Eco-Industrial Clusters in Urban-Rural Fringe Areas

A strategic Approach for Integrated Environmental and Economic Planning

Kansai Research Centre

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Preface

This book is the outcome of the research theme titled "Eco-Industrial Clusters in Urban Rural Fringe Areas of Asia" undertaken as a part of Business and Sustainable Society Project. Industrial clusters shall be defined as a geographic concentration of interconnected industries in a specialized field that cooperate with each other to efficiently share resources and information. The concept of industrial clusters has been emerged as central idea for innovation and competitiveness. Theoretically, urban–rural fringe areas is defined as hinterland between urban centers and the rural areas, providing numerous environmental and socio-economical opportunities as well as obstacles. However, surprisingly little systematic knowledge of industrial clusters in urban-rural fringe areas, their business structure and environmental impacts are available.

As more and more efforts are devoted to foster eco-restructuring of rapidly industrializing Asia, the need to understand the sustainability potentials of bio-based industries located in urban-rural fringe areas has become urgent. Our research on eco-industrial cluster networking is a pioneering effort to fill this gap. This book documents the environmental, technological and policy aspects for establishing eco-industrial clusters in the urban -rural fringe areas of India, Japan, Thailand and Vietnam as a strategic approach for integrated economic and environmental planning.

We would like to thank all the people who made this book possible. First, we are grateful to our research partner Dr.C.Visvanathan (Asian Institute of Technology, Thailand) for his valuable insights and contribution in all phases of research.

We would also like to thank Prof. Van Ha (Ho Chi Minh City University of Technology, Viet Nam) and Dr. Ramachandra Murthy Nagendran (Anna University, India) for their support in country surveys. We have pleasure in acknowledging the contribution made by other research facilitators including Mr. Masaki Kojima (Zero Emission Support Club, Japan) and Mr. Prem Anand (Asian Institute of Technology, Thailand) who helped us in documenting the cluster initiatives through interviews and surveys.

Takashi Gunjima

Executive Summary

Being the home for different type of industries, urban-rural fringe areas are pregnant with environmental issues. More often than not, these areas face pressures of industrialization and growing population. On the other hand, they continue to play an important role in local and national economic development. New eco-industrial systems aiming at efficient sharing and utilization of resources, technologies focusing on alternative use of discarded materials and policies envisaging and enforcing the above in urban-rural fringe areas could play an important part in eco-restructuring of developing Asia.

Eco-industrial clusters are defined as a community of business; geographic concentration of interconnected companies in a specialized field that cooperate with each other and with the local community to efficiently share resources leading to improved environmental quality, economic gains, and equitable enhancement of human resources for both the business and local community. A simple small scale application of this industrial ecology principle can become an innovative approach for sustainability problems faced by the fringe areas.

This multi-country study on the feasibility of establishing eco-industrial clusters was conducted in India, Japan, Thailand and Viet Nam. The fact files and stakeholder consultations made during study revealed that the benefits of such eco-industrial strategies include efficient sharing of local resources, improved environmental quality and equitable distribution of socio-economic gains. A pragmatic operational case study research conducted on select industrial clusters, namely, sericulture in India, wood industry in Japan, rice processing in Thailand and fish industry in Vietnam have yielded thought provoking findings.

Successful eco-industrial clusters are made up of enterprises that constantly seek inter-firm networks, not only to minimize waste and reduce pollution, but also to look for all types of innovation to improve zero emission processes and develop new eco-products. Such networks can generate markets, logistics and cluster management. Active cultivation of such inter-firm networks apparently contributes to the growth of new enterprises. It is also important to recognize that joint action by firms has its costs. The opportunity costs of bilateral or multilateral associational activities and time involved for building vertical and horizontal networks are probably the most obvious example. However, the environmental, economic and social benefits gained through such inter-firm networks are substantial. All the four clusters studied have substantial form of horizontal and vertical inter-firm networks along with significant innovation capabilities which are particularly evident in Japan and Vietnam cases.

It is not sufficient for individual companies to form inter-firm networks in order to become environment friendly; eco-industrial clusters also require a range of technologies available within their reach to do so. Environmental technologies for conversion of waste to energy, wastewater treatment and use of renewable materials have to spread easily among the companies to benefit the cluster as a whole. This is an area where Thailand and Indian clusters need intervention to strengthen existing inter-firm networks enabling to share relevant technologies among clusters firms. Academic institutes that focus some of their research within the clusters are found to be helpful in diffusion of appropriate technologies among the firms and induce eco-innovations within the clusters.

Well-established social networks and a trusting relationship between cluster firms, academic institutions and community-based organizations greatly facilitate inter-firm collaboration as well as diffusion of new technologies. The creation of social capital in the sericulture industry in India through the formation of an eco-industrial cluster would help the industry reach its full potential. Japanese cluster is a good example where high social capital that includes the relationships, attitudes and values governing the interactions among people, businesses and institutions, facilitated the sharing and development of ideas and pertinent market information thus reducing the transaction cost for businesses operating within the clusters. While the concept of mutual trust among competitors is not the norm among businesses, the evidence from Japanese and Indian cases indicate that it can be built through progressive action by community-based cluster players.

Basically any eco-industrial cluster initiative can draw upon existing policies, and their main contribution is to select, adapt and combine policy measures to maximize the synergy. None of these challenges are trivial, but solving them in an integrated way offers a huge reward in terms of the capacity to improve environmental and economic performance of regions through cluster growth and competitiveness. This source book is an initial attempt to rationalize that debate by providing not only a conceptual framework, but also some systematic evidence that goes beyond these four case studies. This consideration notwithstanding, it appears establishment of clusters and transforming them into eco-industrial clusters has the potential to become critical elements in the tool box for sustainable regional development. This is an important finding for business, governments, donors, and other stakeholders who are interested in eco-restructuring of rapidly industrializing Asia.

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List of Abbreviations

ADB	Asian Development Bank
ASEAN	Association of South East Asian Nations
BoI	Board of Investment
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
DIP	Department of Industrial Promotion
EIC	Eco-Industrial Clusters
EPZ	Export Processing Zone
FDI	Foreign direct Investment
GDP	Gross Domestic Product
IC	Industrial Cluster
IP	Industrial Park
IZ	Industrial Zone
MAFF	Ministry of Agriculture, Forestry and Fisheries
METI	Ministry of Economy, Trade and Industry
MEXT	Ministry of Education, Culture, Sports, Science and Technology
MoE	Ministry of Environment
MoSSI	Ministry of Small Scale Industries
NESDB	National Economic and Social Development Board
PCI	Provincial Competitiveness Initiative
SICDP	Small Industry Cluster Development Program
SME	Small and Medium scale Enterprise
SMI	Small and Medium scale Industry
SMIC	Small and Medium scale Industrial Cluster
SSI	Small Scale Industry
TCI	Thailand Competitiveness Initiative
TRC	Technology Resource Centre
TVIC	Trade Village Industrial Cluster
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
VNCI	Vietnam Competitiveness Initiative
VND	Viet Nam Dong

1 Introduction

1.0 Dichotomy of Development and the Environment

The second half of the twentieth century is a watershed era for the Asia-pacific region, which witnessed rapid industrial growth and progressive wealth creation. Today, more people of the region lives longer than at any time in history. But the gains have been inadequate and uneven. More than one third of the population still lives in abject poverty. To reduce poverty, sustained and equitable industrial development is essential. But past economic growth has often been associated with severe degradation of the natural environment. On the surface, there appears to be a tradeoff between meeting the people's need – the central goal of development – and protecting the environment. Indeed economic development and sound environmental management are complimentary aspects of the same agenda. Without adequate environmental protection, industrial development will be undermined; without development, environmental protection will fail. This book argues that in the realm of eco-industrial activity, tangible benefits shall be attained

Towards Sustainable Development - A Paradigm Shift

> "*Humanity has the ability to make development sustainable—to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs.*"
>
> *- Brundtland Commission, 1987*

Sustainable development contains within it two key concepts; the concept of "needs", in particular the essential needs, to which overriding priority should be given, and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs. How can we meet the needs of today without diminishing the capacity of future generations to meet theirs? Sustainable development implies a broad view of

human welfare, a long term perspective about the consequences of today's activities, and global cooperation to reach viable solutions

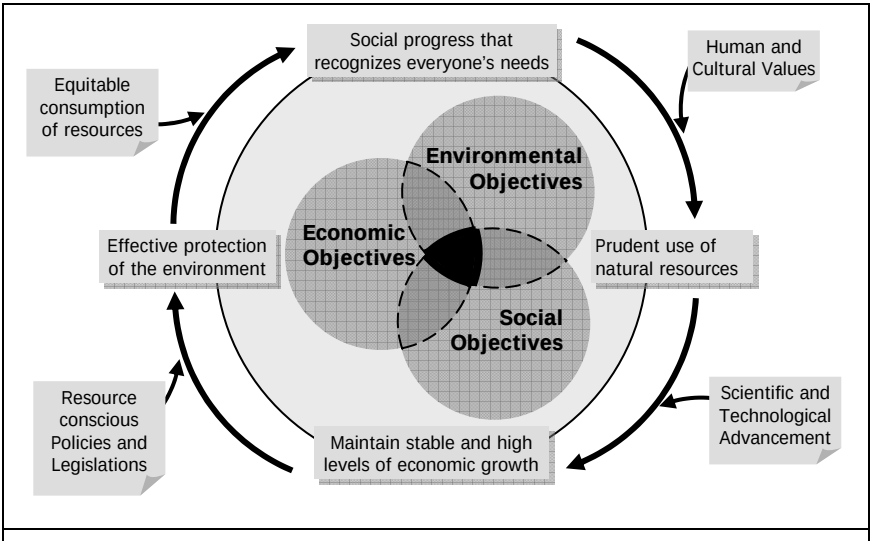


Figure 1.1 Sustainable Development – Components and Drivers

Development is all about the utilization of natural resources to provide goods and services, a business activity for the betterment of mankind. Sustainability is ensured only upon striking a balance between living conditions and resource usage. When one sidelines the other the whole system collapses, in most cases, with irreversible environmental damages.

The real transition from "Development" to "Sustainable Development" is possible only with changes in business attitudes and actions.

1.1 Environment, Industrial Development and Equity Issues in Asia

Asia, the largest of the Earth's seven continents, lying almost entirely in the Northern Hemisphere covers an estimated 44,391,000 sq km with an estimated 3.96 billion inhabitants by 2006. With such a huge population and limited resources most of the Asian countries are in the march towards economic development. Box 1.1 presents the Millennium Development Goals of the Asian Countries.

Box 1.1 Millennium Development Goals for Asia

Goal 1 – Eradicate extreme poverty and hunger

Target 1: Halve, between 1990 and 2015, the proportion of people whose income is less than one dollar per day
Target 2: Halve, between 1990 and 2015, the proportion of people who suffer from hunger

Goal 2 – Achieve universal primary education

Target 3: Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling

Goal 3 – Promote gender equality and empower women

Target 4: Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015

Goal 4 – Reduce child mortality

Target 5: Reduce by two thirds, between 1990 and 2015, the under-5 mortality rate

Goal 5 – Improve maternal health

Target 6: Reduce by three quarters, between 1990 and 2015, the maternal mortality ratio

Goal 6 – Combat HIV/AIDS, malaria and other diseases

Target 7: Have halted by 2015 and begun to reverse the spread of HIV/AIDS
Target 8: Have halted and reversed by 2015 the incidence of malaria and other major diseases

Goal 7 – Ensure environmental sustainability

Target 9: Halve, by 2015, the proportion of people without sustainable access to safe drinking water and sanitation

(Source: UNESCAP, 2006)

Asia is a land mass bestowed with rich natural resources and ecological and biological diversity. Expansion and intensification of agriculture, uncontrolled industrialization, destruction of natural habitats, and increasing urbanization to satisfy the needs of the growing population and economic development have been major threats to the regions rich heritage.

The antagonism between population growth, resource depletion, and environmental degradation is being widely deliberated in the recent years. Arguments, most of the times, are between population growth as the main cause of increasing environmental pressures, economic development, unsustainable agricultural and industrial practices, and excessive or wasteful consumption.

1.1.1 Population Growth

Clearly an intrinsic relationship exists between population growth and environmental stress, but very little empirical evidence exists to prove or disprove it. Prescott-Allan, in his book The Wellbeing of Nations (2001),

concludes that the countries where population is projected to grow fastest have some of the lowest income levels in the world. Eventually, these countries already rank high in terms of environmental stress.

1.1.2 Changes in Consumption Patterns

Economically and industrially, Asia is the fastest-growing region in the world. This economic and industrial development is inevitably accompanied by changing consumption patterns. In the recent years, resource consumption patterns have significantly changed and moved to a use-and-throw state of mind. Such a style, in addition to posing significant threats on resource consumption, also increases the stress on the environment in the form of the disposed waste.

Escalating population growth rates and rapidly increasing levels of consumption in Asia has made the region a significant contributor to the global Ecological Footprint. With 55 per cent of world population, the Asia-Pacific region's footprint occupies 40 % of the world's biocapacity.

With present levels of consumption patterns the Footprint of the Asia-Pacific region is 1.7 times as large as its own biological capacity meaning that, with current rates of consumption, the region needs more than one and a half times its own land and sea space to support its resource demands. See Box 1.2 on Ecological Footprint and Biocapacity.

Box 1.2 Ecological Footprint and Biocapacity

Ecological Footprint measures humanity's demand on nature. The footprint of a country is the total area required to produce the food, fiber and timber that it consumes, absorb its waste and provide space for its infrastructure. In 2001, the global Ecological Footprint was 13.5 billion global hectares, or 2.2 global hectares per person (a global hectare is a hectare whose biological productivity equals the global average).

This demand on nature can be compared with the Earth's bio-capacity, a measure of nature's ability to produce resources from its biologically productive area. In 2001, the Earth's biocapacity was 11.3 billion global hectares, a quarter of the planet's surface, or 1.8 global hectares per person.

The global Ecological Footprint decreases with a smaller population size, lower consumption per person, and higher resource efficiency. The Earth's biocapacity increases with a larger biologically productive area and higher productivity per unit area.

In 2001, humanity's Ecological Footprint exceeded global bio-capacity by 0.4 global hectares per person, or 21 per cent. This global overshoot began in the 1980s and has been growing ever since. In overshoot, nature's capital is being spent faster than it is being regenerated. If continued, overshoot may permanently reduce ecological capacity.

(Source : WWF, 2005)

Obviously, the region has to meets the needs of its population, which it does in two ways, by importing resources and using the ecological production of other countries and the global commons; and, secondly, by liquidating the region's natural capital. On a per capita basis the average footprint of an Asian resident is still far smaller than the average footprint of people living in Europe or North America. Nevertheless, one comforting point here is that, in many Asian countries, the per capita footprint is relatively stable – the growth in footprint being attributable largely to population growth.

1.1.3 Poverty

Ironically, another source of environmental stress is the persistence of poverty in the region. An estimated 900 million people in Asia survive on incomes of less than US$1 per day. Poor slum dwellers in cities, who lack the most basic sanitation facilities, do not worry about environmental quality. In rural areas, poor farmers tend to live in the most marginal, fragile environments where they may be forced to sacrifice long-term sustainability for short-term survival, overexploiting croplands, pastures, and forests (UNFPA, 2001). Welfare and resource economists all over the world consider poverty as the most serious threat to environment in developing countries. In the long run, however, the contribution of the poor to environmental degradation in the region may be small compared to the impact of large-scale businesses and rich consumers.

1.1.4 Energy Demand

Increasing population and growing affluence have already resulted in rapid growth of energy consumption in Asia, and this trend is expected to be accelerated in the future. Energy use, mostly fossil fuels, in the world has increased by nearly 85% in the past 30 years, but the increase has been more than 300% in Asia (EIA, 2001).

Over the next 20 years, the demand for energy is projected to grow more quickly in Asia than in any other region of the world. The fastest growth will be in Asia's developing countries. Energy use in the developed countries of the world is projected to increase by about 29% between 1999 and 2020, while energy use in the developing countries of Asia will increase by about 129%.

1.1.5 Unplanned Urbanization

Primarily as a result of rural-to-urban migration, Asia is the fastest urbanizing region in the world. According to United Nations estimates, the urban population in Asia will nearly double in the next 30 years. By 2030, more than half of Asia's population will live in cities; some 2.6 billion people. The urban population of Asia will be larger than the urban population of all the other regions of the world combined (UN, 2001).

This rapid, largely unplanned expansion of urban areas has robbed many Asian countries of some of their most productive land resources and has resulted in serious problems of air, soil, and water pollution. Despite rapid urbanization, Asia's rural population is also projected to grow, although not as quickly (See Box 1.3).

Box 1.3 From Urbanization to Sustainable Cities

Cities are increasingly becoming the engines of national economic growth and the magnets for new residents flooding in from rural areas. Globalization is having a significant effect on cities, forcing them to compete for international business with other cities worldwide and within their own countries. As a result, the sustainability of cities is under pressure. Decision-makers at all levels are faced with the task of how to resolve urban problems from transportation to waste management, from drinking water supply to the preservation of urban green space.

A city is only considered to be sustainable when:

- It follows a development path where the present progress does not take place at the expense of future generations (i.e. bad planning, debt, environmental degradation, etc. does not export present problems to the future).
- There is an equilibrium between different issues. In other words, the goal is an across-the-board development, instead of handling issues one by one.

In India, the important issues to be tackled, ranked by importance, are population, transportation, large share of public transport, health, water, legislation/enforcement, zoning/planning, air pollutants, sewage and landfills

The main problem is the migration of rural population to the cities for jobs. This puts strain on the infrastructure (water, electricity and communication), health, education, jobs, law and order, food distribution system, governance, housing, etc. In a nutshell the root cause of all urban issues is the growing population. Unless these amenities are provided in the rural sector the migration will not stop. An important aspect in this regard is the creation of satellite townships near the big cities and a shift to them to reduce the burden on the city centre.

(Source : RECCEE, 2007)

1.1.6 Pressure on Land Resources

Asia faces the most acute pressure on lands than any other region in the world. It could be seen from Figure 1.2 and 1.3, that the Asian continent is home to 60% of the world population while having only 32% of the worlds land area. This is a clear indicator of the stress on the environment and natural resources in the region

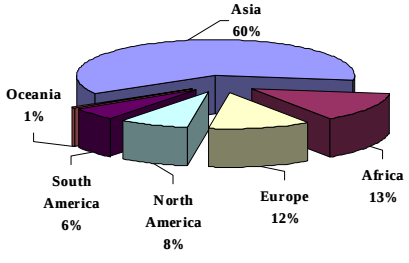


Figure 1.2 Population of Continents

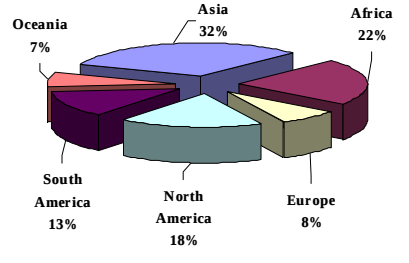


Figure 1.3 Land Area of Continents

Over the past 30 years, while Asia's total population increased by about 68 %, the total area of land under cultivation increased by only 21%; from 355 to 430 million hectares. This expansion has been largely at the expense of lowland forests. Today, there are very few possibilities for further expansion; almost all suitable lands in the region are already under cultivation. Despite past expansion of the area under cultivation, less rural land is available to feed each person in Asia (0.16 hectare per person) than in the world as a whole (0.26 hectare per person) (WRI, 2001).

1.1.7 Habitat Destruction and Loss of Biodiversity

Preservation of the earth's biological diversity is an important goal in its own right. In addition, the diversity of plant and animal species provides a key input for medical and agricultural research. The greatest threat to biodiversity is not destruction of plants and animals per se, but rather the destruction of their habitat. Asia is home to diverse ecosystems that host many plant and animal species. More than two-thirds of the planet's biological resources are found in 17 countries, and five of these; China, India, Indonesia, Malaysia, and the Philippines are in Asia.

1.1.8 Water Scarcity and Water Pollution

Over the past 50 years, water use in Asia has more than tripled. Out of total water consumption, the largest share goes to agriculture at 84%. Industrial use accounts for another 10% and domestic use 6%. Agriculture as it is practiced in much of Asia consumes large quantities of water. With current irrigation practices, an estimated 60% of water is lost.

Over the past century, the use of fresh water increased more rapidly in Asia than in any other region of the world (ADB, 2001). Today, Asia has the least fresh water available per person of any region; this has declined at alarming rates in the recent decades, primarily because of population growth, and is projected to worsen in the future.

Water pollution is also a serious problem, mainly caused by the disposal of untreated sewage and industrial waste, urban and agricultural runoff, and seawater intrusion. Levels of suspended solids in Asia's rivers have grown more than fourfold since the early 1970s and are now about four times the world average and about 20 times the levels typically found in developed countries. Lakes and other water systems are also heavily polluted. Largely because of widespread pollution, one out of three Asians does not have access to safe drinking water defined as a reliable source within 200 meters of the home.

1.1.9 Air Pollution

Asian cities are among the most polluted in the world. Of the 15 large cities with the worst air pollution, measured in terms of suspended particulate levels, 12 are in Asia. Delhi, Beijing, Karachi, and Jakarta top the list with suspended particulate levels many times higher than the World Health Organization (WHO) standards. Other pollutants, including sulfur dioxide (SO_2) and nitrogen dioxide (NO_2), are also much above WHO limits.

