Plastic Lunch-Boxes* as an example. Through the implementation of the rules, the once serious 'white pollution' has vanished. Moreover, 'white pollution' has been transformed to "white resources" through recycling disposed plastic lunch-boxes. A complete industrial chain of disposed plastic boxes has been formed in Shanghai, from production and disposal to recovery, which has achieved positive economic benefits (Jiefang Daily 2005). It is an excellent demonstration that legislation plays an important role in promoting the circular economy.

Through the implementation of national laws and regulations concerning the circular economy, and the formulation and implementation of local regulations and rules, Shanghai has acquired rich experience in the legal system construction of the circular economy. This experience will be very beneficial in strenghening the legal system of the same.

Although Shanghai has done a lot of work in the legal system construction of circular economy, and made some progress, no basic framework has yet been formed, due to the rather incomplete legal regime of the circular economy nationwide, and the resulting inability to provide a solid legal basis for developing the circular economy in Shanghai. As far as the local circular economy legislation is concerned, although relatively good compared to that of other provinces and cities, it remains inadequate to meet the needs of developing the circular economy in Shanghai. Moreover, Shanghai plans to become an international metropolis, despite its lack of resources; hence the urgent need to promote economically, environmentally and socially harmonious development through reinforcement of the legal system within the circular economy.

General strategy for circular economy legislation in Shanghai

Based on the above-mentioned review and study of the concept and theory basis of the circular economy, the necessity, initial general strategy, and main tasks involved in the circular economy development, and the historical experience of the legal system of the same, the general strategy for circular economy legislation in Shanghai can be summarized as follows:

> "Learning and absorbing experiences concerning the legal system for the circular economy from other cities and countries, complying with national laws and regulations, following the laws of ecology and ecological economics and the general strategy of circular economy development, targeting three legal subjects - enterprises (including enterprise chains or industrial parks), the general public and government, focusing on key areas such as saving energy, water, land, raw materials and reusing waste, sorting, formulating and amending regulations, rules and standards concerning the circular economy, and providing

improved legal rules and order for developing the circular economy in Shanghai"

The general strategy includes eight elements:

- Learning and absorbing. To carry out circular economy legislative work in Shanghai, it is necessary to learn and absorb the relevant legislative practice from other cities and countries.
- Complying with national laws and regulations. Circular economy legislation in Shanghai must be conducted within the framework of national laws and regulations.
- Following scientific principles. Circular economy legislation in Shanghai should follow the basic principles and laws of ecology and ecological economics.
- Conforming to the general strategy of circular economy development in Shanghai. Circular economy legislation in Shanghai should follow the general strategy of circular economy development in Shanghai, analyzing the specific conditions of Shanghai and serving to achieve the main tasks of the circular economy development of the city.
- Setting clear legislation targets. Circular economy legislation in Shanghai should target three groups, enterprises (including enterprise chains or industrial parls), the general public and government, stipulating rights and duties for enterprises and the general public undertaking circular economy activities, and powers and responsibilities for government agencies. Therefore, legislators should conduct research into the status, roles and needs of the three targets in the circular economy career, thus enabling them to conduct legislative work with a well-defined objective in mind.
- Determining key areas. According to the initially formed general strategy and main tasks of circular economy development in Shanghai, saving energy, water, land and raw materials, and reusing waste should represent the key content of current circular economy legislation.
- Setting clear and specific tasks. The specific tasks of circular economy legislation in Shanghai comprise sorting, amending and formulating regulations, rules and standards concerning the circular economy in Shanghai, including sorting and amending current regulations, and formulating new regulations. The work should be systematic, carrying out an all-round study of current laws, regulations, rules and standards, with a view to forming a general understanding of the legislation system of the circular economy in Shanghai.
- Defining clear objectives. The objective of circular economy legislation is to provide improved legal rules and order for the development of the circular economy in Shanghai,

and smooth the orderly and effective circular economy work of all walks of life.

Legislative model of circular economy in Shanghai

Legislation should derive from reality. The foremost question of legislation is to know the nature of the key issues and requirements reality raises (Wang Xu 2005). The choice of legislative model of the circular economy in Shanghai should be made based on reality, with clear knowledge of the key issues and requirements needed for the circular economy development.