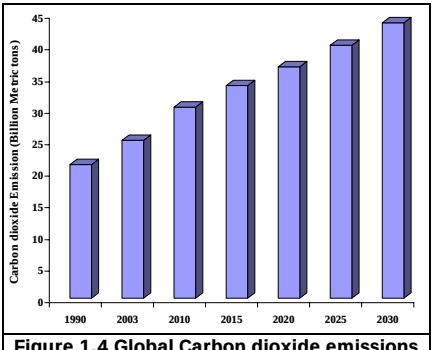


Figure 1.4 Global Carbon dioxide emissions
(Source: EIA, 2006)

1.1.10 Global Warming and Climate Change

The emission of greenhouse gases, such as carbon dioxide (CO_2), methane, nitrous oxide, and chlorofluorocarbons, is much lower per person in Asia than in the industrialized nations, but—given Asia's large population and rapidly increasing energy use—the region plays an important and growing role in global warming. In the 1950s, Asian countries produced about one-fifth of the CO_2 emissions produced by Europe, but by the mid-1980s carbon emissions from Asia surpassed those from Europe. If current trends continue, CO_2 emissions from Asia will double between 2000 and 2020, growing at more than three times the rate of emissions from industrialized countries. Figure 1.4 shows Carbon Emission Globally.

1.2 Synergetic Linkages Among Industries

Agriculture and allied industries has been the main source of livelihood for about 60% of the developing countries' population. Mushrooming needs and preferences have forced the transfer of both labor and other resources to the industrial and services sectors. Profitability and productivity tend to be higher in industries than in agriculture, due to higher investments and advanced technologies. Thus the relative contribution of agriculture to the total Gross Domestic Product (GDP) has generally been declining as economies expand and diversify. See Table 1.2

Worldwide experiences show that forging strong linkages between agriculture, industry and related services can accelerate the transition to a diversified, high-income economy. Agriculture and agro-industries perform a key role as a catalyst and promoter of these linkages. Typically, any agricultural product that is enjoyed by the end consumers has a critical value chain associated with it. This value chain, called so because of the value addition the material receives before reaching the consumer, has many linkages. These linkages, both horizontal and vertical play direct and indirect roles in the marketability of the product and its competitiveness.

The horizontal and vertical linkages in the value chain, in their mainstream process, have both positive and negative effects on the environment and the society. While focusing at improving the economy, the balance between the positive and negative effects of the value chain assumes paramount importance.

Developing countries, especially those in the transition from an agro-based economy to a mixed economy are aware of the strategic importance of agro-industry in accelerating economic growth. The resultant effects on agricultural and rural development have also been recognized (see Table1.1). Rural Employment. However, the essentially commercial nature of agro-industry means that governments are likely to play an indirect, rather than a direct role in promoting this kind of development.

This entails creating conducive policies in addition to supportive facilities and incentives to encourage private sector participation and investment in agro-industry. At the same time, most governments want the benefits of this type of development to be spread as wide as possible, and, in particular, have some positive spin-off on the mass of people living in the rural areas.

Table 1.1 Rural Employment Situation in Asia

0 – 6%	12 – 25%	37 – 50%	50 – 80%
Hong Kong, Singapore Japan Australia Fiji Kiribati	Korea Mauritius Malaysia Maldives	Sri Lanka Philippines Pakistan Mongolia Indonesia China	Thailand India Viet Nam Nepal

(Source: World Bank, 2005)

Table 1.2 Value Addition in GDP through Rural Business

1 – 10%	15 – 25%	25 – 40%	40 – 55%
Hong Kong, Singapore Japan Australia Korea Mauritius Malaysia Thailand	Philippines China Fiji Kiribati Indonesia Sri Lanka Viet Nam India	Bangladesh Pakistan Mongolia Bhutan Cambodia	Nepal Lao PDR Afghanistan Myanmar

(Source: World Bank, 2005)

1.3 Policies and Technologies for Sustainable Development

Future resource requirements and environmental stress in Asia is worrying; be it the increasing population or the effects of inadequately framed economic development plans. It is not easy to predict the future magnitude of

environmental problems in the region, but issues of land degradation, habitat destruction, loss of biodiversity, water scarcity, and water and air pollution have already reached crisis-levels in some places.

Unless significant measures are taken to incorporate environmental concerns into agricultural development, urban planning, technological innovation, industrial growth, and resource management, the situation is likely to worsen in the future. Both, technological innovations and the transfer of technical and management skills are vital in alleviating Asia's environmental problems.

Policies facilitate a systems approach in achieving an ecologically, socially and economically sustainable agricultural sector, supporting the government's commitment towards poverty alleviation, food security and economic development and satisfy the needs of the community and businesses are of paramount importance. This would ultimately lead to the creation of a prosperous agricultural sector while protecting the national biological and physical resource base, as well as enhancing human health and well-being.

Though sustainable development is often contextual Weston's (1993) definition fits aptly when looked in tandem with technology needs.

> "*Sustainable development is a process of change in which the direction of investment, the orientation of technology, the allocation of resources, and the development and functioning of institutions meet present needs and aspirations without endangering the capacity of natural systems to absorb the effects of human activities, and without compromising the ability of future generations to meet their own needs and aspirations*".

Thus, sustainable development is a "process" of redirection, reorientation and reallocation --- an evolving one rather than a simple definition. It is a fundamental redesign of technological, economic and sociological processes to address change. Therefore, as McDonough and Braungart (2002) emphasize, the redesign of processes, at all levels, is absolutely essential to the concept of cradle-to-cradle thinking that is inherent to sustainable development.

Sustainable development requires policy changes and coherence, both within and between sectors. It entails balancing the economic, social and environmental objectives of society, integrating them wherever possible through mutually supportive policies and practices, and making essential trade-offs. Policies

cutting across different sectors should be made emphasizing the interwoven nature of human, economic and natural resource considerations.

1.4 Urban - Rural Renaissance

The distinction between "rural" and "urban" is probably inescapable for descriptive purposes; however, it often implies a dichotomy which encompasses both spatial and sectoral dimensions (Tacoli, 1998). Rural and urban populations are usually defined by a certain size of residence in settlements for all practical purposes such as censuses and other similar statistical exercises. Agriculture is assumed to be the principal activity of rural populations whereas industrial production and services is thought for the urban. In reality, the ways in which nations define urban and rural can be far more complex. The boundaries of urban settlements are usually more blurred than portrayed administratively; population movement, temporary and seasonal migration, are not reflected in census figures thus making enumerations of rural and urban populations unreliable. Strikingly, a large number of households in urban areas tend to rely on rural resources, and rural populations are increasingly engaged in nonagricultural activities.

The definition of urban centers boundary is critical and subjective. In Asia, agricultural and non-agricultural activities are spatially integrated in metropolitan extension areas. Therefore, the distinction between rural and urban has become problematic.

1.4.1 Demarcating Boundaries: Urban-Rural Fringes Areas

The urban-rural fringe can be described as the "hinterland between town and country" or alternatively as the transition zone where urban and rural uses mix and often clash. Its definition shifts depending on the global location, but typically are intensively managed to prevent urban sprawl and protect rural areas. An urban fringe is characterized by certain land uses which have either purposely moved away from the urban area, or require much larger tracts of land.

Despite these 'urban' uses the fringe remains largely open with the majority of the land agricultural, woodland or other rural use. However the quality of the countryside around urban areas tends to be low with severance between areas of open land and badly maintained woodlands and hedgerows.

The urban-rural fringe is the boundary zone outside the urban area proper where rural and urban land uses intermix. It is an area of transition from agricultural and other rural land uses to urban use. Located well within the urban sphere of influence the fringe is characterized by a wide variety of land use including dormitory settlements housing middle-income commuters who work in the main urban area. Over time the characteristics of the fringe change from largely rural to largely urban. Suburbanization takes place at the urban boundary of urban-rural fringe.

Problems stem from the competing land uses within this zone and the constant pressure for new development, even in areas that have green belt status or other forms of protection. The issues of land use and prospective change are significant and are increasing in number.

The urban-rural fringe is an area characterized by a mixture of urban and rural features. As a result of the influence of the expanding city, the rural character of the fringe is gradually or sometimes very abruptly replaced by a more urban profile in terms of land use, employment and income, and culture. During this process of rural-urban transformation, pressure on land is rising because of migration from the core city and rural areas and natural population growth. The pressure on land is further aggravated through the use of land for urban purposes, such as construction building, urban residence and garbage disposal. The result of increasing pressure on land in the fringe villages not only changes the land-use character, but also causes a degradation of natural resources in the rural area. Living conditions of the rural communities are affected due to unstructured land-use planning, lack of adequate civil services and inability of the administrative system to handle institutional and factual problems of the changing urban-rural fringe areas.

The urban-rural fringe areas play a key role in feeding the urban area while acting as a playground for the rural economy. In almost all developing nations, rural areas are the centers of cultivation and agricultural production, while the urban is the source of consumption. The conversion of the raw agricultural produce into edible and or marketable products takes place often in the urban rural fringe which has equal access to the raw material and the market, the urban. In this process of adding value to the raw agricultural produce, the fringe areas suffer considerable environmental damages in the form waste disposal and

resource constraints. Figure 1.5 presents a typical example of activities in a typical urban- rural fringe area.

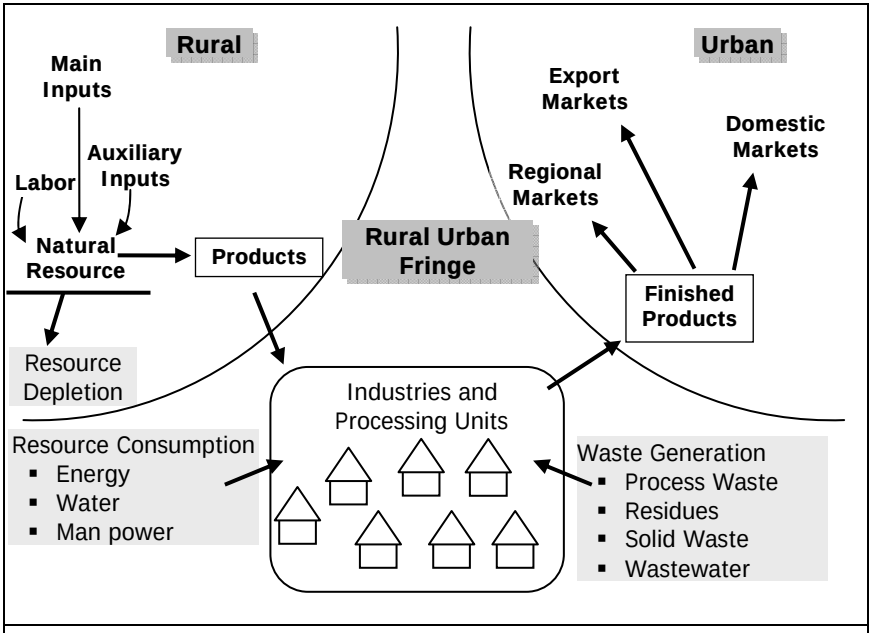


Figure 1.5 Activities in a typical Urban Rural Fringe Area

The neo-classical industrial development and policy process often devotes little space to these urban-rural fringe areas as most of these regions are viewed as black boxes. This lack of attention not withstanding, a wide array environmental measures and industrial development tools may be applied to these areas. This book addresses those measures and two main questions: Do simple eco-restructuring options exist to improve the sustainable development potentials of these areas? How can policies adjust to the increasing importance of multi-functional attributes of bio-based industries located there? It is the goal of this source book to illustrate practical contributions that eco-industrial strategies can make for the sustainable development of these region and formulation of appropriate policy responses.

2 Industrial Clusters and Urban-Rural Fringe Areas

2.0 Industrial Clusters of Asia

Industrial clusters are defined as geographic concentration of companies in a specialized field that cooperate with local community to efficiently share resources leading to improved economic gains and equitable enhancement of environmental quality. Urban-rural fringe areas, in the recent years are home to a multitude of industries with a broad spectrum of products. Most of these industries depend on the immediate vicinity for their resource needs; from labor to raw materials and markets to services. It is common that the industries in the fringe areas have a similar supply chain and fall mostly in the same product range Often, the main driving force for the evolution of these industries is the locally available raw material and labor with different but specific markets. Though regional differences between product chains in the clusters are possible, still the nature and scale of operations tend to be identical. The classification of clusters depends on the national context, often considering the nature of the products, and the linkages within the supply chain. No common and universal method of classification exists for clusters. Table 2.1 presents the differences in the perception of clusters based on their product line.

Table 2.1 Basic Classification of Clusters

Artisan Clusters	Industrial Clusters
▪ Predominance of household based units ▪ Units use personal skills of the artisans for production, rather than electrically driven machinery ▪ Predominantly run by the family labor, both in production and management of the enterprise ▪ Generally produce either handicraft or handloom products	▪ Predominance of small and medium industrial enterprises , with few household enterprises ▪ Uses mechanical and electrical equipments for the mainstream production process ▪ Mostly uses hired labor; decision-making powers often vest with the lead entrepreneur. ▪ Products are for various industrial and commercial purposes

(Source : Adapted from MSME, 2006)

Figure 2.3 presents the various perspectives on the classification of clusters.

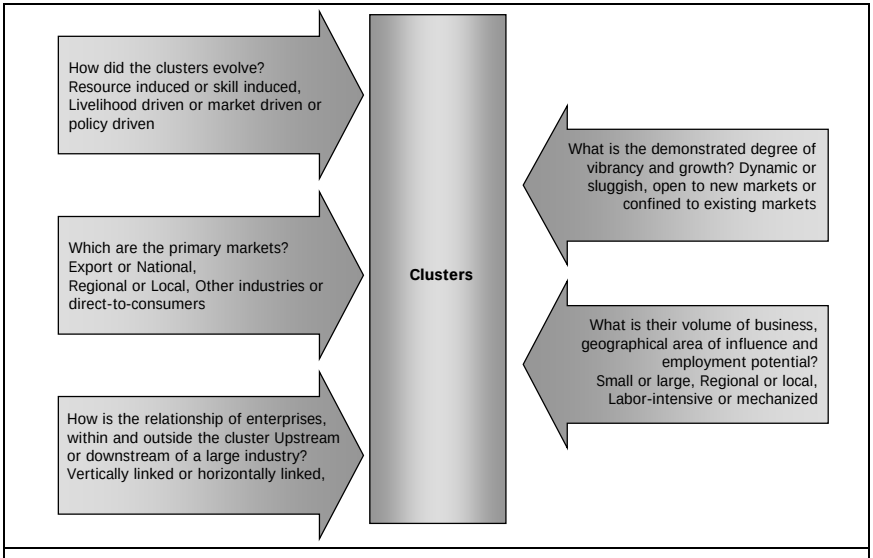


Figure 2.1 Classifying Clusters – Different Perspectives

2.1 Classification of Industrial Clusters

Michael Porter popularized the concept of industrial clusters in his book The Competitive Advantage of Nations (1990). Porter developed the Diamond of Advantage, the four factors that he determined to create a competitive advantage for firms. (Figure 2.2) The four corners of the diamond include factor conditions, demand conditions, industry strategy/rivalry, and related and supporting industries.

Porter used this diamond to determine which firms and industries had competitive advantages, and his emphasis of the importance of related and supporting industries encouraged interest in clusters. While his original thesis was applied to nations as a whole, Porter recognized that the majority of economic activity takes place at the regional level. Porter, in addition, provides a simple definition of two types of clusters: vertical clusters, and horizontal clusters. Vertical clusters are made up of industries that are linked through buyer-seller relationships. Horizontal clusters include industries that might share a common market for the end-products, use a common technology or labor force skills, or require similar natural resources (Porter, 1990).

Porter argues competition is a driving force behind cluster development. Clustering is a dynamic process, and as one competitive firm grows, it generates demand for other related industries. As the cluster develops it becomes a mutually reinforcing system where benefits flow backwards and forwards throughout the industries in the cluster. Porter argues that it is the competition between rival firms in the cluster that drives growth because it forces firms to be innovative and to improve and create new technology.

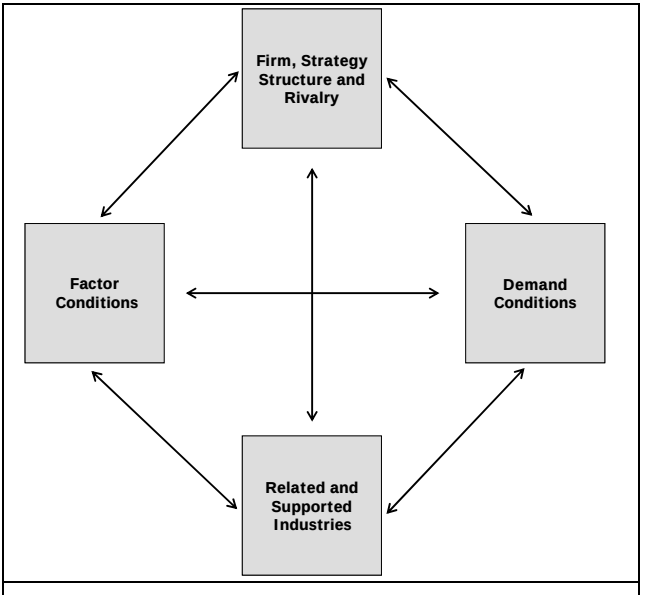


Figure 2.2 Porter's Diamond Model of Advantage in Clusters

This, in turn, leads to new business spin-offs, stimulates Research & Development, and forces the introduction of new skills and services. Because many of the industries within the cluster employ a similar labor force, the labor force can freely move to other related firms within the cluster, thus transferring knowledge to new firms, and continuing to promote competition and therefore growth. This growth can either lead to increasing the vertical integration of the cluster, or it can lead to the horizontal integration of the sector. Increased vertical integration occurs as the division of labor gets more specialized, and new firms are able to fill the new niche markets. Horizontal clustering occurs as the

new technology and labor skills are applied to related industries in different sectors.

Industrial clusters in the urban-rural fringe areas of India, Japan, Thailand and Vietnam are characteristic of the local resources and cannot be classified on a common platform. However, one commonality among the clusters is that they all capitalize on locally available resources as raw materials and have evolved over time.

Clusters of the Asian countries predominantly consist of small and medium scale enterprises and family-run units that evolved over time than by forced by policy or other initiatives. Locally available resources, production techniques inherited from ancestors and through experience from working in similar units, clearly identified markets and need for income to sustain livelihood are characteristics of the clusters in the region. With respect to the management, most of the clusters in the urban-rural fringe areas are either of small and medium enterprises (SMEs) or at family level micro-business entities.

Clusters in the region are equally loaded with horizontal and vertical linkages. Individual units, which thrive either on horizontal or vertical linkages, do exist in the clusters. Depending upon the nature of the products this differs between clusters. Broadly speaking, often the agro-based clusters follow horizontal linkages with a clear supply chain targeting specific markets.

Notably, the clusters in the region have shown a high level of vibrancy with improving fiscal performances in the recent years. Increasing competition among cluster members has forced them to remain open for new markets and innovation. The clusters in the region contain an array of features characteristic to each region and sector with all of them depending on local resources.

India

In a federal setup like India, industrial policies differ between the various states of the country. The prevailing policies and the identified thrust sectors were investigated in tandem with the list of existing industries. Fact File - IN presents a list of Industrial Clusters identified by UNIDO in India. The matrix shows that the sectors are diverse and vary significantly between the states. It is evident that the manufacturing sector has been the focus of almost all states. Availability of markets, resources and skilled labor are the grounds on which other industries

Table 2.2 Industrial Clusters in India

Clusters	Andaman & Nicobar	Chhattisgarh	Delhi	Haryana	Himachal Pradesh	Jammu Kashmir	Madhya Pradesh	Orissa	Punjab	Rajasthan	Uttar Pradesh	Uttranchal	Andhra Pradesh	Karnataka	Kerala	Pondicherry	Tamil Nadu	Arunachal Pradesh	Assam	Bihar	Jharkhand	Manipur	Meghalaya	Mizoram	Nagaland	Tripura	West Bengal	Gujarat	Maharashtra	Goa
Fisheries	✓							✓							✓	✓														✓
Cane/bamboo	✓																								✓					
Coir/coconut	✓																													
Agro/food processing	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓			✓	✓				✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Tourism	✓		✓	✓	✓	✓		✓					✓					✓		✓				✓	✓		✓			✓
Biotechnology		✓						✓	✓			✓	✓	✓							✓				✓	✓				✓
Textiles									✓						✓	✓	✓	✓	✓	✓				✓			✓	✓	✓	
Forestry						✓						✓						✓		✓		✓		✓	✓					
Handlooms handicrafts			✓		✓							✓										✓		✓	✓					
Herbal		✓			✓	✓		✓				✓			✓						✓									
Horticulture					✓	✓					✓						✓						✓		✓	✓			✓	
Sericulture					✓						✓						✓				✓			✓	✓	✓				
Leather										✓				✓	✓	✓											✓			
Sugar									✓		✓			✓																
Plantation fibre																								✓						
Oil																								✓			✓			
Cash crops					✓							✓			✓		✓		✓					✓		✓	✓			
Floriculture												✓													✓					
Aquaculture																									✓		✓			

have been focused. The refined list of clusters with focus on agro/agro based industries is presented in Table 2.2. Evidently, significant potential exists for development as industrial clusters in the agro and agro based sectors. The aim of the UNIDO Cluster Development Programme in India is to contribute to the overall performance and collective efficiency of the small and medium enterprise clusters for sustainable development by assisting selected local communities of firms and associated institutions in the clusters. This entails the implementation of cluster support initiative in selected pilot clusters as well as assistance to central and local institutions in their programmes of cluster modernisation and restructuring. In the pilot clusters, UNIDO strives to act as a catalyst bringing about the necessary qualitative changes at the cluster level.

At the policy level, the primary purpose of UNIDO's intervention is to customise its methodology to the Indian settings so that it can be shared with the partner institutions for replication. In addition to UNIDO, several institutions in India have taken up Cluster Projects besides various government initiatives. The major ones being:

- Small Industries Development Bank of India Technology Up-gradation Program
- State Bank of India UPTECH Program
- National Bank for Agriculture & Rural Development
- Grameen Development Services
- Rajasthan Chamber of Commerce and Industry

Japan

The Ministry of Economy, Trade and Industry (METI) formulated a plan to establish industrial clusters in the local economy owing to changes in the international economic situation. There were two reasons why advanced economies like Japan committed to implement policies for forming industrial clusters: one was agreement of the Plaza accords, while the other was as a response to the relocation of many Japanese factories to China, the so called 'China Shift'. The currency appreciation after 1985 caused manufacturing firms to shift production to developing Asia, and thus ensuing economic deterioration in Japan damaged local economy. The industrial cluster plan, announced in 2001, was aimed to stimulate the business activities of SMEs and promote innovation. The government expects through the implementation of the plan to stimulate

recovery in the local economy. As of now, 24 projects have been executed. The Kanto, Kansai and Chubu regions have executed more than three projects, whereas other areas have executed one or two projects.

Thailand

The Department of Industrial Promotion (DIP), core agency in promoting SME development, considered cluster formation as a mechanism to boost Thailand's SME competition in the world market and initiated the Cluster Development Project. The objective of the project was to build awareness of and participation in cluster development among Thai firms and forge close linkages among companies in clusters that will foster better coordination and trust. The formal linkages in clusters include networks, alliances, and partnerships. The project also aimed at developing mechanisms for sustainable cluster development. The DIP's cluster development project was piloted in three industries. Table 2.3 presents a list of clusters in Thailand. Fact File–TH presents the list of industrial estates in Thailand. A summary of the cluster development initiatives is presented below.

Food clusters in the Central region: The cluster consists of about 120 member units. Food industry is one of the key industries of Thailand as it can enjoy a great advantage based on availability of a resource base in the region. The industry itself has great potential to maintain its competitive success in the global market due to the fertile farmland that produces good quality food products. Besides, the strategic industry offers high profits from value added products. As such, the Government made it a policy to promote this industry with the aim to offer Thailand as the "Kitchen of the World". The cluster development activities during the last two years include gathering of different enterprises on related fields, exchanging their views, setting up a common goal and vision, developing short and long-term strategies, working together on cooperative projects and regional development.

Auto-part cluster located in Bangkok and its vicinity: The large size of the automobile sector with interconnected industries assumes top priority in an attempt to form a cluster. Currently, there are about 100 member units in this cluster. The forming of this cluster is at an infant stage. Initiatives have been undertaken to discuss potential strategic objectives and to prioritize actions. Pilot

Table 2.3 Industrial Clusters in Thailand

Cluster	Northern	Central	Southern	Northeastern
Orange	✓			
Ceramics	✓			
Pineapple Processing	✓	✓	✓	✓
Longan	✓			
Silk	✓			✓
Handicrafts	✓			
Tourism	✓		✓	
Fruit Processing	✓	✓		
Pottery Products	✓			✓
Mulberry paper products	✓			
Pamelo	✓	✓		
Rice Processing	✓	✓		✓
Mango Product		✓		
Sugar Plants		✓		✓
Durian Processing		✓	✓	
Orchid		✓		
Food Processing		✓		
Rambutan Processing		✓	✓	
Chang Island		✓		
Mangosteen		✓	✓	
Organic Asparagus		✓		
Oil Palm			✓	
Parawood			✓	
Seafood			✓	
Coconut			✓	
Fish scale accessories			✓	
Artificial Flowers producers				✓
Paper Pulp				✓
Cotton				✓

Northern Region consists of Chiang Mai, Chiang Rai, Kamphaeng Phet, Lampang, Lamphun, Mae Hong Son, Nakhon Sawan, Nan, Phayao, Phetchabun, Phichit, Phitsanulok, Phrae, Sukhothai, Tak, Uthai Thani and Uttaradit Provinces

Central Region consists of Bangkok, Nakhon Pathom, Nonthaburi, Pathum Thani, Samut Prakan, Samut Sakhon, Ang Thong, Ayutthaya, Chainat, Lopburi, Saraburi, Singburi, Kanchanaburi, Phetchaburi, Prachuap Khiri Khan, Ratchaburi, Samut Songkhram, Suphanburi, Chachoengsao, Chanthaburi, Chonburi, Nakhon Nayok, Rayong, Prachinburi, Sa Kaeo and Trat Provinces

Southern regions consists of Chumphon, Krabi, Nakhon Si Thammarat, Narathiwat, Pattani, Phang Nga, Phatthalung, Phuket, Ranong, Satun, Songkhla, Surat Thani, Trang, Yala

Northeastern region consists of Amnat Charoen, Buriram, Chaiyaphum,Kalasin, Khon Kaen,Loei, Maha Sarakham, Mukdahan,Nakhon Phanom, Nakhon Ratchasima, Nongbua Lamphu, Nong Khai, Roi Et, Sakon Nakhon, Sisaket, Surin, Ubon Ratchathani, Udon Thani and Yasothon Provinces

projects of this cluster will focus on trainings that enhance skills, opportunities, new markets pioneering, and technology upgrading.

Textile cluster in garment industry located in Chaiyaphum: Textile industry in Chaiyaphum province in the northeastern part, mostly relocated from Bangkok and other provinces has been developing on the strength of locally available skilled labors. The cluster consists of 25 member units from textile companies. Textile products of this cluster are divided into two categories, knitwear, mainly exported to foreign countries and garments, distributed through wholesale markets in Bangkok. The pilot cluster formation is timely and in line with the collective efforts made by private agencies to promote textile and garments as a strategic industry in the province.

Vietnam

The country is currently facing tremendous growth in the industrial sector. The Government, along with UNIDO and similar organizations and academic institutes has been playing a proactive role in industrial development in the country. Several initiatives have been taken both at the national and provincial level to improve the performance of the industrial sector. During the industrialization, modernization and urbanization of Vietnam several industrial production areas were developed either as a centralized industrial zone, small and medium industrial clusters, or trade-village industrial clusters.

Centralized Industrial Zones

Areas without habitations have been identified and boundaries clearly defined following relevant polices. These areas are marked as Centralized Industrial Zones and are provided with necessary services supporting the development of industries.

Until May 2005, Vietnam had about 122 Centralized Industrial Zones (IZ) and Exporting Processing Zones (EPZ) with an area of about 25,000 ha and 670,000 laborers. Of these about 69 IZs are operative with 61% of land rented and 628,000 labors. In 2004, the Government issued a Decision on economic and social development in the targeted economic areas until 2010 and oriented them to 2020. This Decision increased the number of provinces targeted for economic development from 20 to 30, and encouraged the expansion of industrial zones.

Small and Medium Industrial Clusters

The Small and Medium Industrial Clusters (SMIC) are industrial zones established in towns and rural areas to assemble similar production enterprises in a suitable way to stimulate development of private economy, small and medium enterprises and rural industries. In addition to infrastructure investment and financial aids for relocation expenses, outside structures and public structures, the workshops and plants could be built and sold for SMEs in the manner of 10-year deferred payment. There is no statistical data available on SMIC for the whole country. Some existing industrial clusters in Southern areas are listed in Fact File - VN.

Trade-Village Industrial Cluster

The third type of industrial development is the Trade-Village Industrial Cluster (TVIC). Trade-Villages are considered as group of residents living in village, having non-agricultural jobs and producing and trading independently. Contrary to the centralized industrial zones, TVICs have smaller production scale and poorer conditions of infrastructure and environmental treatments. The TVICs are different from the IC in that they contain newly established SMEs or those moved out from the city under the relocation policies on polluting enterprises while TVICs are mainly established from household enterprises, and SMEs of the traditional trade-villages in Vietnam. Vietnam has about 2,017 traditional trade villages of which 63% is located in the Northern areas. The distribution of trade villages in Vietnam is presented in Table 2.4

Table 2.4 Trade Villages in Vietnam

Location	Northern	Central	Southern
Textile, worm-silk, leather	139	24	10
Food processing, pharmaceutical products / materials	145	42	21
Waste recycling	64	24	5
Handicrafts	398	121	87
Construction materials, stone exploitation	19	9	3
Others	211	77	42

2.2 Industrial Clusters and Conservation Issues

Small towns and their surrounding rural areas are home for clusters. They remain as part of the same functional system, and as a result numerous types of environmental and economic linkages exist. Industries located in urban fringe area may rely on neighboring areas for renewable inputs, raw materials, labor etc. As a result of these and other related links, the urban-rural fringe areas form an important component of local economy and society. Especially, the Asian countries in a phase of rapid growth have been victims of the phenomenon over the last few decades. Ironically, the environmental cost of living and doing business are increasingly becoming higher when compared to any other region of the world. However, in reality, not much attention has been paid to the environmental impact of high density of economic activities, resulting from the relative concentration of similar/related industries in the same locality. In this context, a western style of eco-restructuring models such as eco-town is essential but may have limited application because of difference in industrial development stages, structure and patterns.

Evidently, the challenge lies in the fact that the environmental impacts of industrial clusters cannot be considered in isolation as they have had a large impact on the socio-economic fabric of local communities and countries. Figure 2.3 presents the major linkages identified by considering the value chain of the industrial activities in urban-rural fringe areas.

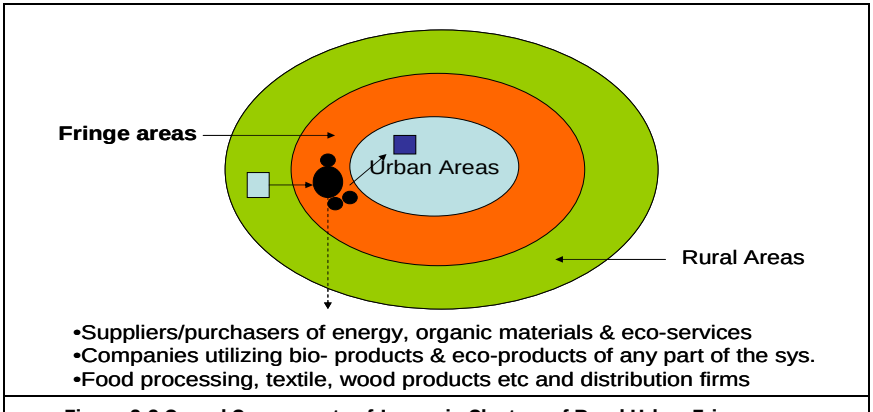


Figure 2.3 Causal Components of Issues in Clusters of Rural Urban Fringe areas

Considering the diverse nature of the sustainability components varying from geographical location to products and governing policies, it is essential that they be first reviewed in isolation to understand their significance.

2.2.1 The Environmental Challenge

Differences in the characteristics of nations and their socio-economic, demographic and industrial development status prevent a single globally accepted definition for urban and rural fringe areas. Countries define urban in their own way often depending upon the specific situation.

Traditionally, the distinction between urban and rural areas within a country is based on the difference in the way of life. By and large, a higher level of living with access to all amenities and services including education, healthcare, modern transportation, business and trade signify an urban area. However, national differences in classifying urban and rural areas exist. Table 2.5 presents the national definitions of urban areas in some Asian Countries. Similarly, though a clear definition of rural is not possible, it is customary that all areas outside the urban are rural, which is also termed as inner areas, country sides or less populated areas.

Table 2.5 Definition of Urban Areas in Different Countries

India ▪ Towns, places with municipal corporation, municipal area committee, town committee, notified area committee or cantonment board ▪ All places having 5,000 or more inhabitants, a density of not less than 1,000 persons per square mile or 390 per square kilometre, pronounced urban characteristics and at least 75% of the adult male population employed in pursuits other than agriculture	**Japan** ▪ City also called Shi having 50,000 or more inhabitants with 60% or more of the houses located in the main built-up areas and 60% or more of the population, including their dependants, engaged in manufacturing, trade or other urban type of business ▪ A Shi having urban facilities and conditions as defined by the prefectural order is considered as urban
Thailand ▪ Municipal areas	**Viet Nam** ▪ Cities, towns and districts with 2 000 or more inhabitants

(Source : UNSD, 2001)

Often, societal and economic development theories and practices are based on the differentiation between rural and urban areas' populations and activities. This is echoed in the separation of policies, both spatial and sectoral, with urban planners focusing on urban and giving little consideration to rural areas. In turn, environmental planners tend to ignore fringe areas and assuming these areas consist only villages and their agricultural land.

In the conflicts of inter-regional development, the landscape locked between the rural and urban, known as urban-rural fringe, serving as a transitional zone is often overlooked. It is this zone where urban and rural uses mix, rather clash. While the rural and urban areas often have specific issues to be addressed, the urban-rural fringe is confronted by a mix of complex issues.

Many of the environmental pressures that urban activities impose on the surrounding area involve either urban demands for rural resources or the use of rural land, water or air to dispose of waste/pollution (Gordon *et al.*, 2004). The consequences of these pressures depend on the physical and institutional circumstances in these rural areas. Some rural lands and waters are more susceptible to particular forms of pollution and some rural resources are more prone to overuse.

Not all of the environmental challenges associated with urbanization are easily categorized in terms of environmental burdens such as pollution, waste or demand driven resource depletion. One of the major concerns ecologists have raised about cities, for example, is that while ecological flows tend to contribute to eco-cycles, urban systems tend to generate linear flows. This linearity can cause problems at the points of origin (e.g. the loss of soil nutrients), at the points of destination (e.g. the accumulation of heavy metals) or both (as in the case of nutrients that end up as sewage). Moreover, many of the most historically significant rural consequences of urban development have involved changes in the qualities (rather than just quantities) demanded by urban markets. The urban markets for meat and grain, for example, have contributed to the rise of rural monocultures. To complicate matters further, because of the way markets operate, falling demand can be just as damaging for some resources as increasing demand can be for others.

The rural-urban fringe area is distinguished by the important role it plays in meeting the sustainable development needs of the inner regions. Importance on

one side, the rural urban fringe is strangled with intertwined environmental and social issues. The issues and concerns in the fringe areas are, in most cases coupled with various factors.

2.2.2 Economic Doctrine

For many years, urban areas have been the centre of economic activities with inputs flew from the rural areas. Raw materials were transported in their native form to the urban where it was processed, refined and supplied to local, regional and national markets. Following the era of globalization and liberalization, many new market avenues opened up and hence the pressure on the businesses increased. Eventually, business operations had to expand in both quality and quantity. Urban areas with their rapidly increasing cost of living and other social and environmental concerns did not allow physical expansion. Hence, businesses had to find an alternative location with ease of access to services and raw materials. Evidently, the fringe areas become a natural choice and ideal location to site new resource dependent businesses.

With more business and industrial activity, the fringe areas started to have a key role in the regional economy. Figure 2.4 presents the possible flows between the rural and urban areas.

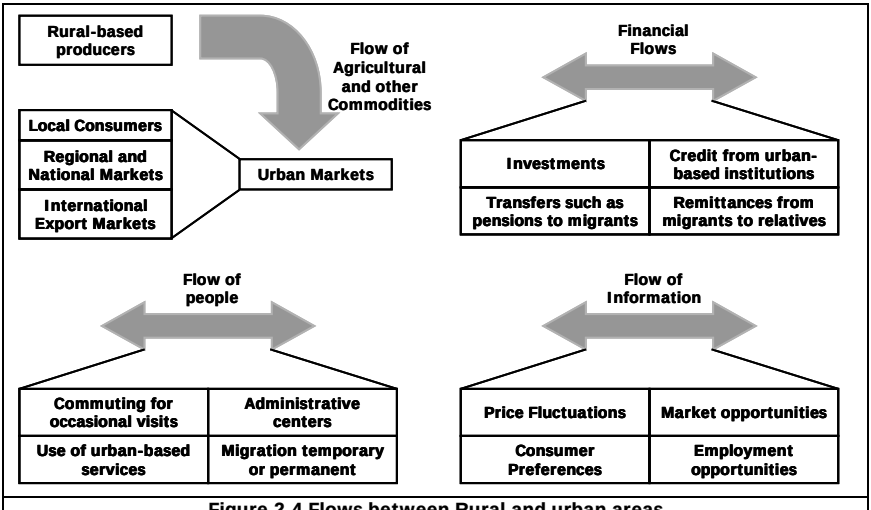


Figure 2.4 Flows between Rural and urban areas
(Source : Adapted from IIED, 2003)

Eventually, fringe areas turned to be the playground for new businesses. As a result, rural populations started migrating to the fringe areas for better employment opportunities and access to services previously enjoyed only by the urban. Fringe areas now are a zone of activities with increasing population and business activities.

Businesses enjoy the benefits of easy access to labor, natural resources, land for industrial activities and, in some cases, large uncontrolled ways of disposing wastes. However, communities reap the benefits through increased employment and markets for their produces from rural areas.

Industries and businesses use raw materials from the rural areas to meet their market demands. In this process, they consume enormous material and human resources thus contributing to economic activities such as purchase of raw materials, agricultural produces, energy, water, and employment.

Income generation opportunities created by way new small business in the fairly large supply chain drive newer economic activities.

Development of infrastructure such as better roads, stable power supply, sanitation and water supply, telecommunication facilities and other amenities such as community health centers lead to the improvement of the overall economy of the region.

Increased industrial activities also lead to an increase in the floating population of the region for various purposes. This in turn favors the creation of new business. Thereby, a cyclical process of economic activities each inducing new businesses occurs in the region.

2.2.3 Environmental Face

The urban-rural fringe is an area of continuous interactions between the humans and the biosphere. With increasing industrial and social activities, the fringe areas are in a situation that they have to supply enormous resources and receive huge wastes. The environmental problems in the urban fringe areas are twofold, with resource regeneration and waste assimilation constraints.

Industries and communities need inestimable resources for their betterment. It is pitiable that the fact natural resources are finite and fast diminishing is infrequently realized in developmental planning. Fringe areas are under tremendous pressure in providing the resource needs.

Apart from providing the resources needed for the local industries, the fringe, in most places is haunted by the waste generated from the urban areas. This adds to the resource threats faced by the fringe areas.

In addition, changes in land use patterns from marginal to industries, settlements, roads and by-passes cause irreversible damage to the environment. Air pollution from increasing vehicular movement and industries, water pollution from industrial processes, water resource depletion due to high consumption at habitations and industries increase the pressure to unsustainable levels. Pressure on land is further aggravated for multifarious urban purposes such as construction of new commercial establishments, residential buildings, and waste disposal facilities. In simple terms, though the rural urban fringe has a significant role in the economy of the region, it is often under huge environmental costs.

2.2.4 Social Dimension

Rural urban fringe areas are the frontier zones of the rapidly changing urban lifestyle and the traditional rural culture. The fringe areas as in the case of their geographical location are caught by social issues characteristic to both the rural and the urban. Social issues in the fringe areas vary from changes in lifestyle to consumption patterns and have both positive and negative effects.

Urban lifestyle is of characterized by a use-and-throw mentality, thus leading to higher resource consumption at the household level. While rural lifestyles predominantly reuse and recycle materials till the ultimate end of life of a product, a shift towards the urban style leads to higher consumption. The effect of the urban sphere of influence is considered to be a major threat to the fringe areas.

On the other hand a positive spin off is the improvement in the basic living conditions, often deprived for the rural, on par with the urban. Improved access to healthcare, education and life support services is considered as a benefit of being in a fringe area.

Occasionally, social conflicts between the rural migrants and urban resettles seeking more calm and clean living conditions do arise in the fringe areas. Such conflicts arise due to the differences in the cultural values of the urban and the rural. Thus, social issues arising from differences in the rural and urban value system often characterize the fringe area.

2.3 Policies on Industrial Clusters and Resource Use

Businesses and communities consume resources and deliver products and services. Such a process of consumption of resource often fuels the economy of businesses and communities. In this process, both communities and businesses generate by-products and wastes. The rate and quantity of waste generation is as important as the resource consumption. While continuous resource consumption is essential to feed and sustain the economy, their rates also need to be controlled. In most cases controlling rates of resource consumption is possible not only by technological changes and modernization. Appropriate policies envisaging resource constraints and advanced technologies are essential.

Sustainable development is all about conserving resources for the future generations while meeting the demands of the present generation. Countries in developing Asia have started recognizing the need for their development to be sustainable and the role of policy in ensuring it.

Present policies on resource consuming cluster businesses are wide and extend over a broad horizon. In most countries, policies concerning clusters are focused on improving their competitiveness and productivity. Clusters are considered under the Small and Medium Enterprises (SMEs) category and policies are formulated considering their capital investment, technology, market and product profiles. Policies governing clusters concentrate on their development, fiscal measures for their promotion and pollution control and prevention. Time and again, resource use is not found to have been straightforwardly addressed in these policies. Whatever be the nature and scale of operation of the cluster, they are compulsorily governed by the industrial and environmental policies of the respective countries and in some cases, where relevant, by the agricultural policies too.

2.3.1 Industrial Policy

The Industrial Policy of any developing country aims at improving the status of the industries that contribute a significantly major share to the National GDP. While promoting the growth of industries, the role of the policy is to provide a conducive environment and political situation, which can facilitate easy access to all resources required. On top of the priorities of an industrial policy is its commitment to provide the required resources at affordable costs. Businesses are

increasingly willing to avail of the natural resources at lower costs and hence tend to locate themselves at places which offer them at attractive terms. This clearly indicates that businesses tend to shift to places with easy access to natural resources. Thus, industrial policies across almost all developing countries attract industries by providing the required resources, natural, physical, infrastructure and human. Box 2.1 presents the snapshots of Vietnams Five Year Socio-Economic Development Plan 2006-2010 for the Mekong Delta. It could be seen that the plan has been formulated keeping in mind the local availability if resource and natural wealth in the region. The impetus provided by this plan results in increased investments on the specified sectors of the Mekong Delta. Interestingly, the Five Year Plan emphasizes the growth of the fishery and agro related sector. Tasks and solutions to develop key sectors, agriculture and industry are also presented.