Legislative work should take into account costs. Legislation cost includes the consumption of human labor, finance, time and other resources during the law formulation process. In addition, the costs of implementation should be considered. Legislation should also consider whether regulations will be operational or not, and their implementation effect as well.

Based on the above-mentioned considerations, the authors think that the legislative regime of the circular economy in Shanghai may choose the model of “resolution of the Standing Committee of Municipal People’s Congress plus specialized regulations, rules and standards”.

As discussed above, relevant agencies in Shanghai have done considerable work over the past decades with respect to legal system construction of circular economy. Although the work was not titled “circular economy”, it was aimed at developing the same. Shanghai has formulated a series of local regulations or agency rules regarding saving energy, coal ash, waste paper, disposal plastic lunch-boxes, cleaner production, domestic garbage, restaurant garbage, moon cake packaging, building energy saving, and green electricity. These regulations and rules have been very effective,. Currently, Shanghai is, on the one hand, actively formulating new regulations and rules relating to the circular economy; and on the other, amending current regulations and rules. In the meantime, relevant agencies have agreed upon an initial general plan of circular economy development. Research into the current status of circular economy development that we conducted shows that drawing up a comprehensive *Regulation on the Circular Economy in Shanghai* is not an urgent task. Therefore, drawing up a comprehensive local regulation on the circular economy is not a key requirement raised by the circular economy practice to legislative work. In addition, with the legislation cost and operational and implementation effect of comprehensive regulation taken into consideration, to prioritize the formulation of a comprehensive local regulation on circular economy seems unnecessary.

However, a comprehensive local regulation has two essential functions, namely declaring policy and leading the regime as a whole, which cannot be replaced by specialized regulations and rules. To promote the circular economy, it is necessary for the legislative body to declare, by certain legal means, the policies and general requirements of circular economy development. This type of function could be achieved by the Standing Committee of Municipal People's Congress through the issuance of a *Resolution on Promoting the Circular Economy*. The Resolution may declare the general objectives, general strategy and main tasks of circular economy development in Shanghai, and the status and roles of enterprises, general public and government in developing the circular economy, illustrate to the general public the importance of developing the circular economy, and mobilizing the general public to care, support and undertake work in the circular economy. In the meantime, the Resolution may, to some extent, function as comprehensive regulation in leading and integrating the current regulations, rules and standards concerning the circular economy. A legal system of the circular economy would be formed, headed by the resolution of the Standing Committee of People's Congress, and other specialized regulations, rules and standards. Compared to drawing up a comprehensive regulation, the legislation cost of the resolution by the Standing Committee of People's Congress is much less, while its legislation effect remains more or less the same. Therefore, it is a reasonable choice.

Keys of circular economy legislation in Shanghai

What are the key requirements that the reality raises for circular economy legislation in Shanghai? Research we conducted shows the urgent need to develop the circular economy in Shanghai also requires the further formulation and improvement of specialized regulations, rules and standards with respects to saving energy, water, land, raw materials and reusing waste, safeguarding and promoting vastly improved effects of circular economy activities in various industries and sectors.

Based on the above discussion, the following key areas of current circular economy legislation in Shanghai were put forward for reference by the relevant agencies:

Studying and drawing up a circular economy legislation plan

The main work of the circular economy legislation plan is to identify the objectives, key areas and implementation scheme of circular economy legislative work in Shanghai.

The objective of circular economy legislation in Shanghai is to formulate or amend regulations, rules and standards concerning the saving of energy, land, water, raw materials and reuse of waste. This is determined by the specific conditions of Shanghai. Shanghai has a huge economic scale, fast development, large population, limited land, high resource consumption and inadequate supply of its own resources. Therefore, saving energy, land, water, raw materials, and reusing waste to develop the circular economy has far-reaching significance.

The implementation scheme of circular economy legislation work in Shanghai can be summarized as follows: realizing the current status of regulations, rules and standards concerning the circular economy in Shanghai, proposing a list of regulations, rules and standards that need to be formulated, amended or adjusted (including mergers, abolishments and others), and in light of the legislative model of "resolution of the Standing Committee of Municipal People's Congress plus specialized regulations, rules and standards", organizing and combining related legal instruments as a connected system according to their nature, level and involved industries, sectors or sections, and drawing up specific legislation plans (formulating, amending or abolishing) for each legal instrument.

Setting energy, land, water, raw materials saving, and reuse of waste as the key areas: formulating or amending related regulations, rules and standards

Based on the analysis of the initially formed general strategy and main tasks of circular economy development in Shanghai, the key areas of current circular economy development include saving energy, land, water, raw materials, and reusing waste. Therefore, the formulation and amendment of specialized regulations, rules and standards should focus on these items. The Standing Committee of the Municipal People's Congress could organize staff to conduct an overall review of regulations, rules and standards related to saving energy, land, water, raw materials and reusing waste. Moreover, considering legislation needs, costs and the operational and implementation effects of regulations, the Standing Committee of the Municipal People's Congress could propose a list of regulations, rules and standards that need to be formulated or amended, and carry out the legislation work step by step.

Drafting and formulating the *Resolution of the Standing Committee of Municipal People's Congress on the Promotion of the Circular Economy*

As discussed above, a Resolution on the Promotion of the Circular Economy formulated by Municipal People's Congress is necessary. It would, at a relatively low legislative cost, function as a comprehensive regulation in leading other regulations, rules and standards within the legal system of the circular economy. Because of its leading role, the proposal of main content of the Resolution must build on a systematic and all-round review and study of the current regulations, rules and standards concerning the circular economy, so that the Resolution may provide a macro and strong guidance policy declaration to develop the circular economy, and direct the general public to work together to build up a circular economy society in Shanghai.

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15. Towards Sustainable Rural Development: Combining Biodiversity Conservation with Poverty Alleviation - a Case Study in Phu My Village, Kien Giang Province, Vietnam

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ABSTRACT

In many developing countries, there is a prevailing conflict between biodiversity conservation and the need for poverty alleviation. One possible solution for solving that conflict is to find ways that help poor people directly benefit from nature conservation activities. That approach has been tested in a wetland conservation project in Phu My village, Kien Luong District, Kien Giang Province. The 2,000-hectare seasonally inundated grassland, dominated by the sedge *Lepironia articulata* (Cyperaceae); in Phu My Village is the last of its kind remaining in the Mekong Delta. In January 2004 a new model of protected area was established in Phu My Village. It is an "open" protected area where the local Khmer ethnic minority people are still allowed to harvest Lepironia as they have been doing for centuries. The project provides local people with skills training and production equipment, allowing them to make fine handicrafts from the Lepironia they harvest. The project also helps market handicraft products to more profitable export markets. After two years of operation, the daily income of those who participated was an average of twice that before the project. The unique remnant wetland is protected, and would otherwise have been turned into a rice cultivation area according to the previous land use planning of Kien Giang Province.

Keywords: Lepironia, Sustainable rural development, Poverty alleviation, Kien Giang

INTRODUCTION

Located in the southwest corner of the Mekong Delta, the Ha Tien Plain is a geological anomaly – a shallow basin on which sheet floodwaters pool for a longer duration each year, creating its characteristic acid-prone, inundated grasslands. These grasslands are diminishing rapidly, along with other plant communities: saltwater mangroves, coastal lagoons, freshwater grassland and limestone karst vegetation (Triet et al. 2000).

Classified in its natural state as 'unproductive', the Ha Tien Plain has been the testing ground for several episodes of failed economic development, including forestry (22,000 hectares of abandoned *Eucalyptus* plantation), rice (extremely low yield) and the ongoing boom in shrimp aquaculture (highly acidic water requiring constant neutralization) (Triet 2004). These activities are failing to alleviate long term poverty in the region while simultaneously destroying the ‘natural capital’, which could power a sustainable economic engine for the region.

Far from being unproductive, the Ha Tien grasslands support a rich biodiversity. Yet the value assigned to that biodiversity has been low – due to Vietnam’s legitimate concerns to ensure its own food security and raise its citizens out of poverty. The centrally planned economy rewards provinces on attaining production targets for rice and other staples and in doing so, provides no incentive to include conservation within its land use mix. The natural capital of the Plain is therefore being heavily exploited, but without bringing significant economic gain to the local population.