Box 2.1 The Five Year Socio-Economic Development Plan 2006-2010, Vietnam

Overall goals for the Mekong Delta

- To mobilize the best possible resources to make full use of its strategic location and advantages
- Promote industrialization and modernization in agriculture and rural areas to establish a large-scale and specialized commodity-producing region
- Develop Mekong Delta as a national focal economic zone with high effective and sustainable growth rates
- Improve the socio-cultural conditions to be in line with the national average standards
- Improve the spiritual and material life of local people, especially Khmer people and people in flood-prone areas,
- Socio-economic development is to be closely related to environmental protection, political stabilization, ensured social security and defense.

Tasks and solutions to develop key sectors

Agriculture: Develop an ecological tropical agriculture by diversifying crops based on the strategic advantages of sub-regions, establish intensively cultivated areas with crops of high value, good quality, especially rice, fruit trees and industrial crops. Maintain rice-growing areas of 1.8 million ha out of which 1 million ha is for rice of high value for export. Develop fruit trees and industrial crops to provide raw materials for industry and animal feeds plants. Develop aquaculture, fishery and seafood processing industry as the focal export sectors in Mekong Delta. Preserve and develop coastal mangrove forests, Phu Quoc primitive forest, expand cajuput forests in the wetland and alum-contaminated areas in Dong Thap Muoi, Long Xuyen Tetragon, western side of Hau River and Ca Mau peninsula.

Industry: Exploit gas reserves in Southwestern Sea to develop gas-electricity-fertilizer industry. Effectively develop industrial parks, accelerate the construction of gas-electricity-fertilizer producing complex in Ca Mau. Strongly develop agricultural and fishery product processing industry. Continue to improve productivity and quality of plants for cement, concrete, bricks and tiles, building components. Develop agro-and fishery-machinery engineering industries. Improve the quality and quantity of artistic ceramics production for export.

(Source : MARD, 2006)

2.3.2 Environmental Policy

Any industrial activity across the world, irrespective of the development status of the country, is required to comply with the local legislations pertaining to environmental protection and resource conservation. Box 2.2 presents an overview of the National Environmental Policy of India.

In developing countries, especially where natural resources are at a stake, no relaxation is given to polluting industries. Various laws and rules governing the components of the environment are enacted and periodically reviewed in these countries. However, pollution reduction through command and control measures is the priority in developing nations. More often than not, resource conservation refers to the protection of rivers, water bodies, fertile lands, wet and marshy lands, and places known for high biodiversity. Natural resource conservation, in the context of improving resource efficiency in industries is rarely addressed in these policies.

Box 2.2 National Environmental Policy 2004, India

The National Environmental Policy, 2004 addresses the issues of revamping legislation, substantive reforms in the areas of forest, coast, biotechnology and sensitive zones. It integrates economic principles in environmental decision-making, monitoring and implementation. The Policy focuses on conserving environmental resources: land, forest, wildlife, biodiversity, freshwater, mountain, coast and manmade heritage. Action-oriented plans have been detailed for setting environmental standards, climate change, eco-labeling and certification, environmental management, awareness, education and information.

Actions for pollution abatement relating to air, water, soil and noise have been detailed in the Policy. Clean up of pre-existing toxic and hazardous waste dumps, in particular, in industrial areas, and reclamation of such lands for future, sustainable use is addressed. The policy further aims to distinguish between noise standards and protection measures in the context of occupational exposure and environmental exposure to third parties. Use of revenue enhancing fiscal instruments to promote shifts to clean technologies in both existing and new industrial units has been proposed.

However, approach of the Policy to resource-use efficiency should integrate cleaner production and industrial ecology in a broader system encompassing industrial firms, networks or chains of firms, eco-industrial parks and regional infrastructure to support resource optimization. State owned and private enterprises, government and private infrastructure and consumers all have a role in achieving sustainable development of eco-industrial clusters, which should be addressed.

2.3.3 Development Policy

The priorities and envisaged progress of the agricultural sector of a country is often factored into its agricultural policy. The major source of income in the rural areas of most of the Asian countries is through agriculture. Considering the vast

potential, most countries have specific agricultural policies clearly indicating the activities that are both allowed and prevented. Mainstream agricultural policies, in the recent years, have been very progressive and incorporate innovations leading to improvements in productivity. Although rural development policies more commonly address issues related to cultivation, in some cases references are also made to agro industries and their improvement. Box 2.3 presents an overview of the National Agricultural Policy of India. It could be seen that the policy softly attempts at addressing agro-based industries. However, the instances where such policies insist agricultural and natural resource efficiency are rather uncommon.

Box 2.3 National Agricultural Policy 2000, India

The National Agricultural Policy aims to cater to demand-driven domestic markets and maximize benefits from exports of agricultural products. It seeks to promote sustainable agriculture, food and nutritional security, Broad-based and revitalized research and to manage adequate and timely supply of quality inputs, in addition to integrated pest management.

The policy endeavours to create a favourable economic environment for increasing capital formation and farmer's own investments by removal of distortions in the incentive regime for agriculture, improving the terms of trade with manufacturing industrial sectors and bringing about external and domestic market reforms. Private sector investments in agriculture will also be encouraged more particularly in areas like agricultural research, human resource development, post-harvest management and marketing. Public investment for narrowing regional imbalances, accelerating development of supportive infrastructure for agriculture and rural development particularly rural connectivity will be stepped up. Setting up of agro-processing units in the producing areas to reduce wastage, especially of horticultural produce, increased value addition and creation of off-farm employment in rural areas will be encouraged. The database for the agriculture sector will be strengthened to ensure greater reliability of estimates and forecasting which will help in the process of planning and policymaking.

(Source : Krishnagiri District Profile, 2005)

2.4 Transforming Industries to Industrial Clusters

Traditionally, industries are always looked upon in isolation and not as a part of a broader system. As a result, the efficiency of the industry and the entire system to which it belongs is relatively lesser compared to it being a part of the system. Essentially, linkages between the isolated industry and its broader system need to be established to improve the efficiency. Many such linkages between individual industries and the broader system create a network of material flow thus maximizing resource efficiency of the system.

Apart from improved resource efficiency, linking industries also has several effects. In order to establish linkages, industries need to come forward and work

in a collaborative way, indeed with differentiated but common responsibilities. While working together in a collaborative way industries and businesses can take advantage of their collective bargaining power at different stages; from sourcing of raw materials and labor to marketing of products.

When working in a collaborative way with established linkages that enhance material and resource sharing, opportunities of waste disposal at relatively lesser cost or at times as an income source also exists. Pathways where the waste or leftovers of one industry turn out to be the raw material of another can also be explored. Such an arrangement, known as industrial waste exchange, is common in many countries and has proved to be successful.

Industries, with the objective of increasing their resource efficiency, cutting production costs, reducing waste disposal concerns and improving their public image need to transform into environment friendly industrial clusters. Such industrial clusters, apart from helping the industries in directly improving their financial performance can also help the community in more than one way.

The benefits enjoyed by acting as a cluster are numerous and needs no discussion in this context. In the recent years, most industries, industrial associations, governments, policy-makers and other stakeholders have realized the benefits of being in a cluster and initiate activities in this direction. It is momentous, that businesses, industries and economies in this transition move one step ahead of being in a cluster; the real transformation to an eco-industrial clusters.

2.5 Need to Develop Eco-Industrial Strategies

Clusters, though defined in numerous ways is ultimately utilizing the real power of oneness and being together. Adding inter-firm network to a cluster is the strategic shift to an eco-industrial cluster.

While clusters are characterized by the benefits they can bring to the individual members, eco-industrial clusters are characteristic of their benefits to the community at a whole. An eco-industrial cluster adds adequate importance to the community to which it belongs and includes its development in all critical decisions.

Eco-industrial clusters aim at maximum material and resource efficiency in many ways. Regional development through efficient use of locally available raw materials and waste byproducts is an emphasis of eco-industrial clustering.

Apart from meeting the demands of the industry in innovative ways, eco-industrial cluster strategies also preserve and sustain natural resources through their efficient use. Therefore, the present transformation from industries to industrial clusters warrants the shift towards eco-industrial clusters.

The following pages create a rich picture of eco-industrial initiatives in select economic sectors of different parts of developing Asia. What are their objectives? In what national and regional settings they are emerging? What drives good and bad practices; unexpected and expected outcomes? These are some questions addressed in the following chapters.

3 Eco-Industrial Clusters: Ideas in Action

3.0 Eco-industrial Strategies for Regional Revitalization

Old style manufacturing, embodied in industrial clusters that litter the urban landscape, may soon become dinosaurs of industrial development in Asia. They have to be replace by eco-industrial clusters in urban-rural fringe areas that link manufactures more closely together into an ecosystem for business and environmental excellence. This will also unleash the synergy between the environment and economic development, if the companies expand to larger supplies in rural areas and markets in urban centers. Abandoning the fantasy that each company is an island and integrating them into a network of large ecological system is a smart business that nourishes corporate success and sustainable local development.

Rural fringe areas of Asia primarily depend on bio-resources as the principal means of survival and income generation. Bio-products, now a days, originated from those areas have crossed national borders and target international markets. This has resulted in an unimaginable stress on the natural resources in the rural areas, where agribusinesses are often concentrated. With the ever-increasing market opportunities come the environmental problems, social disparities and inequity in natural wealth and income distribution. Some of the bio-based industries have been observed to cause objectionable pollution to the environment. Social issues caused by some sectors have been serious enough to slow down their market potential. The economic contribution of industrial cluster and their supply linkages in the Asian developing countries is enormous that they cannot be overlooked. Their revival is essential to sustain a stable economy.

Eco-industrial clusters, one of the applications of the principles of industrial ecology aims at grouping industries and makes them realize benefits by the virtue of being together. As an idea and practice still in its infancy, the feasibility of transforming existing industrial clusters into eco-industrial clusters was attempted in four Asian countries; India, Japan, Thailand and Vietnam.

3.1 Sericulture Clusters of India

With a population of about 1.1 billion in 2.9 million km² of land, the Indian subcontinent is divided into 28 states and 7 union territories administratively. The population growth rate is 1.38% with a GDP per capita (PPP) of US $3,300. Interestingly, with the huge population and vast landmass, India is considered as the world's largest democracy. Agriculture, industry and services contribute about 18.6, 27.6 and 53.8% of the GDP, respectively, while labor force is 60, 17 and 23%.

The labor force and contribution to GDP are clear indicators that India is an agrarian country. The rural areas still thrive on agribusinesses while the urban is ruled by the services and manufacturing sector. India has been the hub of investments in the Information and Communication Technology sector in the recent years. Other businesses flourishing in the country are textiles, pharmaceutical, heavy engineering, leather garments, chemicals, steel, transportation equipment, cement, mining, petroleum, etc,.

Among the many export products from the country, silk finds a prominent place in the international market. India is the second-largest exporter of silk next only to China were silk is said to have produced first. However, an active and healthy competition exists between China and India through a broad spectrum of silk products varying both in quality and in design. Today the most popular is mulberry silk, though other wild varieties known as tassar, munga and eri are available in the market. The smooth, lustrous and sensuous fabric has been the passion of many people and is often called the "Queen of Textiles". In India, silk has a special significance and is considered a sacred fabric — a must for family level functions and special occasions.

Unlike most other fabrics made from plant products or chemical synthesis, silk is extracted from the cocoon of Bombyx mori, an insect. The coveted secret of silkworm cultivation began 5000 years ago in China, as old as the heritage of India. Sericulture (the production of raw silk by raising silkworms) spread to Korea and later to Japan and southern Asia.

Although artificial fibers have replaced the use of silk in much of the textile industry, today it is cultivated in many countries such as China, India, Japan, Brazil, Korea, Thailand and Vietnam. India, with a tropical climate and a

conducive weather for silkworm rearing has been the world's second largest silk exporter next only to China. Indian silk exports have contributed to about 13% of the global market.

In India, mulberry plantations alone amount to about 165,000 ha and produce about 120,000 tonnes of cocoon every year. The major regions of mulberry cultivation are Tamil Nadu, Karnataka, and few other places in Northeast India. Silk industries located around Bangalore, Karnataka are well known for their quality and designs, both modern and traditional. Hosur, a developing town near the political border between Tamil Nadu and Karnataka has been home to many sericulturists. Figure 3.1.1 presents a map indicating the location of Bangalore and Hosur in India.

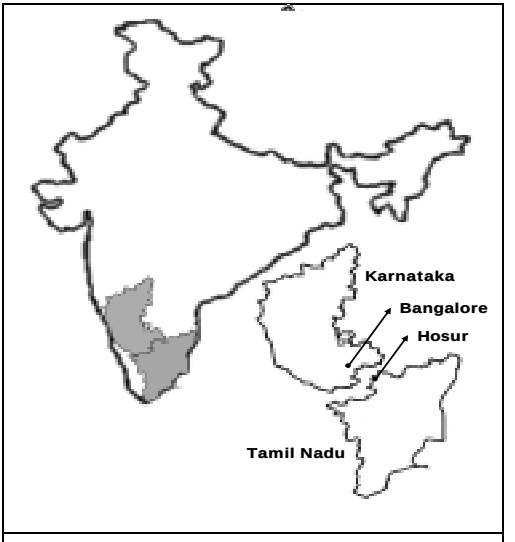


Figure 3.1.1 Location of Bangalore and Hosur

Silkworm rearing, a labor-intensive agro-based industry, has intrinsic relationships with several other sectors of the community. The fringe area caught between Bangalore and the rural areas of Hosur finds an important place in the silk atlas of the country. In the fringe areas of Bangalore urban and rural Hosur, sericulture is a means of livelihood to over 52,000 families. Silkworm rearing and mulberry plantations are done at the household level in many villages in this region. Haunted by environmental and social issues, both, the silk weaving sector and the region are at the crossroads of sustainability. As small and medium enterprises, sericulture units in the region have been operating as geographically co- located clusters. The environmental and social issues prevailing in the sector are common to all the units within the cluster. Therefore, establishing an eco-industrial clusters and moving the units to a higher degree of environmental and social competitiveness becomes vital to eradicate the issues.

3.1.1 Environmental Baseline of the Hosur / Bangalore Fringe

This case study focuses on the sericulture sector in the Hosur / Bangalore fringe area. The fact that the sector and region are invaded by environmental and social issues warrants an assessment of its present condition considering various socio-economic aspects. The following sections describe the current scenario of the region.

Topography and Physical Setting

Hosur a small town in about 1000 km2 is strategically situated in Krishnagiri District, the political boundary between Tamil Nadu and Karnataka. Krishnagiri district is bordered by Karnataka state in the west, Vellore and Tiruvannamalai districts in the East, Andhra Pradesh in the North and Dharmapuri District in the south. The area of the entire district is about 5200 km2. Unlike many other places in Tamil Nadu, Krishnagiri district is elevated at about 300 to 1400 m above Mean Sea Level. Figure 3.1.2 presents the key map of Hosur.

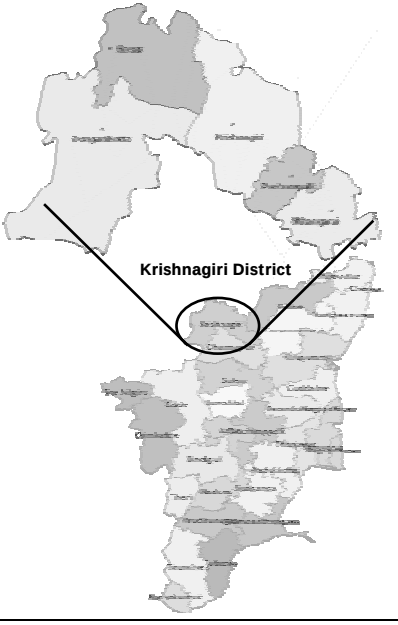


Figure 3.1.2 Key Map of Hosur

Meteorology

The Hosur region in a higher altitude is almost a forest area and has a very cool climate for about nine months in a year. From middle of March to middle of June, when the Southwest Monsoon sets in, the weather becomes markedly warmer. Still, even on the hottest day the temperature rarely crosses 37°C. In the winter, from December - January the minimum temperature is often below 18°C while the maximum seldom exceeds 31°C.The monthly distribution of rainfall shows a pronounced maximum in October with a secondary maximum in September. Usually, rains first start in the form of thundershowers in late April and are followed by heavy falls in May.

Population and Ethnic Groups

Krishnagiri district, by virtue of being in the state borders has diverse groups of communities that have migrated in the past from different parts of the country. Three languages namely Tamil, Telugu and Kannada are predominantly spoken in this district. Major religions are Hindu, Islam and Christianity.

The population of the district is about 1.54 million with a near-equal sex ratio. However, a large difference is seen between the urban and rural population at 254,000 and 1.29 million, respectively. Evidently, the rural population outnumbers the urban clearly indicating the developing nature of the region. Remarkably, the district has an incredibly low population density of about 300 / km^2 as compared to about 24, 000 / km^2 in Chennai, the capital of Tamil Nadu.

Economy

Hosur now thrives on the huge number of manufacturing industries mushrooming in the region. The strategic location of the district at the interstate border, the industrial estates have been able to capitalize on various factors. Easy access to other parts of country, well developed road networks, availability of abundant labor, attractive industrial and fiscal policies and above all excellent infrastructure provided by the government have drawn the attention of various industries. Appendix IN-1 presents detailed information on the industries, the major economic contributors of the region. See Box 3.1.1 SIPCOT Industrial Estate in Hosur – Key of the economy

Box 3.1.1 SIPCOT Industrial Estate in Hosur – Key of the economy

The State Industrial Promotion Corporation of Tamil Nadu, SIPCOT, has developed one of the largest industrial complexes of the country in Hosur. Spread in over 750 ha acres the estate hosts Large, Medium and Small industries with the Small Industries Development Corporation (SIDCO) offering comprehensive services.

The Hosur SIPCOT industrial estate is the fuel of the Krishnagiri district's economy. Goods produced here vary from safety pins to small aircrafts. The credit goes to the good climate, incentives and inspiration provided by the State Government and Central Government. Hosur's proximity to Bangalore, one of the business hubs of the country is its unique selling point. Industries of various kinds such as electrical, electronic, automobile, chemical, iron & steel are flourishing because of favorable business conditions and infrastructure availability.

(Source : Krishnagiri District Profile, 2005)

Vast forest resources such as sandal, teak, rosewood and bamboo are a source of income for the vulnerable communities. Timber from these trees have great

demand for structural works, construction, ship building, paper and pulp, pencil and ply wood industries. Growing nursery for herbs and medicinal plants, extraction of sandal wood oil for perfumery is another source of income. Tribal communities rely on forest products like bamboo rice and honey as food supplements.

Agriculture

The important crops of Krishnagiri District are Paddy, Maize, Ragi, Banana, Sugarcane, Cotton, Tamarind, Coconut, Mango, Groundnut, Vegetables and Flowers. The district has an excellent scope for agribusiness. A Regional Agricultural Research Center under the umbrella of Tamil Nadu Agricultural University has been functioning efficiently since 1973. This center helps the farmers to develop and adopt modern techniques of cultivation. The center has developed hybrid seeds with higher yields and better quality. Figure 3.1.3 presents information on agricultural cultivation in the District

Cool weather for most part of the year owing to high altitude and high fertility of the soil make Krishnagiri District more suitable for horticulture. Commonly observed farming includes medicinal plants, fruits, vegetables, spices, and flowers are grown well by way of its. Figure 3.1.4 presents the horticultural farming in the area.

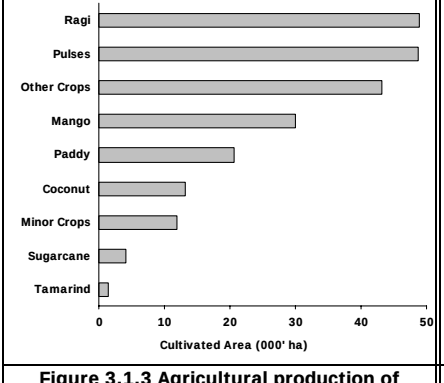


Figure 3.1.3 Agricultural production of Krishnagiri District
(Source : Krishnagiri District Profile, 2005)

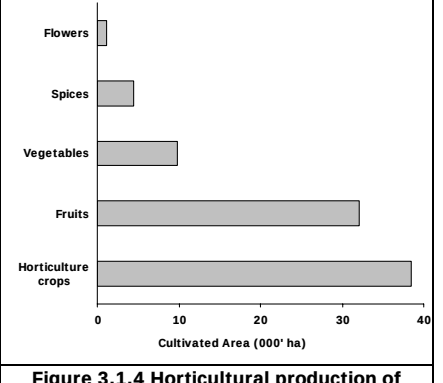


Figure 3.1.4 Horticultural production of Krishnagiri District
(Source : Krishnagiri District Profile, 2005)

Sericulture

Sericulture plays an important role in the economy of Krishnagiri District. The District ranks first in the state in cultivation of mulberry and production of Cocoons. Area under Mulberry during 2000-01 was over 6,500 ha accounting for over 75 % state area under mulberry and cocoon production stood at 36 tonnes valued at little over Rs. 400 Million (US$ 94 Million).

Mulberry is cultivated in almost all parts of the district .See figure3.1.5. Yet, Shoolagiri, Hosur, Pennagaram, Kelamangalam, Veppanapalli and Thally together account for over 75% of the total area under mulberry. Area under mulberry, which stood at 8,700 acres during 1996 - 97 declined to the present level due to lower prices realized for cocoons by the farmers. The farmers had switched over to other crops. The import of Chinese silk had also contributed to lower prices for the domestic product.