The problem facing the Ha Tien Plain is a near universal one in the developing world – the perceived conflict between development and conservation. Some new models of sustainable economic development need to be implemented to break this downward spiral.

Located within the Ha Tien Plain, the 2000-ha wetland of Phu My Village, Kien Luong District, Kien Giang Province supports the last extensive remnant of *Lepironia* grassland ecosystem (named after the dominant sedge species *Lepironia articulata* - Cyperaceae) of the Mekong river delta (Fig. 15.1). The Phu My wetland is not only important for biodiversity conservation, but it also provides an economic base to the Khmer ethnic minority, who harvest *Lepironia* for the production of woven goods.

Established in November 2004, the "Phu My *Lepironia* grassland conservation and sustainable use" project (hereafter referred to as the Phu My project) seeks to protect this important wetland by implementing an innovative model that combines nature conservation with improving the daily income of local people whose livelihood depends upon harvesting natural resources from the wetland. The project began by successfully convincing the Kien Giang province authority to grant protection status for the Phu My wetland. Unlike many other "traditional" protected areas, in Phu My the access of local people to natural resources still continues but is being organized in a more sustainable way.

SITUATION BEFORE THE INITIATIVE BEGAN

The Khmer ethnic minority people, the main ethnic group of Phu My's inhabitants, have long been harvesting *Lepironia*, but only for making simple household products. The products made are of low value – a mat taking two days to make, for example, will be sold for 10,000VND (approximately $0.70). Due to this low profit margin, the *Lepironia* is being harvested in an unsustainable manner as households produce a higher volume of goods to sustain themselves.

The provincial government wanted to convert the whole area into a rice farming area. Acid soils and the lack of freshwater supply, however, made the land unsuitable for rice cultivation. A feasibility study prepared by scientists from Can Tho and Ho Chi Minh City National University showed that the natural *Lepironia* wetland landscape was deeply valued by local Khmer ethnic minority people, who have lived in the area for hundreds of years (Triet 2004). Maintaining the area in its natural state is therefore both ecologically sound and culturally just.

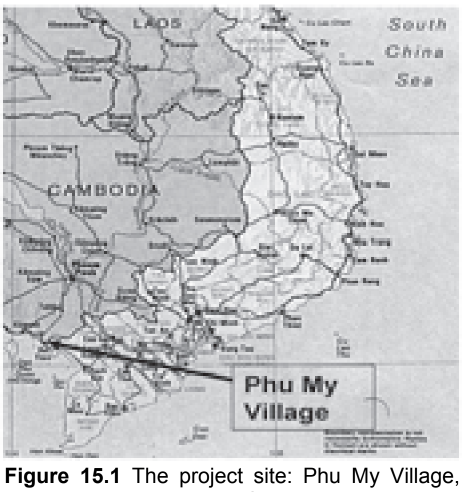

Figure 15.1 The project site: Phu My Village, Kien Luong District, Kien Giang Province

OBECTIVES AND STRATEGIES

The priority of the project is to preserve the unique, biodiversity-rich wetland remaining in Phu My Village. The main goal is to ensure that the use of natural capital does benefit local people by maximizing the income they receive from the sustainable use of wetland resources. The project seeks to:

- protect the Phu My wetland;
- promote the sustainable use of *Lepironia;*
- increase the income of local people; and
- promote the community-based management of natural resources.

These objectives were formulated as a result of a feasibility study, in which a social survey was conducted to document the local community's opinions, perceptions and valuation regarding wetland resources and values and how to best manage the area (Triet 2004). The management strategy is to create an "open" protected area where access to wetland resources continues but is organized in a sustainable manner.

In developing this alternative, the intention is to demonstrate to other residents of the Ha Tien Plain – and the government officials who administrate them – the validity of the approach and encourage them to adopt similar techniques. A wholesale switch from rice or shrimp is implausible – but it may help to conserve the last remaining fragments of grassland.

PROCESS

The project won a US$102,000 award from the World Bank's Development Marketplace award competition in 2003 and received co-funding of US$100,000 from the International Finance Corporation. Kien Giang Province's Department of Science and Technology contributed $20,000, while the project also received in-kind support in the form of expert consultation from Ho Chi Minh City National University and Can Tho University. The project is managed by the Vietnam Program of the International Crane Foundation and is working under the supervision of a steering committee, consisting of representatives from governmental agencies and community organizations of Kien Giang Province and Phu My Village.

Since the establishment of the project, local people are still allowed to harvest Lepironia inside the protected area. The project provided local villagers with skill training so that they can make fine handicraft products, and help with marketing so that villagers can sell their products to more profitable markets. Besides providing a better return for their labor, new fine handicraft products do not consume as much raw materials as traditional handicrafts and thus reduce the pressure of resource harvesting.

The project seeks to redirect the *Lepironia* products toward higher value markets – such as the burgeoning tourist markets in Ho Chi Minh City, where a handbag typically sells for $3.00 or more. Selling into such markets significantly increased household incomes, despite the additional transportation costs.

Land encroachment has been a serious problem. By cooperating closely with local community and authorities land encroachment was prevented to some extent. Illegally occupied lands were spotted early by local people and reported to village authorities who then enforced the return of occupied lands to the project.

Over-exploitation of *Lepironia* is another important issue. Before the project was introduced, there was free access to the area for Lepironia harvesting, meaning that people from outside the area often applied indiscriminating harvesting techniques. They cut all Lepironia plants, both long and short and took only the former. Local villagers harvest not by cutting but by pulling up the plants and only select those long enough for weaving. This traditional method is more laborious but does not deplete the grassland as quickly as the "cut" method. A new regulation was issued by Phu My commune to ban the "cut" method and to limit access only for villagers of the project area. Illegal exploitation was reduced but not eliminated. To solve this problem requires considerable time and patience as well as good people skills from the project management.

The project regularly carries out monitoring and eradication of invasive alien species in and around the protected area. *Mimosa pigra* – a highly invasive weed, which has started to infiltrate the wetlands of the project area, is the primary focus of the eradication effort. With assistance from village's Buddhist pagodas, environmental education activities were conducted to raise awareness within the local community about the conservation importance of the project area.

Buddhist belief is an important cultural aspect of the Khmer community living in Phu My Village. The project's goals, objectives and activities were developed in close consultation with the supreme monks of the village. The project has also been receiving effective support from the village's pagodas in communicating with the community.

There is a unique cooperation among the local community, Buddhist pagodas, governmental authorities (village and provincial levels), international NGOs and development agencies, academic institutions and private companies in the implementation of this project.

RESULTS ACHIEVED

The project established a wetland protected area of 2,890 ha in Phu My commune, Kien Luong District, Kien Giang Province, Vietnam, conserving the last remnant of *Lepironia* grassland in the Mekong Delta.

After one year of operation, the project now involves 200 of 350 families living in the project area. An average mat-making labor can earn a net income of 20,000 VND a day, while handbag-making labor can earn 30,000 VND a day. The average income of people making Lepironia products before the project was about 8,000 to 10,000 VND a day.

After the project was established, human disturbances and encroachment in the new protected area were reduced, leading to an improvement of the biodiversity value of the area. The annual Sarus crane count, carried out by the International Crane Foundation in 2005, recorded 45 cranes in the project area - a significantly higher number of cranes visiting the area as compared to the year before; the number of cranes recorded in Phu My during the 2006 annual census was 41 (Triet and Barzen 2005; Triet et al. 2006). The project area was also included in the Kien Giang Biosphere Reserve; being nominated to UNESCO by the Government of Vietnam.

By working with district and provincial authorities, and having strong support from the local community, the project successfully prevented the digging of a canal, proposed by a shrimp farming company located nearby, which would have cut through the project area and potentially had a considerably adverse impact on the wetland and its wildlife.

At a provincial level, the project implementation resulted in a change in provincial economic development planning, leading to the establishment of a protected area on land that had been planned for agricultural development. At district and village levels, a new regulation was issued to promote the sustainable harvesting of wetland resources of the project area.