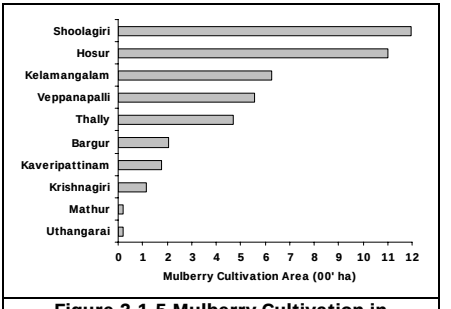


Figure 3.1.5 Mulberry Cultivation in Krishnagiri District
(Source : MoSSI, 2002)

Water sources

The rivers that flow across the district are Kaveri and South Pennar. Kaveri enters the district from southwest, forms a waterfall at Hokenakkal, and flows into Mettur Dam.

South Pennar originates in Nandidurg of Karnataka and flows through Hosur, Krishnagiri and Uthangari. Later, Vanniyar and Markanda rivers join this South Pennar.

The Krishnagiri Reservoir Project, Shoolagiri-Chinnar Reservoir, Thangarai Reservoir, Pambar Reservoir, Kelevarapalli Reservoir and Baarur Tank are the sources of irrigation for the district. All these reservoirs irrigate about 19,000 ha of land.

Solid Waste

The main source of solid waste is from households, markets, commercial establishments, hotels, and restaurants. Wastes from agricultural activities including both plant and organic wastes contribute a small extent to the total waste quantity. Wastes from industries and construction activities contribute the non-biodegradable component. Figure 3.1.6 presents the composition of solid waste in Hosur. Due to the absence of a designed solid waste disposal facility, at present garbage is disposed in a dumpsite of about 1.5 ha in the outskirts of Hosur.

Indiscriminate dumping of medical waste by private hospitals along with municipal wastes and hazardous wastes from industries pose grave health hazards. Recently, the local administration has drafted an action plan to implement a comprehensive solid waste management system in Hosur town. A new compost yard in about four hectares has been proposed.

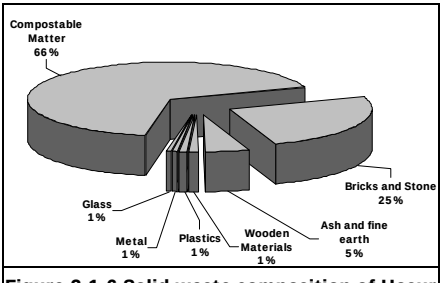


Figure 3.1.6 Solid waste composition of Hosur
(Source : Krishnagiri District Profile, 2005)

3.1.2 Background of the Sericulture Clusters

India continues to be the second largest producer of silk in the world and has the distinction of producing all the four varieties of silk, mulberry, muga, eri and tussar. In 2004-05, production was 16,500 tonnes, of this mulberry accounted for 14,500 tonnes and non-mulberry silk 2,000 tonnes. Sericulture provides gainful occupation to more than five million people in the rural and semi-urban areas in India. Of these, a sizeable number of workers belong to the economically weaker sections of society with substantial involvement of women in this industry.

Though spread over various parts of the country, mulberry silk is produced in large quantities in the Hosur/ Bangalore. Mulberry plantations, silkworm rearing and silk weaving in the region are carried out mostly at the household level, with very few medium scale industries. The remotest parts of the region still contain

many women-headed families surviving on micro level, disorganized silk weaving units thus forming typical clusters.

Considering the income potential from these units, many families run their own silkworm rearing units to make their livelihood. The State government has promoted sericulture as a high employment, agro-based, income-generating industry. Both the State and Central Governments have initiated various programs and policy measures to support these industries. Still, the sericulture sector in this region is disturbed by various social and environmental issues, predominantly by child labor and gender related issues.

The nature and scale of operations of the sericulture sector are so small that any attempt towards alleviating the issues involves the active participation of the entire community. A cluster approach, often applied to small and medium scale industries for improving their competitiveness, is attempted in this sector. Unlike the other sectors where clustering focuses on bringing economic and environmental benefits, here it is expected to create a social capital. Essentially, social capital of a society includes the institutions, the relationship, the attitudes and values that govern interactions among people, industries and contribute to economic development. Thus, creating social capital in the region with sericulture sector as the pivotal axis is believed to alleviate the prevailing issues.

3.1.3 Components of the Eco-Industrial Cluster

The industry comprises many processes - growing mulberry plants, rearing silkworms, producing cocoons, and reeling silk yarn. While the cultivation of mulberry and the rearing of silk worms are agricultural in character, the reeling, twisting and weaving of silk are distinctly industrial in nature. The reeling of cocoons is done in cottage establishments or in larger factories called filatures. See Figure 3.1.7 Principal Components of the Eco-Industrial Cluster.

Mulberry Plantations

The systematic cultivation of mulberry, the food plant of *Bombyx mori*, is the first step in the production of mulberry silk. The total area under cultivation is 1300 ha out of which 1250 ha is irrigated and the remaining is rain-fed. Mulberry is raised as bush plantation in the Hosur/ Bangalore region. Four Indian species of *Morus*, namely *M. Alba, M. Indica, M. Serrata* and *M. Laevigata*, are raised as main food plants for silkworms. The propagation of mulberry in Hosur/ Bangalore region is vegetative.

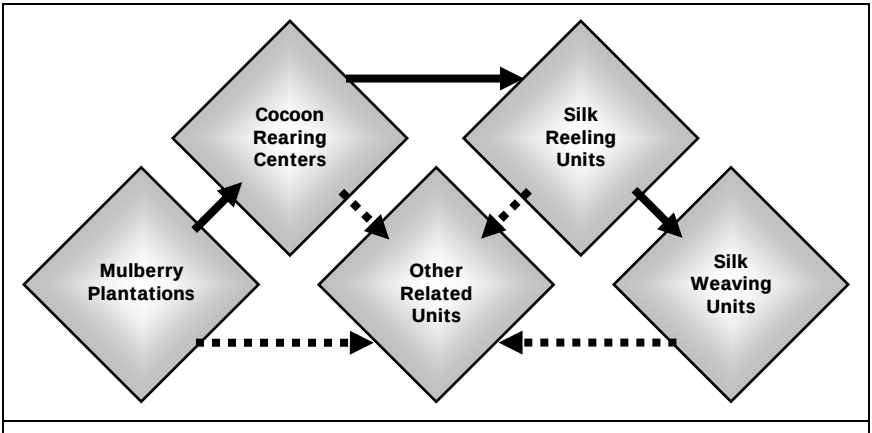


Figure 3.1.7 Principal Components of the Eco-Industrial cluster

Mulberry is a perennial plant and once established in the field, continues to produce in full form for at least 15 years. Though arboreal in nature, it is trained as low bush for commercial exploitation. Mulberry is a hardy plant and can tolerate varied range of agro-climatic conditions. However, the most suitable range of conditions includes a temperature range of 20-30°C with sunshine of 9 to 13 hours per day. On an average, mulberry requires 50 to 60 mm of water once in a week. Under such conditions (prevailing in southern tropics of India), 5-6 crops can be harvested in a year, whereas in temperate conditions, 2-3 crops are harvested.

As mulberry is a deep-rooted plant, the soil for of mulberry garden should be fertile, deep, friable, sandy loam to clayey loam in texture and porous with good water holding capacity. Soils with a pH range of 6.5 to 7.5 are ideal.

The cost of producing mulberry has a direct impact on the cost of producing cocoons, as nearly 60% of the total cost of production of cocoons goes to procurement of mulberry leaves. Experiments conducted in the horticulture divisions of the research institutions to evolve new varieties of mulberry & improved methods of cultivation have shown that over 30,000 kg of quality leaf can be produced per annum at competitive costs against 15,000 kg by adopting the traditional methods under irrigation. Many high-yielding varieties have been introduced which not only double the leaf yield, but also maintain the moistness of the leaves, a factor that is very important under tropical conditions.

Cocoon Rearing

The Hosur/ Bangalore region where the temperature ranges from 16 - 31°C, enjoys favorable climatic conditions for rearing the *Bombyx mori* throughout the year. In a life span of 50 days of *B.mori*, the egg lasts 10 days, the larval stage lasts longest, about 25-30 days. The pupa takes 10 days. The silkworms pass four moults, a natural process where the silkworm sheds its skin, during growth.

The total quantity of leaf required to raise a unit of 40,000 larvae is 500-600 kg using traditional methods. Silkworms consume as much as 95% of the food after the third and fourth moults. At the end of the larval duration, the silkworm emits silk from its mouth & constructs a cocoon on scaffolding.

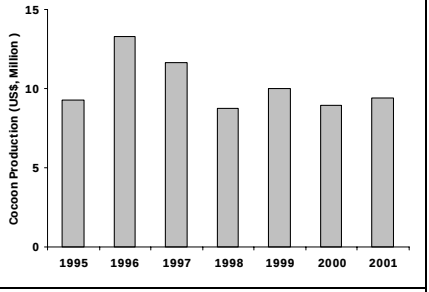


Figure 3.1.8 Cocoon Production in Hosur
(Source : MoSSI, 2002)

Silk Reeling Units

The cocoons are cooked in hot water and the silk fiber is unwound from the cocoons. This process is called reeling. Silk consists of two layers, the inner core of fibroin and an outer cover of gum sericin. During reeling, the cocoons are soaked in hot water at 95-97°C for 10-15 minutes. This process, called cooking, enables the outer portion to soften and make unwinding easy without breaks. The cocoons after cooking are reeled in hot water in different types of machines.

Smaller silk reeling units adopt olden techniques such as a simple country charka, a wooden wheel mounted on a hand-rotated axis, to reel. The silk produced with the country charka is of very poor quality as it holds many stubs, and hence not uniform. Improved cottage-type basins have been introduced recently. Provision of buttonholes and proper crosier systems to maintain the thickness of the fiber controls the neatness thus facilitating the production of better-quality silk.

Large-scale reeling units have basins organized and scientifically arranged in filatures for the extraction of superior quality fiber. Silk produced by the filatures are superior because of the low level of defects due to uniformity in the thickness of the fiber.

Silk produced from multivoltine races of silkworms are poor in quality and are known to have greater defects, such as lousiness, and defects in neatness and cleanliness. Silk produced from bivoltine races of silkworms possess superior neatness and cleanliness, without lousiness and has high tensile strength.

Newer technologies of handling silkworms in the country have shown that bivoltine silkworms (having two breeds in a year), yielding international grade silk can be produced throughout the year in the Hosur/ Bangalore region. It has been shown that, about 30-35 kg of cocoon yielding 3-4 kg of high grade silk can be produced by rearing 40,000 eggs of bivoltines, as compared to 25 kg of multivoltine cocoons (having multiple breeds in a year) producing 1.4 kg of low-quality fiber.

Silk Weaving

The final stage where the reeled fiber is converted into fabric is the silk weaving. Unlike synthetic fabrics using modern power looms, silk is weaved in traditional handlooms by artisans. Silk weaving itself is considered more of an art than a vocation. The intricate designs on the fabric are made with extraordinary care and experience. Silk weaving is mostly done by women at the household level. Silk fiber, in addition to being weaved into fabric is also sold to other parts of the country and the state.

3.1.4 Material Balance and Flow

The sericulture sector has a material flow critically linked to both the environment and the society. Although, the processing from silkworm to silk fiber appears simple, it has to be performed with due care. Silkworm easily is infected by diseases and hence needs adequate measures for its appropriate growth. Like any textile process, silk weaving also leaves behind various materials that are often discarded as waste. The major residues of the silk life cycle are the partially consumed mulberry leaves and the dead cocoons. On the other hand, the sericulture industry is major consumer of resources such as water for mulberry plantations and cooking of cocoons, thermal energy for boiling water. Sericulture, in the present days, also consumes certain chemicals for disinfecting the cocoons and its containers.

Silkworms subsist on mulberry leaves and their remains are reported to contain chlorophyll, the pigment of the leaves believed to have nutritional value. Dried

mulberry leaves and twigs are used as bio-fuel for ovens to generate thermal energy, both for domestic and silk reeling. Waste from the silkworm itself finds application as an organic fertilizer. Figure 3.1.8 presents the material flow in the sector.

Mulberry Plantations

In India, all the parts of the Mulberry plant find many uses. It is essential to sericulture, as the foliage constitutes the sole feed of the mulberry silkworm. Mulberry is a fast-growing tree, but for the convenience of sericulture practices, is maintained as a bush. When mulberry is used for silkworm rearing it is possible to obtain 30 - 35 tonnes / ha of leaf every year. In addition to its designated use as feed for silkworm, mulberry also serves the following purposes:

- Produces large amounts of renewable biomass in the form of branches, shoots, leaves and fruit
- By growing mulberry, a farmer obtains fodder, fuel and fertilizer. Farmers in India feed their livestock with leftover branches and leaves from silkworm rearing. Many farmers feed their animals with surplus foliage but always mix it with straw.
- Use of pruned mulberry branches as fuel
- Leftover twigs are allowed to dry in the garden itself. Residues of rearing are also converted to valuable farm yard manure for mulberry garden by putting them in a pit for four to five months prior to use
- As mulberry is mainly propagated by cuttings in the tropics and sub-tropics, a certain quantity of pruned branches can be used for the preparation of cuttings and the remainder as fuel.

Various parts of the mulberry plant find use in Ayurveda, an Indian style of medication. The diaphoretic and emollient effects of the leaf are used for making a decoction that can be used as a gargle that throat inflammation. The fruits are used to treat sore throat, depression, high fever and are both a coolant and laxative. The root extract has hypoglycaemic properties. The root bark is used as an anthelmintic, purgative and vermifuge. Mulberry root juice is administered to patients with high blood pressure. The leaf tips from young leaves are boiled with tea to control blood pressure. The milky latex is used as a plaster for sores and for the preparation of dermal creams.

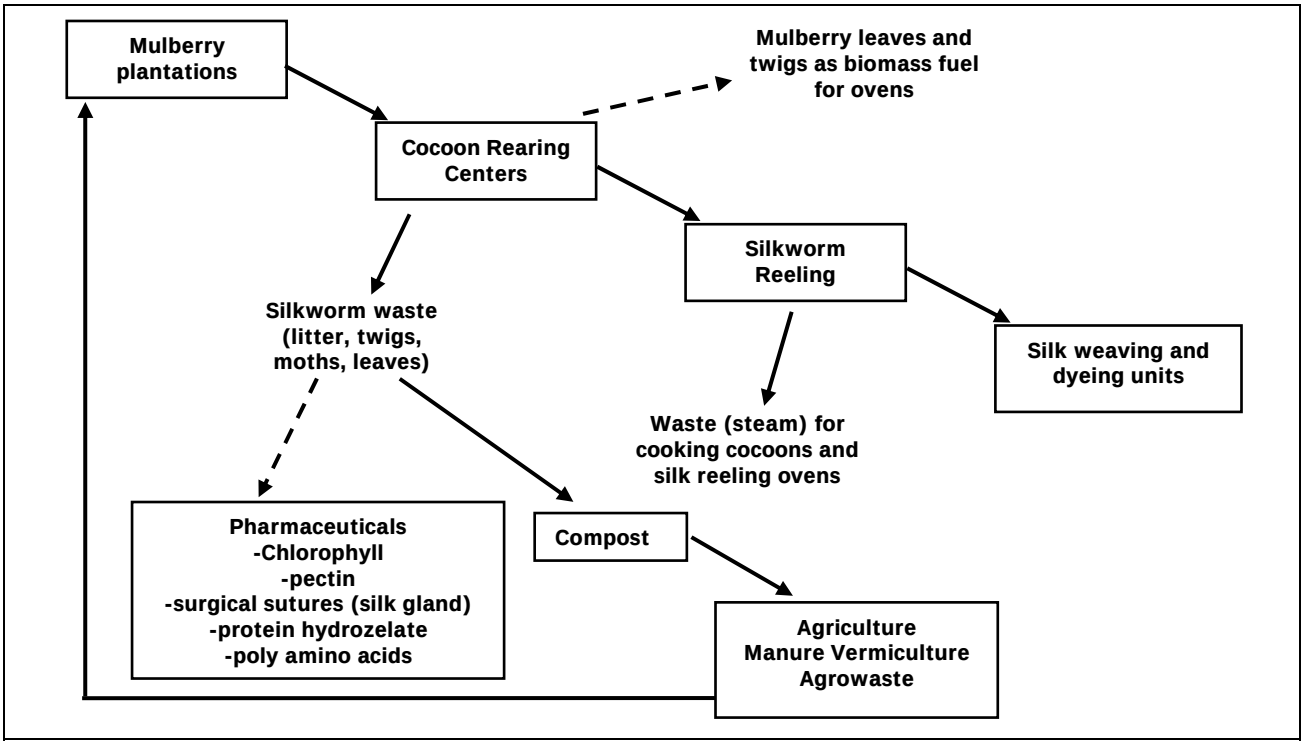


Figure 3.1.9 Material Flow in the Study Area

Cocoon Rearing

The silkworm, *Bombyx mori*, is the chief source for production of fabulous mulberry silk in sericulture industry. Throughout its rearing period, it has to be taken care of and nourished with good quality mulberry leaves. Provision for optimum environmental conditions and protection from pests and diseases are also vital. Depending on the number of generations per year, silkworms are classified into univoltine, bivoltine or multivoltine breeds. Univoltine and bivoltines breeds are specific for temperate areas, while multivoltines are for tropical areas. In tropical areas, where mulberry grows luxuriantly throughout the year, 5-6 rearings are conducted in a year while in temperate/ sub-tropical areas it is common to raise one/ two crops.

From hatching to its full-grown stage, the silk worms pass through five molts and the worms up to stage three are called young age worms or Chawki. As they are susceptible to infections and vulnerable to adverse weather conditions, special care is required for rearing of chawkis.

Mulberry silkworm rearing, being completely domesticated, demands specified environmental conditions like temperature (24-28°C) and relative humidity (70-85%). It is therefore necessary to evolve measures for economic cooling through selection of proper material for wall and roof fabrication, orientation of building, construction method, design, etc. Further, enough space must be available to carry out leaf preservation, chawki rearing, late age rearing and molting. It should also be convenient enough to conduct effective cleaning and disinfection.

The size of the rearing house depends upon the quantum and type of rearing. The different types of rearing are shelf or stand rearing, platform rearing and floor rearing. Shelf rearing requires minimum space and is most common in India. A floor area of 14 m^2 can provide rearing space for 100 cross breed disease-free-laying or 75 bivoltine disease-free-laying.

In platform rearing, the larvae are shifted to shoot rearing platforms after 3rd molt. Ideal size of each platform is 1.5 x 7 m accommodating 50 disease-free-laying up to spinning. Platforms can be arranged in two / three tiers with a gap of 0.6 - 0.9 m. A floor area of 23 – 27 m^2 is required to rear 100 disease-free-laying of cross breed or 75 disease-free-laying of bivoltine.

Silk Reeling Units

The function of a reeling unit is to procure cocoon from the growers, stock and reel them and to sell the ultimate products –the raw silk fiber. A cocoon is a continuous filament of silk, two or three kilometers in length, out of which almost half of it can be reeled. Reeling is a process of unwinding the cocoon.

Standard porcelain eyes and crosier rollers are provided with the machine. Steam is used to heat the water for reeling and cooking. Thermal energy consumption for boiling water to cook the cocoons is very high. Often locally available materials such as mulberry plant trimmings, sticks and firewood are used in stoves to generate the required heat. Studies indicate that the efficiency of these systems is very low resulting in higher fuel consumption and more pollution.

Significant potential exists in the modernization of the processes in these units by improving the efficiency of the boilers, stoves, etc.

3.1.5 Technology Needs for EIC formation

The Hosur / Bangalore Fringe region has enormous potentials to be tapped in becoming the silk hub of the country. However, introducing the right technology in the right context at the right time is of prime importance in enhancing the competitiveness of the sericulture industry. An analysis of the various components of the sericulture value chain clarifies their role in the making of silk. The inputs and leftovers are biological in nature and are often pollution-free. Water consumption in mulberry plantation and for steam generation in cocoon cooking, firewood for heat generation, etc indicate the resource dependence of the sericulture sector.

It is worthwhile to note that the technology used in the industry is primitive and in some, rare cases intermediate. Sericulture and silk reeling, being delicate activities are often carried out manually. The sericulture sector is lined foremost by woman and child laborers, indeed with its distinctive social issues.

Transfer or introduction of newer technologies can result in many benefits, both social and environmental. Some of the technological interventions for this sector that are supposed to bring in additional income or increase competitiveness are presented in the following sections.

Biogas generation from mulberry and cocoon waste

Sericulture waste is highly organic with plant and silkworm remains and excreta. As in the case of any organic substance, sericulture waste can also be appropriately treated to generated biogas. However, a minimum quantity of waste to ensure a constant supply of feedstock for the reactor is essential. Considering the vast number of small and micro sericulture based industries, it is possible to collect their wastes using a cluster approach. This helps in reducing production costs by securing value to the waste and by generating clean energy from indigenous sources. Box 3.1.2 presents a lab test done biogas generation from sericulture waste.

Box 3.1.2 Alternative Resource for Biogas generation - Sericulture Waste

Biogas program in India has relied essentially on the use of cattle dung as the feedstock. However, the dependence on cattle dung alone poses two problems from the point of view of equitable development. The cattle dung in the villages is an inadequate source and is accessible only to the richer segments of rural society in developing countries. Dung is also a limited resource, and the total collection of dung is not practical. It is therefore clear that if a biogas program is to have a widespread impact on all sectors of society, there is a need to explore other sources of feedstock that are easily and freely accessible for biogas production.