On a broader level, the Phu My project demonstrates the benefits of multi-use land management. Land reform is a recent phenomenon in Vietnam and as such, there are many cases where conflicts exist. This is particularly so in less industrialized provinces like Kien Giang, where the pressures to stimulate economic growth and provide land tenure are more acute. Officials are caught in the middle - they understand these pressures, but often have inadequate data available on which to base land use planning decisions. The Ha Tien Plain is a case in point – it has suffered due to the assignment of blanket land use designations, rather than land use based on an assessment of its natural capital. The resulting monocultures have destroyed 98% of the Plain's natural habitat and made the population over-reliant on single agricultural commodities – which have routinely failed to provide adequate economic returns to the majority. A much more 'balanced portfolio' is required - a multi-use model based on sustainable management principles. The Phu My project is a first step towards such a portfolio.

SUSTAINABILITY

Financial

Even though the project operation is not for profit, the production of handicrafts can still bring a certain amount of income for project management. The goal is to for the project to be financially self-sustaining. Yet to be completed, however, is the development of a business plan that will help guide the long term economic aspects of the project.

Social and economic

Weaving products from *Lepironia* is a traditional livelihood activity of the Khmer community living in Phu My. Maintaining the wetland in its natural state and continuing *Lepironia* handicraft production are, therefore, socially acceptable. Economically, this resource management option is also superior to transforming the wetland into a shrimp farming area because the local people lack knowledge of shrimp farming or sufficient capital investment. Nonetheless, shrimp farming in the Mekong Delta is a very risky business.

Cultural

The *Leprironia* wetland has been part of the natural landscape of the area for centuries, something which is deeply appreciated by local people.

Environmental

Given the characteristics of the wetland environment in Phu My, which is unsuitable for rice or shrimp cultivation, maintaining the Phu My wetland in its natural condition is an environmentally-viable option. The exploitation of natural resources (*Lepironia* sedge) is organized in a more sustainable way: indiscriminate harvest techniques were banned; the volume of harvested raw material was reduced; wetland habitats have been well protected and major disturbances prevented.

Institutional

By approving the implementation of the project, the Kien Giang authority formally recognized the Phu My wetland as a protected area. This remarkable change in provincial policy has seen the entire area enlisted for agricultural expansion. The project is supervised by a steering committee, consisting of representatives of project partners, including provincial and district agencies, local community, donors and academic institutions.

The project has good potential to be replicated elsewhere, especially in the Mekong delta region, both in Vietnam and Cambodia. In fact, the project ideas and activities have been applied in the areas surrounding Phu My village, which share similar environmental, cultural and ethnic characteristics. The project received requests from many people living outside the project boundary and has provided skills training for more than 200 people from three nearby villages. Many of them are now beginning to make handicraft products to be sold by the project. Increasing the production of *Lepironia* products has lead to the protection of fragments of *Lepironia* wetlands in the surrounding area and therefore reduced the exploitation pressure on the core zone of the project site. The boundary of the project is much wider than that administratively designated.

LESSONS LEARNED

The role and capacity of local villagers in managing their own resources from the wetland have been improved along with the implementation of the project. The family income of local villagers participating in the project has increased and people are more appreciative of the value of the wetland and have a better sense of ownership of the area. This is perhaps the most important reason for the project to exist in the area.

Cooperation among many different stakeholders is important for projects that involve community development and nature conservation. Within that cooperation, local knowledge and expertise has been truly respected and mobilized.

The experience from Phu My has shown that it takes time to develop projects that involve nature conservation and community development, projects that require changes in governmental policies and regulations and in the way people manage the natural resource base. The time necessary to make those changes is often longer than the one/two-year lifetime of typical projects receiving outside funding. It is important to build a strong support base involving many different partners, both from within and outside the project area or region.

CONCLUSION

The Phu My project has addressed three principal problems: (1) the perceived conflict between development and conservation, (2) the low value assigned to the biodiversity in question and (3) government incentives to convert the land to other uses. A fourth problem can be added – a lack of creativity in the responses to these problems, particularly in relation to the role the private sector can play. The project supplied that creativity by encouraging a rural Khmer population to benefit from the "reform" policy of the government, which encourages private commerce, and in doing so; demonstrate the economic case for maintaining a high value ecosystem in its present state. Assigning an economic value to an ecosystem like Phu My is among the first of its kind in Vietnam.

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