Locally available materials such as leaves of *Populus deltoides*, which are shed profusely in autumn; *Eupatorium adenophorum* weed, which is found growing luxuriantly; and sericulture waste, a vast source of waste in the silk industry—have been utilized for biogas production.

On characterization, sericulture waste has shown about 16.5 % of moisture, 83.5 % Total Solids, 71.8 % Volatile Solids, and 14.35 % Fixed carbon and a calorific value of 17.97 MJ/kg. With a carbon content of 39.38 % and Nitrogen of 2.75 % the C/N ratio is about 14. 51.

Tests conducted on these substrates, both independently and in combination, have shown that sericulture waste alone was able to produce 250 L of biogas / kg of TS. When mixed with other wastes, the yield significantly improved to as high as 450 L / kg of TS.

Depending upon field conditions, various options of biogas generation, from sericulture waste can be tried.

(Source : Patrabansh and Madan, 1999)

Biomass gasification technology for thermal applications

The sericulture sector is much disorganized with little or no efforts to promote the productivity. Thermal energy to heat water for cooking of cocoons is a major process in the silk lifecycle. In the present scenario, the industries use uncontrolled combustion techniques, such as open stoves and flares with firewood to generate heat. The quantity of fuel consumed is enormous to the extent that it amounts to a significant portion of the productions costs. In

addition, uncontrolled combustion is mostly partial with lot of smoke and soot particles emission. This also leads to health hazards of the laborers.

An alternative to this is existing practice is a biomass gasification system which ensures controlled combustion of the fuel. Unlike the present system, a biomass gasifier allows control over the operating parameters and fuel consumption. Heat losses are also minimized in a gasifier-based system. Box 3.1.3 presents information on biomass systems for sericulture industry in India.

Box 3.1.3 Cottage Basin Ovens to Biomass Gasifier – Improving Energy Efficiency

The annual fuel consumption of cottage basin ovens in the sericulture industry is estimated at 120,000 tons of fuel wood, while charkhas consume 105,000 tons of locally available biomass, such as groundnut shells, tamarind and rice husks and coffee beans. However, the consumption of these fuels by the silk industry is only 11 to 15 % efficient. To tackle the problem of inefficient energy consumption, the New Delhi based Tata Energy Research Institute (TERI) considered a two-way strategy that involved: (a) retrofitting existing ovens to improve their efficiency, and (b) introducing gasification technology. Efforts focused on developing gasifier-based cottage basins that could be commercialized.

The main drawbacks of the traditional ovens are that they do not allow fuel consumption to be controlled and that large fluctuations occur in such process parameters as water level and temperature. There was plenty of scope, therefore, for improving the efficiency and design of the ovens. As a first step, existing ovens were retrofitted to control their burning rates, maximize their flue gas heat recovery and reduce other losses.

Retrofitted ovens allowed modest energy savings of about 25 %, but this was not enough to encourage silk reelers to face the inconvenience and expense of retrofitting their ovens. To be economically viable, the project had to come up with an alternative design that was capable of meeting the energy needs of silk-reeling units while generating substantial fuel savings.

A downdraft, throat-less gasifier was selected because less tar and particulate matter are produced in its raw producer gas, it allows the use of relatively large wood chips, and other fuels compared with updraft and cross-draft gasifier. A water seal tank was placed under the gasifier to collect ash and cinders.

An economic assessment showed that the new technology had a payback period of less than a year in terms of reduced fuel consumption and increased productivity and profitability. In fact, the new ovens allow fuel savings of 70 % or more, representing nearly Rs. 300,000 (US$ 6,600) a year.

With the gasifier ovens, fuel consumption declined by 57 %, water consumption by 28% and renditta (the number of kilograms of cocoons required to produce one kilogram of silk) fell by 3 %. Quality improvements included fewer breaks during winding and a cleaner, neater, stronger product.

(Source : TERI, 2002)

Silkworm rearing

The bivoltine breed of the silkworm is the most common in the sericulture clusters of Hosur / Bangalore Fringe. However, in some places, the multivoltine

breed is still used. Better breeds with high quality yield needs to be introduced to diversify the product range and improve the competitiveness.

Social Interventions

The sericulture industry in the Hosur / Bangalore Fringe region, in addition to technological backwardness, is also threatened by social issues. The sericulture business by itself is labor intensive and unlike many other sectors, the scope for modernization is very little.

The foremost social issues of the sericulture industry are due to child labor, bonded child labor and gender related issues. Unrelentingly, the both child labor and bonded child labor are the most alarming issues of the sector. Not to mention, a number of studies that have been performed on child labor in the sector. However, the issues still prevail.

3.1.6 Policy Implications for EICs

The sericulture sector in the Hosur / Bangalore Fringe region consists mainly of the community and little of other external services. Governmental agencies and policies play an important role in the sector. The very nature of the industrial setup with community interaction to a larger degree makes the implementation of any new activity tougher unless the benefits are directly visible. In cases where the benefits cannot be visualized by the community, it has to be implemented through policies and incentive based mechanisms. The following sections present the key policies governing the sericulture sector.

National Textile Policy

The National Textile Policy is the umbrella policy of the sericulture sector. The policy focuses on achieving international standard in all varieties of silk by:

- Improving Research & Development and the effective transfer of technology at all stages
- Considerably improving the production of non-mulberry varieties of silk
- Augmenting efforts for the spread of bivoltine sericulture
- Encouraging clustering of activities of reeling and weaving and strengthen linkages between the producers and industry
- Periodically reviewing the import policy for raw-silk taking into account the balanced interests of the sericulturists as well as the export manufacturers

Policy of Department of Sericulture

Important activities of Sericulture Department are as follows:

- Motivating the farmers to plant high yielding mulberry varieties;
- Assisting the farmers to get required quantity of saplings in time;
- Imparting training to farmers to adopt improved technologies developed in mulberry cultivation and silkworm rearing;
- Providing assistance for the construction of separate rearing house and procurement of improved rearing equipments;
- Ensuring timely supply of good quality disease free layings to the farmers;
- Ensuring distribution of quality disinfectants to the farmers for successful harvest of cocoon crops without any disease attack in silkworm rearing;
- Providing assistance for the establishment of private chawkie rearing centres to enable to distribute healthy chawkie silk worms to the farmers;
- Providing assistance to the farmers to install drip irrigation system in their mulberry garden; and
- Providing marketing facilities for the sale of cocoons produced by the farmers

MSME Policy

Micro, Small and Medium Enterprises Act was passed on 16 July 2006 and is currently in force. The Act provides the definition for Micro, Small and Medium Enterprises and provides clarity on the support it offers for their development.

In the case of enterprises, engaged in the manufacture, or production of goods pertaining to any other industry as:

- a micro enterprise, where the investment in plant and machinery does not Rs. 2.5 million (US$, 55,000)
- a small enterprise, where the investment in plant and machinery is more than Rs. 2.5 million (US$, 55,000) but does not exceed Rs. 50 million (US$ 1.1 million)
- a medium enterprise where the investment in plant and machinery is more than 50 million (US$ 1.1 million) but does not exceed Rs. 100 million (US $ 2.2 million)

Similarly, the act also clarifies the definitions for businesses involved in the services sector as

- a micro enterprise, where the investment in equipment does not Rs. 1 million (US$, 22,000)
- a small enterprise, where the investment in equipment is more than Rs. 1 million (US$, 22,000) but does not exceed Rs. 20 million (US$ 440,000)
- a medium enterprise where the investment in equipment is more than Rs. 20 million (US$ 440,000) but does not exceed Rs. 50 million (US $ 2.2 million)

The Central Government intends to facilitate the promotion and development and enhancing the competitiveness of micro, small and medium enterprises, particularly of the micro and small enterprises.

Development of skill in the employees, management and entrepreneurs, provisioning for technological up-gradation, providing marketing assistance or infrastructure facilities and cluster development of enterprises with a view to strengthen backward and forward linkages, are the strategies the Government intends to follow in achieving the goals.

Central Silk Board Act

The Central Silk Board Act governs the sericulture industry at the micro level and is instrumental for the implementation of technological and policy decisions. Figure 3.1. presents the various institutions under the Central Silk Board. The Acts aims at

- Undertaking, assisting or encouraging scientific, technological and economic research;
- Devising means for improved methods of mulberry cultivation, rearing, developing and distributing healthy silkworm seeds, reeling, spinning of silkworm cocoons, improving the quality and production of raw silk,
- Improving the marketing of raw silk;
- If necessary, by making it compulsory for all raw silk to be marketed only after the same has been tested and graded in properly equipped raw silk conditioning houses;

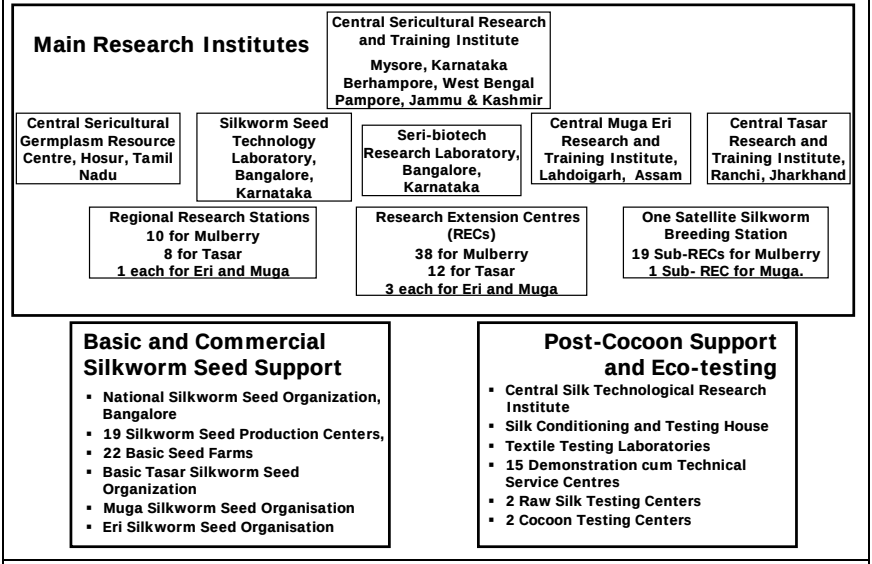


Figure 3.1.10 Government Agencies for Sericulture Business

International Interventions

Silk, the ultimate product from sericulture often targets international markets and has attracted them. In the recent decades, efforts by various international agencies have helped the sericulture industry move forward. Of the various efforts taken, the Japanese International Co-operation Agency (JICA) assisted bivoltine sericulture project assumes more importance in terms of its contribution to the sector. The JICA project was launched jointly by the Central Silk Board, JICA and the Karnataka, Andhra Pradesh and Tamil Nadu Governments.

The project aims at strengthening extension systems for bivoltine sericulture and developing an effective extension system for promotion of bivoltine sericulture in the three southern States. JICA provided financial assistance to the tune of Rs 230 million (US$ 5 million).

JICA deputed sericulture experts from Japan and trained the Indian counterparts in Japan apart from supplying necessary equipments for the project. The CSB provided laboratory facilities and organised training for the field staff, farmers and reelers.

Box 3.1.4 Going Global to become SMEs of the future

According to the chairman of Federation of Indian Chamber of Commerce and Industries, - Tamil Nadu State Council, SMEs operating in clusters should avail themselves of the advantages of collective bargaining, which is key to succeeding on the international stage. The need for governments to facilitate credit access and technology transfers for SMEs and accord them some protection until they can face global competition was stressed.

The paradigm shift towards export and growth of SMEs, not just from small to medium, but also from national to international was emphasized.

Indian SMEs were also encouraged to leverage the advantages of collective efficiency and flexibility by partnering with their counterparts in other countries. The Consul General of Japan Yoshiaki Kodaki clarified that the strong SME sector in Japan is increasingly looking to invest in India and shift some of their manufacturing bases here. India has gradually become popular among Japanese companies as their destination for FDI. According to a survey, India was listed as the second most desirable destination of FDI, only after China.

Considering the Tamil Nadu government's efforts to attract Japanese SME investment, three Japanese trade delegations had shown their interest in investing in the state. Osaka Prefecture Economic Mission consisting of SMEs, Japan External Trade Organisation and the Japan Machinery Association are some of the agencies that have showed interest.

(Source : The Hindu, 2007)

3.1.7 SWOP Analysis

The study on sericulture in the Hosur / Bangalore Fringe region has stimulated thoughts on various aspects, from resource dependence to resource efficiency to social issues and all connected aspects.

Clearly, the sericulture sector is in a phase of growth well accelerated by the efforts of all its stakeholders. Environmental and social issues concerning the sector also scale-up as the sector grows. The sericulture sector though facing various issues has significant potential which needs to be rightly tapped so that they become internationally competitive and contribute appreciably to the economy. Equally loaded with positive and negative aspects the issues prevailing in the sector can be alleviated by appropriate policy and technological interventions. Table 3.1.1 presents a summary of the Strength, Weakness, Opportunities and Potentials of the sericulture sector.

Table 3.1.1 Sericulture eco-industrial clusters – SWOP Analysis

	Strength	Weakness	Opportunities	Potentials
Present industrial clusters	• Proximity to the National Highways and arterial roads • Access to services from Bangalore City • Conducive policies from all stake-holding departments • Support from society • Family labour available • Foreign investment capital • Co-operation with other institutions in country • Program training to develop employee skills • Complete of machine processing and high capacity	• Low farmer education / awareness / knowledge • Primitive technology • Cash crunch faced by almost all industries. • Unexploited collective bargaining power • Social issues – Child Labor, Bonded labor, gender related issues, • Low expertise in marketing • Inappropriate use of wastes and resources	• Conservative and hence judicial use of resources • Self sufficient and self-dependent rural economies • Can have better quality of cocoon / eggs • Ensure equitable growth and distribution of wealth • Establish rights of children • Regain women rights	• Increased number of industries / businesses • Mulberry improvement • Silkworm care • Become a model for sericulture business in the country • Utilize locally available technology and material to generate heat using biomass gasifier • Generate biogas from sericulture wastes
Ideal eco-industrial clusters	• Handmade silk products • Improvement of employee skills by community training • Better sericulture activities with a farming example • Decreased production cost • Quality product and service within industries • Expanded market compartment	• More industries in cluster may exert increased pressure for raw material requirements • Increased farmer / people awareness – insight into gains • Expansion of urban 'tentacles' into rural • Improved quality of industry through broad-based and revitalized research – need for more expansion	• Creation of more businesses • Attraction of new investments • Prevention of population migration to urban areas • Socialization of silk and its products • Expand both vertically and horizontally • Increase number of industries • Diversify product range • Involve silk weaving at the cluster level	• Increased silk production and quality to take on competition in the WTO regime • Add fillip to handloom sector of India • Sericulture-based agro-forestry • Agro waste as manure for agriculture • Biogas from organic waste • Become a model agro eco-industrial cluster across the world

The material flow pattern in the sector creates interest in that it is biological in nature, unlike many textile units.

The sericulture sector faces more of social issues such as child labor and gender related issues.

All or most of the initiatives in the revival of the sector have focused only on the nucleus – silkworm rearing and its varieties, mulberry plantation and its care, silk weaving and its marketing. Very little efforts, with real results have been taken in addressing the social concerns.

It is evident from an analysis of the related policies that the focus is on the economic component of the sericulture sector than the environmental and social components. Clearly, it is not a healthy sign of ensuring sustainability of the sector.

Governmental efforts through the Central Silk Board and other international efforts also have been interested on the development of silk varieties and improving competitiveness. Improving the social values has not been taken care of adequately.

The need for the creation of social capital reflecting the values, attitudes and relationships of the people and the institutions that govern them is essential to attain and sustain the real growth of the sector.

3.1.8 Lessons Learned

The sericulture sector is the lifeline of many families in the Hosur / Bangalore Fringe region. Small and medium scale sericulture based industries in the region have been contributing to the national economy. In this process, of survival and growth, many hurdles need to be crossed. Some are crossed upon jumping over and some by relenting to them. Both these have their own results on the overall growth. Proactive policies adequately envisaging the constraints of the sector are the need of the hour. Present policies and initiatives focus only on the core business of the sector. Integration of social issues and concerns into existing policies is vital and need of the hour to alleviate further problems and ensure sustainability.

3.2 Wood Industry Clusters of Japan

Wood industry is one of Japan's oldest economic sectors. Until the early 20th century, this sector, including agriculture and fisheries, accounted for more than 50% of employment and national wealth. Today, the nation's forest resources are abundant and well developed to sustain a large lumber industry that mostly serves the domestic market. Of the 245,000 km² of total forest area in Japan, 198,000 km² is classified as active forests, about a two third of which were owned by private enterprises. Nearly 33.5 million m³ of round wood is produced annually by those dispersed enterprises in rural areas, of which 98 % was destined for industrial uses in urban areas (MAFF, 2006).

Japan's economic boom that began in the 1950s has had great implications on the wood industry and affected the socio-economic fabric of households in mountainous areas. During the course of four decades, three types of households emerged in the rural-urban fringe areas: those engaging exclusively in wood industry or forestry activities, those deriving more than half their income from the wood industry, and those mainly engaged in jobs other than wood industry (71.3 % up from 41.8 % in 1965). As more and more labor force turned to non-wood activities, outward migration occurred. Local governments and wood industries were determined to arrest these phenomena and were provided with generous governmental assistance under which high prices were guaranteed for wood products and industries were encouraged to increase the output and employ local population. In Japan, one out of six wood industry workers is female. Women are playing important roles as operators of high-performance forestry machinery, as well as in local wood industries as specialty products processors. It becomes important for policy makers to develop conditions in which wood industries can reinvigorate local communities. An encouraging sign is that the Forestry New-Employment Training Project started in 2003, added about 5,300 new workers in three years.

According to the Annual Report of the Forestry Agency (MAFF, 2007), the total output of the nation's forestry in 2005 was worth 41.68 billion yen. The self-sufficiency ratio, which was around 90 % in 1955, came down gradually, but it recently climbed back to 20 % in 2005. The latest rise in the ratio has been caused by various factors. A lower yen value and increased shipping costs due to rising oil prices have pushed up import prices. The overseas supply has also become

tight because of construction booms in China and tightened supply from Southeast Asia. This is being used as a chance to increase domestic wood production. Due to the development of advanced processing technologies that can also process smaller logs and through utilizing logs with lower prices, the use of domestic coniferous wood for plywood production increased by 60% in 2004, compared to the previous year. The rate of wooden houses to all independent houses was 82 %, showing strong orientation to wooden houses in Japan. Recently, public facilities, including schools and post offices, are increasingly constructed with wood. Further, wood use in public civil engineering projects, including road construction and forest conservation, is also on the rise. In 2006, the volume of thinned wood used in these projects reached 310,000 m^3, nearly 1.7 times of the volume two years before. Many studies predict this trend will accelerate in future (Kuchiki and Tsuji, 2005). The central and local governments and wood industries need to cooperate to keep the momentum.

As the demand and supply mechanisms of wood industry accelerate, the socio-economic fabric of the communities in the urban-rural fringe areas witness dynamic changes and challenges, the industry faced severe problems of waste management. In the year 2003, the total biomass waste generated by wood industries totaled 15 million tons (Table 3.2.1), less than 50% of them is recycled or reused for meaningful purposes, posing great concerns for both the business and government.

Table 3.2.1 Biomass Waste Utilization in Japan

Type of Biomass Waste	Quantity (million tons/yr)	Current Status of Utilization
Live stock waste	91	80% used as fertilizer
Food waste	22	less than 10% used as fertilizer
Sewage sludge	76	About 100% used as energy source
Residue at lumber mills	6	90% used as energy or fertilizer
Construction derived wood residues	5	40% used as paper, carboard etc
Forestry residues	4	-

(Source: MAFF, 2007)

The forestry cycle now is such that s species like the one Japanese cedar planted immediately after World War II are in a stage ready for felling, adding additional challenge to policymakers and business. Many efforts were made in different parts of Japan to convert this wood waste into local wealth, by extending the

value chain from rural to urban fringe areas, by making the markets work for them. Once such local effort carried out in a wood industrial cluster in the urban-rural fringe of Maniwa is described in the following sections and analyzed for its strengths and weakness.

3.2.1 Environmental Baseline of Maniwa

Demography

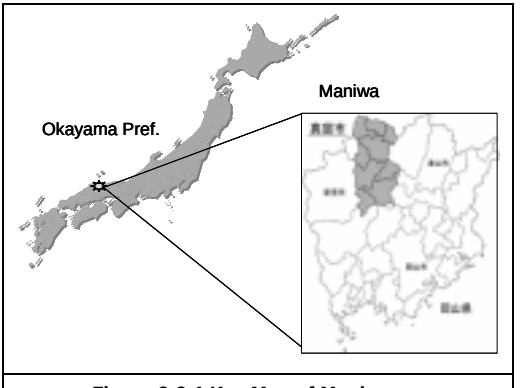


Figure 3.2.1 Key Map of Maniwa

Maniwa City is located midway between Okayama City and Yonago City in the northern part of Okayama Prefecture (Figure 3.2.1). Okayama prefecture in west Japan is ranked 17th largest of Japan's 47 prefectures. Forest land use accounts for 67 % of the prefecture and 80 % of the Maniwa (Table 3.2.2). The demographic and industrial profile of the Okayama prefecture and Maniwa area is summarized in Table 3.2.3. Maniwa is a typical inner mountainous region as defined by the government. The population of Maniwa has decreased by 2.6 % in the past five years. The demographic distribution is that people over 65 year-old constitute 24.3 %, the young population is 16.4% and the working population accounts for 59.3 %, which is below the average at the prefecture level. This region is endowed with good traffic network and is located at the intersection of two highways crisscrossing the prefecture.

Table 3.2.2 Forest Area in the Maniwa region

Region	Total Area (ha)	Forest Area (ha)		
		Total	Public	Private
Okayama Prefecture	711,169	484,340	38,375	445,965
Maniwa	82,435	66,495	7,791	58,704

Table 3.2.3 Demography and Economy of Okayama Prefecture and Maniwa

Particulars	Okayama	Maniwa
Area (km²)	7,113	828
Population	1,950,661	52,958
No. of households	691,620	16,967
No. of households in primary sector	90,053	6,779
No. of enterprises	85,719	2,940
Employed population	753,390	20,366
No. of manufacturing enterprises	4,729	182
Annual shipment value (million yen)	6,402,422	80,246
No. of service enterprises	25,469	945

(Source : TOYO Keizai, 2002)

Industrial Portfolio

Maniwa has a plenty of natural resources and the local economic activities of the area are substantiated by a vibrant wood industry. About 65 % of the planned forests of Maniwa are owned by the private. These wood industries contributed for a gross production of 2,730 million yen in 2002. The gross production of primary agriculture is 4,250 million yen, which accounts for 3 % of total production. But, there is an increase in new economic activities like flower and gardening in addition to paddy cultivation and diary. Part-time farmers, 10.3 % of the workforce in Maniwa are often engaged in forestry especially lumbering, apart from those who serve in companies. The secondary or manufacturing industries contributed for a gross production 44,330 million yen to Maniwa with 301 business enterprises operating. The shipment value of manufactured products is 8,860 million yen, which accounts for 1.4% of total prefecture production and plays an important role in employment market (Table 3.2.4). Major industries include timber products, ceramic industry, electronic machinery, textiles etc. In recent years, textile and electronic machinery witnessed declining growth therefore local resource-based industries such as timber and ceramic industry are expected to play a major role in economic development. A 34 ha industrial complex and distribution centre was completed recently and has started invigorating the local economy. The service industry contributes for 71,150 million yen in the year 2005. Wholesale and retail businesses are big earners. In the service industry, medical services and collaborated works are dominant in-terms of employment.

Table 3.2.4 Business establishments and employment in Maniwa

Type of industry	Year	Maniwa		Okayama	
		No. of units	Employers	No. of units	Employers
Minor industries	1986	6	84	179	2,225
	1991	1	11	144	1,678
	1996	4	141	126	1,521
	1999	6	122	116	1,314
Construction industry	1986	275	2,188	9,295	80,377
	1991	274	2,159	9,571	84,530
	1996	307	2,347	10,418	92,029
	1999	301	2,254	9,869	80,802
Manufacturing industries	1986	289	5,748	14,152	237,589
	1991	315	5,748	13,205	238,327
	1996	255	5,946	11,253	220,303
	1999	224	5,088	9,824	196,652

(Source : Maniwa Municipality, 2004)

Solid Waste Generation

About 142,000 tons of wood biomass is annually generated in Maniwa region. This includes waste from raw material market and timber factories comprising 78,000 tons of wood logs, 40,000 tons of chips and 24,000 tons of bark. Other types and amount of wood waste generated from the industries is shown in Table 3.2.5. It is also estimated that 10,000 tons of wood remains in the forests and about 1,000-2,000 tons of them can be readily utilized. There is potential for utilizing them for useful purposes in the future by appropriate technological modernization in logging. Due to the change in industrial waste treatment, it is prohibited to have open incineration except at farmers' houses and therefore the remaining wood is left alone in forest. The leftover forest residues are huge in amount but unaccounted, which not only inhibit the growth of plantation but also degrade the water resources. The construction wood waste generated from the region is estimated to be about 500 ton/year. Regarding reconstruction and demolition waste, the new law makes it mandatory to separate demolition waste, and it was not technologically and economically feasible to re-separate wood waste to be utilized, for energy conversion or material reuse.

Table 3.2.5 Wood waste generation in Maniwa

Type	Block (tons)	Chips (tons)	Powder (m^3)	Bark (m^3)	Molder (tons)
Cedar	1,450	10,372	18,892	15,532	681
Cypress	3,606	25,521	27,436	34,927	719
Others	161	5,849	3,615	1,956	120
Total	**5,217**	**41,742**	**49,943**	**52,415**	**1,520**

(Source : Maniwa Municipality, 2004)

Due to the ban on open incineration, it is important to develop the technologies to utilize construction-engineering waste, but it is hard to assure the development in the long term because of the difficulty in foreseeing the amount of waste generated. Bark wastes generated from the timbering process are treated as industrial waste by law. Until the 2002 legislation on dioxin emission, nearly 5,000 tons of bark waste was burned. After that, they were converted into other products and sold with sawdust for other purposes. Creating an economically resilient waste disposal and conversion system becomes a challenge for the business community. Despite the existence of unused wood biomass, business operators and other community facilities continued to use a considerable amount of fossil fuel. New industrial products like wood pellet were also not examined on commercial lines. In order to tackle these problems a cluster-based eco-initiative was started some 10 years ago which resulted in systematic evolution of inter-firm networks to share the resources and convert the waste into energy and material forms.

3.2.2 Background of the Wood Industrial Cluster

Traditionally, wood processing has been a major business in the Maniwa region, where 34 timber factories, 16 dry wood factories, dozens of furniture makers and two major trade centers, effectively interacted with each other. The eco-cluster initiatives underway in the Maniwa region today started in 1992 when a study meeting was convened by about 20 people, who were concerned about the future of that area and thought it was necessary to encourage companies and individuals to take action to revitalize the region. The chronology of the events that lead to new enterprise development and evolution of inter-firm networks within the cluster is presented in Table 3.2.6. The gradual decline in favorable

relationships between the business and concern over the economic and environmental situation led to the study meeting. A series of study meetings led to the establishment of two new companies viz., Maniwa Bioenergy Ltd. and Maniwa Biomaterial Ltd., as business approach to convert wood biomass from the cluster into energy and material wealth by exchanging resources within the cluster. The study group was a catalyst in collecting necessary technological and marketing information from outside, driving the business to develop eco-products, and calling the attention of governments to support such activities.

Table 3.2.6 Chorological Order of Eco-events in Maniwa

Year	Main activities in Maniwa wood industrial cluster
1997	A Symposium Environmental Town planning was organized
1998	Meiken Kogyo Co. Ltd starts producing electricity from woody biomass waste.
2000	A market survey on locally produced wood products is commissioned
2001	- Concept of 'wood resource recycling industry cluster' evolves. - NEDO sponsors a study on New Energy vision for Kuse town - Feasibility study on wood resource recycling in Maniwa - Landes Co. Ltd commercializes the wood chip concrete - BMD Co. Ltd commercializes the cat sand
2002	- NEDO undertakes a FS on biomass energy use in Kuse town - MLIT undertakes a pilot project on participatory regional planning in Maniwa
2003	- NPO – 21st Century Maniwa Forum was established - Okayama Pref. awards a project on Biomass utilization Project - Landes Co. Ltd invents and commercializes wood chip interlocking concrete - Watanabe Co Ltd & Dainippon Pharmacy joins hand to invent NAPLUS products - Meiken Co. Ltd start selling the surplus electricity to Chugoku Electric Power Co.
2004	- BMD in association with METI undertakes a study on volatile components and Recycled products. - Mitsubishi Co. Ltd establishes Ethanol plant on experimental basis

In 2003, the study group was transformed into a Non-Profit organization (NPO) named Maniwa School of the 21st Century with wider membership of wood industries, lumber dealers, sake brewers, furniture workers, a doctor, government employees, and a printer. At the request of the school, the local forestry association also started funding the eco-efforts of new companies as a way to strengthen inter-firm networks. During the course of time, local and prefecture governments also ensured that these new businesses enhance their capabilities, deliver successfully, distribute and manage various kinds of eco-

products and efficiently exchange waste materials. Table 3.2.7 indicates the different stages of how eight new enterprises emerged; most of which are operational now.

Table3.2.7 Stages of New Eco-Enterprise Development in Maniwa EIC

Project	Preparation stage		Pilot running stage			Advanced operational stage		
	2002	2003	2004	2005	2006	2007	2008	2009
Cluster Project Steering committee	→	→	→	→	→	→	→	→
Naplus project	FS	Planning	→	→	→	→	→	→
Bio-energy project	FS	Planning	→	→	→	→	→	→
Wood pellet project			→	→	→	→	→	→
Information center		→	→			→	→	→
Cooperation with knowledge institutes			→	→	→	→	→	→
Lignin cellulose						→	→	→
Wood log business						→	→	→

3.2.3 Components of the Wood Industrial Cluster

The business entities in Maniwa wood industry have their own strengths. The eco-initiative aimed to network such strengths for economic purposes, created a mechanism to supply energy on one hand and produce new products on the other. The local governments aimed to combine such business efforts for further socio-economic development and enhancement of human resources as illustrated in Figure 3.2.2.

Four innovative components transformed the Maniwa wood industrial cluster into an eco-industrial cluster. First of them is the eco-power generation from wood wastes. Second is the continued effort to convert woody biomass into other materials in the form of pellets and heat. Third is a bio-fuel inter-linkage that turns wood cellulose material into ethanol and fourth, the utilization of wood waste as materials for construction and other domestic purposes. The initial business actors in the eco-industrial network are illustrated in Figure 3.2.3. At Meiken Lamwood Corporation, the waste wood shavings are used to feed the boiler and generate steam, which is used to dry wood materials. The power generated from the boiler not only meets the companies' energy demands but

also sold to other companies. This green energy is estimated to be an equivalent of 58,000 ton CO_2, an environmental benefit.

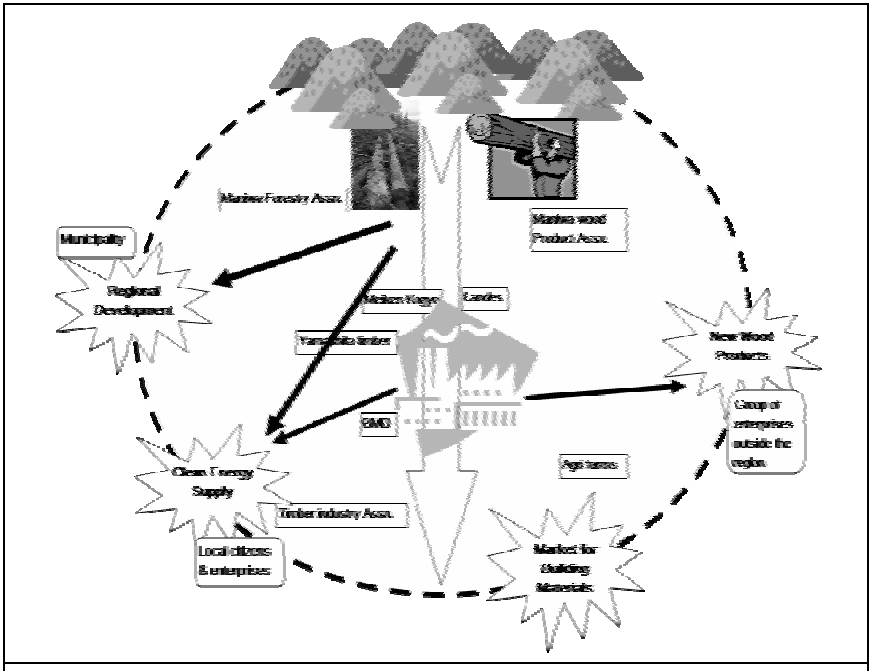


Figure 3.2.2 Integrated Development Plan of Maniwa
(Source: Maniwa Municipality, 2004)

Today, the company is a commercial success in converting the wood waste collected from other companies into energy and created employment opportunities of 110 man months. As a means of gaining carbon credits, other non-regional players like Chugoku Electric Power Company and Kansai Electric Power companies are competitive in securing green power from Meiken Lamwood Corporation. Nomura Holdings, another non-cluster company also purchases the power under their green purchase program for a monthly fee of 600,000 to 700,000 yen (Nakashima, 2006). As the market for green power expanded, the capacity of boiler originally designed to consume 60 to 70 tons of wood waste in a day was increased to 150 tons of wood shavings. But, the supplies of wood materials are limited, so that a community-wide cooperation to secure such a huge amount of feed is being looked by the company.

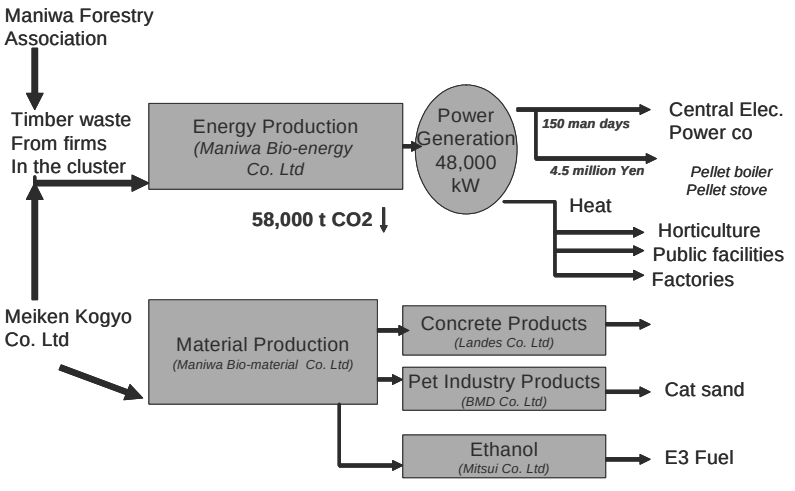


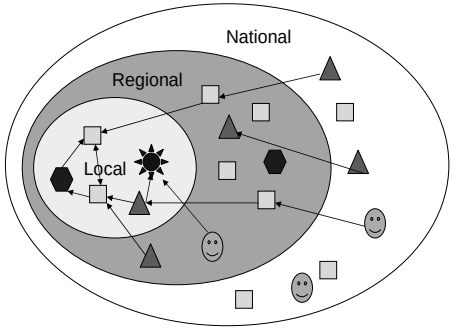
Figure 3.2.3 Initial Business Actors in Inter-firm Material Flow

The second innovative component of the cluster is new uses for bark wastes and shavings. Although there are many lumber mills in the cluster, it is very difficult for these mills to establish a mechanism to recycle bark wastes at their premises. Moreover, because of a dioxin regulation incineration of bark as an industrial waste is completely banned. To cope with the situation, the companies decided to incinerate a huge amount of bark waste in a privately owned boiler. Fully dried wood materials are in high demand in the wood industry, but that requires high-end facilities for processing. To meet the demand, the company began producing pellets from wood shavings and supplied them to lumber mills as a fuel for drying wood materials. More specifically, Maniwa Biomaterial Company within the cluster produces pellets from the remainder of wood shavings and supplies them to commercial facilities and boilers for industrial use. Since then pellet production from the cluster has been increasing gradually. Today, Maniwa cluster is synonymous with pellets in Japan, as most of the annual 10,000 tons production is from this cluster. In addition, the waste wood materials are used as fuel for heating greenhouses for horticultural purpose. The strawberry fruits grown in those facilities were labeled and sold as carbon offset fruits that received special premium from eco-conscious consumers.

The third innovative component emerged is production of bio-fuel from the wood biomass. The biomass potentials and eco-initiatives of Maniwa cluster has attracted outside business. As a result, Mitsui Engineering and Shipbuilding Company recently built a plant, where ethanol E3 is produced from woody biomass. The ethanol produced from this cluster is mixed with gasoline and sold in the market. Most of the purchase is done by Okayama prefecture for use in government vehicles. Some resorts within the region also use bio-diesel fuel for their vehicles.

As the fourth innovative component, wood waste is converted into materials and used for various purposes other than as an energy resource, such as for making kitty litter or cat sand. Intelligent use of discarded materials is also increasing in the construction industry. Landex Company, a manufacturer of secondary concrete products started producing wood-based concrete. As the mechanical properties of the innovative wood based is equal to that of conventional concrete, it widely adopted in public works project through, green purchase programs of the Okayama prefecture.

The distinctive characteristics of the components that transformed Maniwa industrial cluster into eco-industrial cluster is that visionary business leadership contributed for devolution responsibilities and new forms of knowledge partnerships that made innovations to happen. A number of interested organizations like Forest conservation network, knowledge institutions like Okayama University and interested individuals ought to contribute the local government with little experience in new policy design to set eco-approaches in motion. The different type of actors in that innovative space is illustrated in Figure 3.2.4. Their efforts also served as useful tool for mobilizing local community for joint actions and promoting cooperation among policy makers at different levels for improving the learning process. To spell it out succinctly, eco-innovations happened within the cluster and transformed itself as a space for social innovation. This system innovation process is essentially guided by the participation of non-regional actors and turned to be an open process of collective learning.



	Local	Regional	National
Firm	9	5	6
Business Association	4	1	-
Knowledge Institution	-	4	4
NPO	1	1	1
Government	2	2	2

Total 42 institutions

Figure 3.2.4 Actors in Social Capital Creation of Maniwa EIC

3.2.4 Material Balance and Flow

As a major productions and trade centre, Maniwa houses specialized groups of timber factories that have been responding to the increasing demand for trimmed cypress and housings frames. The annual inflow of material in three raw wood markets located in the cluster is estimated to be 100,000 m^3. The total raw wood processed in 34 factories is 230,000 m^3 in 2004 of which 160,000 m^3 of product is shipped out. The types and amount of wood industry by-products used in the cluster is presented in Table 3.2.8.

Table 3.2.8 Byproducts from wood wastes in Maniwa

Type of waste	Wood log	Chip	Powder	Bark	Molder	Total
Pulp	670	41,743	-	-	-	42,413
Energy	1,590	-	-	1,044	-	2,634
Burned	1,165	-	-	2,815	1,520	5,500
Compost	-	-	-	9,566	-	9,566
Pet sand	1,561	-	5,420	10,161	-	17,142
Sold as it	232	-	573	-	-	805
Total	**5,218**	**41,743**	**5,993**	**23,586**	**1,520**	**78,060**

(Source : Maniwa Municipality , 2004)
Note : All quantities in tons

The wood material outflow of the cluster also includes 5,500 tons of bark which was transported outside and incinerated at the cost 2,000 yen/m^3. Some of them are also used as fuel, manure, spreading material, charcoal etc. The cost of such hardwood bark charcoal is about 2000 yen/ton. Waste wood logs are often incinerated or used as domestic fuel. Sometimes they are also chipped to be sold for pulp industries. The chips are sold at a price of 2,000 yen/m^3 for pulp industries. The sawdust is sold at the rate of 500-3,000 yen/m^3 for spreading material and for mushroom farming. About 10,000 tons of raw wood is estimated to remain in the forests and the construction wood waste generated from the region is estimated to be 500 tons/year. Figure 3.2.5 illustrates various possible uses of such by-products.

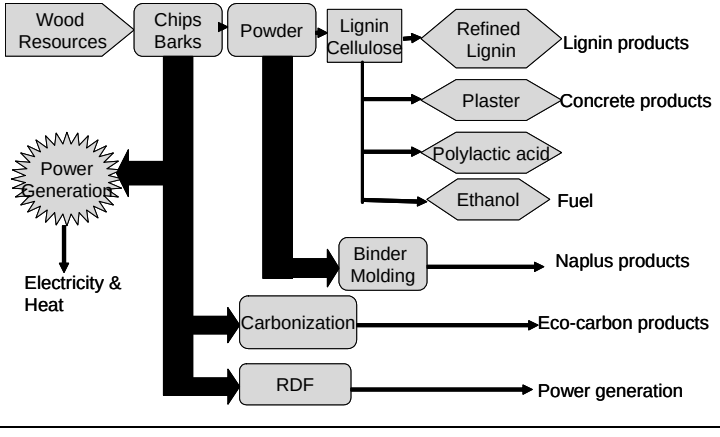


Figure 3.2.5 Material by-product flow envisioned in Maniwa EIC

Ample opportunities exist for them to be converted into energy and material forms. It has been estimated that new eco-products like bio-degradable naplus wood plastics, for use in gardening; lignin in cellulose for use as liquid fuel and lactic acid are financially feasible (Tables 3.2.9a & 3.2.9b), creating additional employment opportunity of about 720 man months. This, along with full-scale conversion of biomass waste into further heat and energy sources will help further strengthening of inter-firm networks within the cluster. The ideal one will be as shown in Figure 3.2.6. This cascaded use of wood resources will eventually transform Maniwa industrial cluster into the first zero emission zone in Japan.

Table 3.2.9 (a) Estimated Revenue and Expenditure in Pellet Business

Revenue	Particulars	Unit Price (Million yen)	Cost	Unit	Cost (Million yen)
Income	Pellet sales		2,000,000	kg	
	Charcoal		20,000	kg	
Expenditure	Raw materials	3	4,000,000	kg	12
	Manpower	5	1	persons	5
	Electricity				10
	Maintenance				10
	Land	3,000 yen	600	m^2	1,8
	Other	@23.5/kg			10
	Total				47
	Depreciation				18
	Net income	@32.5/kg			65

Source : METI, 2001

Table 3.2.9 (b) Estimated revenue and expenditure of Lignin cellulose plant

Revenue	Particulars	Price	Unit	Cost	Annual cost (million yen/yr)
Income	Lignin sales	5,107	tons/year	450,000	298,240
	Polymers	5,391	tons/year	350,000	1,886,976
	Total				4,185,216
Expenditure	Ash disposal	3,840	Tons/year	15,000	57,600
	Running	256	per day	4,385,750	1,122,752
	Labor cost	24	persons	7,500	180,000
	Maintenance				360,000
	Total				1,720,352
Net Profit					2,464,864

Source : (METI,2007)

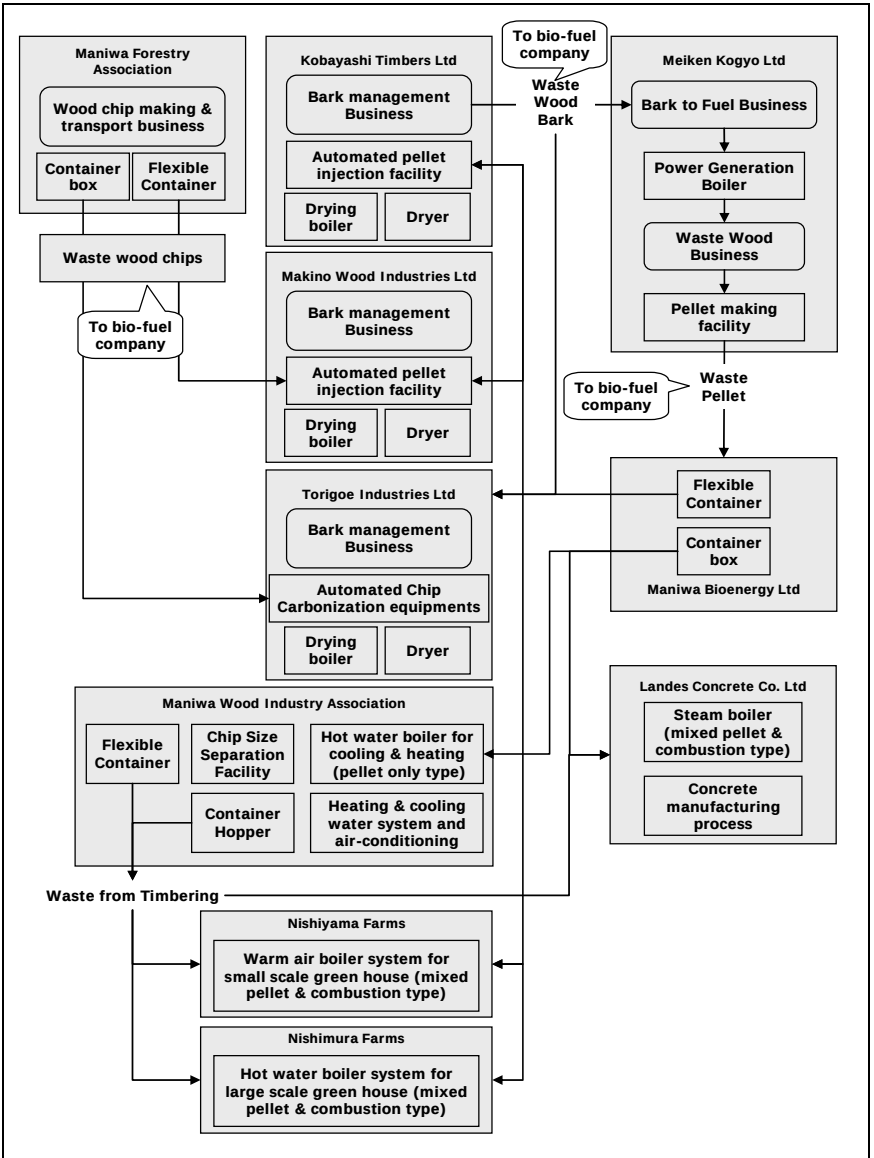


Figure 3.2.6 Optimized Inter-firm Networks for an Ideal EIC

3.2.5 Technology Needs for Strengthening EIC formation

The assessment of technology needs for transforming the Maniwa eco-industrial cluster into a zero emission zone is a complex task as it involves whole supply chain and product chain. There is widespread belief that Japan lacks behind Europe in efficient environmental technologies. Nevertheless, a wide range of technologies that exist to convert wood biomass into more useful forms of energy, heat, liquid or solid products depends upon many factors including. A select number of companies in the cluster contacted for a questionnaire survey (IGES, 2006) aspired for the following technological advancements

- Naplus production: advanced technologies for naplus pellet production in commercial scale. The cluster association can be a party-in-charge if necessary
- Fluidized bed combustors: for appropriate small scale timber industries to incinerate bark and produce power and heat needed for their own use, and supply surplus energy to the naplus industry
- Automated wood pellet machine: to produce wood pellets for public facilities, prospectively to meet the demand of group of households. The use of wood pellet as fuels to dry wood is aspired by timber factories.
- Boilers of high efficient type: for drying woods and power generation by large sized timber mills
- Lignin cellulose production technology: to attract new businesses to the cluster in correspondence with technological development at international level
- Ethanol extraction technology: for converting cellulose into fuel in a cost effective manner
- Advanced sorting and grading technology: for separating woods from concrete in construction wastes.

The realization of full potential of Maniwa eco-industrial cluster depends on how these technologies are made available to the business operating in the cluster, in a commercially attractive way. The following six points need careful consideration for introduction and uptake of new environmental technologies into the cluster.

- Type of appropriate environmental technologies that are internationally available now and in immediate future
- Type of technologies that are suitable to Maniwa that will enable new eco-products and process development in a commercial way
- Impacts of technology on the inter-firm networks within the cluster as well as socio-economic fabric of the community such as employment, equity issues
- The level of investment needed to adopt such technologies and financial mechanisms to support it
- The level of risk from investing or promoting such technologies at national level

3.2.6 Policy Implications for EICs

Industrialized economies like Japan have passed through four stages along the path to a sustainable development. The Japanese policies of the 60s and 70s were driven by environmental degradation caused by rapid economic growth. Improving efficiency of the industrial production process through resource optimization became a major task following the oil crisis in the 70s and 80s. From the 90s onward the environmental concerns were transformed into opportunities to develop markets, based on improved eco-efficiency performance and dissemination of green products through integrated policy. Governmental bodies like Okayama prefecture also promoted the green market development through green procurement. There is close correlation between the introduction of these policies and developments in Maniwa wood industrial cluster, even though some time lag is observed. The policies that facilitated the companies to come together and favored the evolution of inter-firm networks in Maniwa shall be discussed under three groups.

Environmental Policies of Ministry of Environment (MOE)

Figure 3.2.7 shows the linkages between the fundamental law for establishing a sound material cycle society and specific related laws promulgated by the Ministry of Environment (MoE). These laws perceive many categories of waste as resources and demand their appropriate recovery. In that sense, the MOE policy clearly emphasizes that resource recovery must follow the hierarchal 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-town projects are local/prefecture initiatives that promote sustainable resource management. Currently, a variety of end of life resources like wood industry wastes are being encouraged to being recycled and or recovered on local scale.

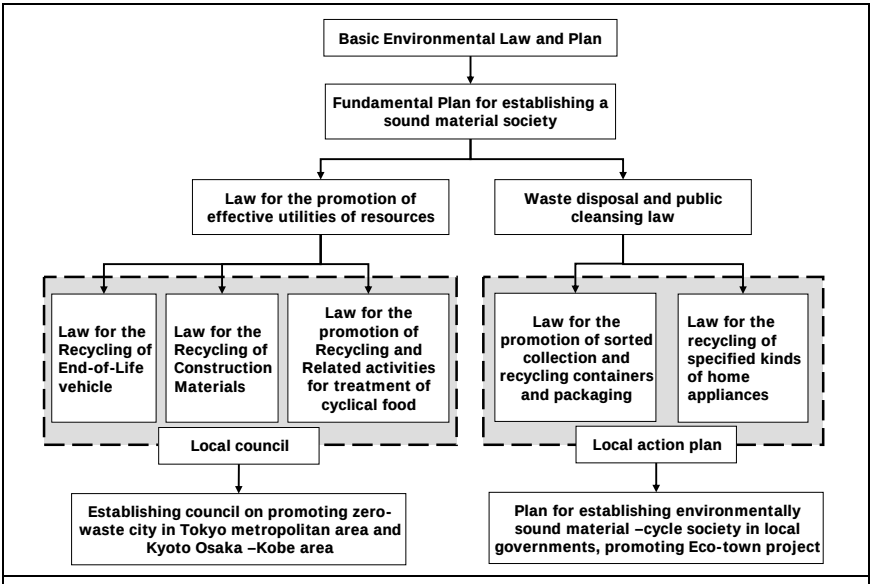


Figure 3.2.7 Principles of Basic Environmental Law
(Source : MOE, 2003)

In order to promote sustainable industrial activities, the Ministry 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. The objective of this plan is to promote comprehensive policies towards a closed loop economy at local and regional level. More specifically, the plan sets a target for each of the three indicators representing the three aspects of material flows of the economy viz, input, cycle and output indicators. The three indicators with quantitative targets for the period 2000-2010 are (i) the ratio of resource input to productivity (40% improvement) (ii) Material recycling rate (40% improvement) and (iii) the ratio of waste input to disposal (decrease by 50%). Whereas the material recycling rate and waste output indicators relate to the conventional view of industrial waste management, the input indicators

reflects a comprehensive view of the relationship between economic activities and raw material use i.e., decoupling of economic growth from environmental degradation. This concept and supportive regulatory framework favor inter-firm networks to evolve within industrial clusters.

Ministry's efforts also included the sustainable use of renewable energy resources. The legal framework stipulated to combat global warming includes two main policies, the law concerning the promotional measures to cope with global warming and the law concerning the rational use of energy. With this policy platform and industrial collaboration, Japan expects to achieve the Kyoto Protocol 5.2 % greenhouse gas emission 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 urban fringe areas by means of previously mentioned eco-town projects. Eco-towns are regional initiatives that target the common utilization of products and byproducts among companies within a industrial cluster. This eco-town initiative not only encourages the application of industrial ecology practices through the exchange of by products, but also promotes sustainable business models by promoting innovative products and services (Moriokka et al, 2005). This along with the regulation concerning dioxin, that banned the incineration of industrial wastes facilitated or forced companies in Maniwa to make joint actions tackling the waste generated from the cluster.

Policies of Ministry of Economy, Trade and Industry

The Ministry of Economy, Trade and Industry (METI), in cooperation with Ministry of Environment introduced the eco-town initiative in 1997. Generous, financial support by both the ministries triggered regional scale initiatives that target the effective resource circulation of a full range of by-products based on industrial ecological principles. Currently there are 26 eco-town projects in Japan (Figure 3.2.8). There are also efforts to promote integral cooperation among eco-towns through clustering. There have been some efforts to classify the eco-towns in terms of their most predominant characteristics. Sato et al (2004), for example categorized the eco-towns into (i) eco-towns that promote the development of new environmental industries (ii) eco-towns that focus on waste treatment (iii) eco-towns that enhance community's participation. Enacted in 2002, the Law concerning special measures for promotion of the use of energy, the Renewable

Portfolio Standards Law requires all electric power utilities to supply 1.35 % of total electricity from renewable sources by 2010. This provision facilitated independent power producers in Maniwa cluster to sell the surplus energy produced from wood waste to non-cluster companies on competitive prices and to get carbon credits out of this sale, creating a win-win situation for both the buyer and the seller.

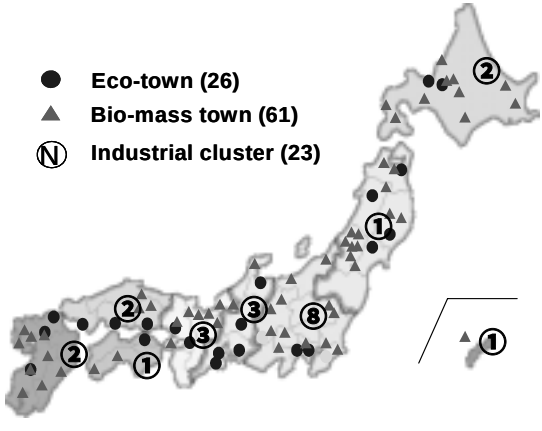


Figure 3.2.8 Eco-towns, Biomass towns and industrial clusters in Japan

Policies of the Ministry of Agriculture Forestry and Fisheries

Since 2004, the Ministry of Agriculture, Forestry and Fisheries has been publicly inviting rural municipalities that actively and appropriately produce and use biomass fuels to apply for "Biomass Town" designation. In 2005, the second announcement concerning the "Biomass Town" concept identifies municipalities that deal comprehensively and appropriately with local biomass resources, from generation to utilization. Entries are examined for conformity to standards set by the Biomass Japan Comprehensive Strategy Promotion Council, established by the Cabinet Office and six other concerned ministries. Once conformity is established, the information is shared among the ministries that can help establish an environment for the Biomass Town to promote active participation by local citizens, a main catalyst for further development. The Ministry plans to increase Biomass Town designations to 500 by 2010. In 2006, Maniwa was

designated as one of the biomass-towns. This will help Maniwa wood industrial cluster to introduce new economic and environmental ways to use biomass in an effective way and helping promote networking among other rural areas engaged in biomass production and utilization all over Japan.

Policies of the Ministry of Education, Culture, Sports, Science and Technology

In 2001, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in cooperation with METI formulated a research plan to establish industrial clusters in the local economy. The implementation consists of three core programs. One program is to support companies to form alliances with other companies or knowledge institutions like universities. The second program is to help technical innovation occur in the industrial sector. The third program is to fund institutions for the promotion of entrepreneurs. The separately, allocated about 476 billion yen in funds for these programs. For the first program, network formation, the ministry allocated 39 billion yen. In the seven sub-programs, the government aims to connect the industrial sector with universities to exchange information. In terms of knowledge institutions, the benefit of these programs understands what kind of technology is needed for the clusters. From the viewpoint of industries, they can develop environment friendly production technologies. For the second program research and development, the government allocated more than 65% of the budget. The six sub-programs have earmarked funds to enhance research activities in industrial sector. A remarkable feature of the program is the target part of resources to enable the small and medium enterprises to keep up with the large enterprises in the area of research and development. For the third program, incubator establishment, the government allocated 125 billion yen. The three sub-programs are for establishing facilities and training entrepreneurs to start new businesses. In these action programs, the government has played the role of a facilitator between companies and knowledge institutions to foster business cooperation. It enabled rural-fringe area and local governments like Maniwa to attract private companies like Mitsui Metals to invest in Maniwa wood industrial cluster (Shibusawa, 2006). Other than that, the national universities like the University of Tokyo and Okayama University, under the jurisdiction of MEXT, actively participated in the stakeholder dialogues held in Maniwa, thus facilitating national and local level knowledge transfer.

Policies of the Okayama Prefecture

In Japan, regional level policymaking is undergoing transformation and redirection where excessive resources and central planning are being decentralized (Frideman, 1998). As illustrated in Table 3.2.10, a good deal of efforts has been made by Okayama prefecture in providing subsidies to new environmental business activities, notably in two areas. First, reducing the large company bias in the overall industrial supportive framework and the second channeling credit to small eco-business activities. Okayama's successful lending schemes tend to focus on joint activities, have decentralized decision-making, screen financial requests based on characters of the entrepreneur and project feasibility rather than collateral. But so far, most attempts suffer from a deficiency that they are too supply oriented – that is overly focused on inputs for production, viz., skills, technology, raw materials and not sufficiently focused or concerned with emerging markets for eco-products or green energy (Nakashima, 2006).

Table 3.2.10 Subsidies for Industrial Activities in Okayama Prefecture

Category	Type of industry	Focal industries	Subsidy amount
Local development	Cooperative	-	> 9 million yen
Regional industrial augmentation	Small and medium enterprises	New Product development	2/3 or 1 to 4.5 million
New venture business	Individual entrepreneurs	-	3/3 or 10 million yen
Development of Environmental technology	Small and medium enterprises Business associations	-	1/2 or 4 million for SME 6 million for groups

Indeed, the national and local governmental policies that enabled inter-firm networks evolve within Maniwa industrial cluster have also transformed individual business activities into a form of community – corporate partnership. Even though, many governmental institutions and individuals are involved, there is no formal monitoring of policy integration/coordination. All institutional efforts are done in fragmented manner over a span of time with no real integration of polices. This is because current policy frameworks for eco-industrial cluster development are fragmented on ministerial lines, not as a result of negligence, but due to inconsistent strategies. Even though, some events of coordination are noticed, they are limited to simple information sharing or

shallow consultations. Little of those is systematic and depends on informal liaisons. However, the need for change has been increasingly recognized. Bench marking of eco-industrial clusters for integrated economic and environmental performance shall be one way for policy integration to occur in which authorities can learn and exchange information for developing zero emission zones in urban-rural fringe areas. If the policy bench marking process is sufficiently broad and stimulates understanding the need for cross-sectoral cooperation, it will bring tangible benefits for the industrial clusters that wish to become more eco-friendly.

3.2.7 SWOP Analysis

The results of SWOP analysis are presented in Table 3.2.11, which identifies the Strengths, Weaknesses, Opportunities and Potential of Maniwa initiatives in different sets of realities. In the broader context, the Maniwa eco-industrial cluster seems to represent a success story of an advanced country. This was made possible by commitment shown by the local stakeholders and enabling policy environment. In the past, efforts of stand alone wood companies have mainly focused on the economic return on investment. Now, the triple bottom line approach is being undertaken by many companies that enabled Maniwa cluster to have greater weighing on socio-environmental issues. From the social perspective, there can be little doubt that developing a fully functional eco-industrial cluster protects existing employment, provide new jobs, gives learning opportunities to transfer skills, and provides training and educational opportunities. Two principles guided the cluster companies, namely they need to be business oriented and eco-production grounded. Business orientation refers to two components viz., aiming at visible improvements in the economic situation and granting the cluster a competitive advantage. The second focus principle is on eco-production point to the importance of process and product innovation and structural improvements as opposed to for example, a temporary surge in increased sales of eco-products from an occasional surge in purchases in bulk amounts. However, implementation of them is not without its challenges as it has to appease different stakeholders involved (IGES, 2006).

Table 3.2.11 Maniwa eco-industrial clusters – SWOP Analysis

Strengths	Opportunities
▪ Existence of visionary business leaders and committed community ▪ Situated on major highway road crossing ▪ Abundant wood resources ▪ Traditional status as wood commercial centre ▪ Okayama university ▪ Outward looking companies ▪ Well trained/educated business leaders and government officials ▪ Well developed social infrastructure ▪ Proximity to tourism attractions	▪ Niche market for eco-products ▪ Development of economic activities based on green energy production and sales ▪ Advancing administrative and territorial reforms ▪ Present and future development in technological advancements ▪ Modern, progressive outlook of municipal government ▪ Efficient utilization of opportunities of special economic/environmental zones ▪ Attractive to large companies and associated investments
Weakness	**Potentials**
▪ Poor policy coordination at different levels ▪ Fragile markets for green energy and eco-products ▪ Lack of effective lobby in prefecture and national assembly ▪ Outward migration rate and declining birth rate ▪ Survival budget of municipal government ▪ Low value investments ▪ Scale merits of technology	▪ Long tem integrated policies for environmental preservation ▪ Break up of city's public utilities and communal energy services ▪ Unresolved relations between local and prefectural government ▪ Competition from better located regions ▪ Lack of management frameworks transferring strategic objectives into daily activities ▪ Expensive house heating systems ▪ Instability in environmental education

- Companies want good returns for collecting, storing and using the waste materials and want the market to value the eco-products in a distinguished way
- Companies particularly in green energy business want the security of long term fuel supply contracts in place before proceeding
- Users of biofuel ethanol E3 want quality liquid product delivered all year around to an agreed prescribed standards and characteristics
- Equipments manufactures want to design their products to have improved thermal efficiencies, better control, reliable feedstock handling to gain better returns and a fair share of the market
- Financiers want to reduce the risks of green investment having purchase agreements in place, along with fuel contracts and perhaps green pricing operations
- Competing markets want wood waste biomass for mulch, pulp, fibre board, chemical feed stocks etc,
- Communities and local governments want secure and long term-employment, independence, and some control over management of local resources
- Environmental groups are sensitive to certain issues of eco-industrial clusters and always want for 'more sustainable eco-industrial clusters'

In this context, a focused analysis is made on the major strengths and shortcomings of Maniwa eco-industrial cluster.

Strengths: Social Capital as Space for Eco-innovations

Strong leadership and visionary local community are the main strengths of Maniwa industrial cluster. Business leaders, despite being corporate managers, act as one of the citizens of the local community. Subsequently, people from outside namely knowledge institutions, governments and non-governmental organizations began to support it. This is how social capital of the community – the attitude and values that govern people, institutions and the relationships contribute for economic and social development as well as environmental preservation and Maniwa model turned to be a success story. The community was clearly aware of its goals and moreover, the community was capable of determining how much money and what type of measures, human resources and technology would be required for achieving these goals. Thus, the community planned for interaction with different ministries and agencies according to their own assessment of the need for such connections. This initiative in selecting partners distinguished Maniwa from other local communities or clusters. Nevertheless, it should be noted that the success of Maniwa, as evidenced today, is owed mostly to the fact that about ten years ago, prior to any administrative initiative or public policy, the local community formed a clear vision of how they would like to grow.

This augmented social capital turned to be the main driving force, for the companies to come together. Proximity between firms exists to share the resources if an efficient interaction is possible due to common environment and economic goals. Figure 3.2.9 clarifies this phenomenon in the case of Maniwa. Technological proximity between the firms as well as other actors like knowledge institutes, community based organizations exist, if an environment or economic related cooperation is possible without one of the actors having to shift its business path. In Maniwa's case, Firm A-Landex and Firm B-Meiken Lamwood Co are within technological proximity of each other in using the wood waste in an innovative way. They were able to collaborate while maintaining the current development path. In contrast, the Firm C- Maniwa Biomass Materials and Firm D-Watanabe Co. Ltd were initially located outside their absorptive capacity. In course of time, Firm C and D also collaborated in spite of product differences, thereby making shift from the business pathways. For this shift, Firm C acquired competencies from Firm B. This knowledge transfer is facilitated by

Maniwa School's multitask social capital building process (Figure 3.2.10). This social capital is built upon community rules, cultural conventions, environmental points of view or certain traditional values on economic development.

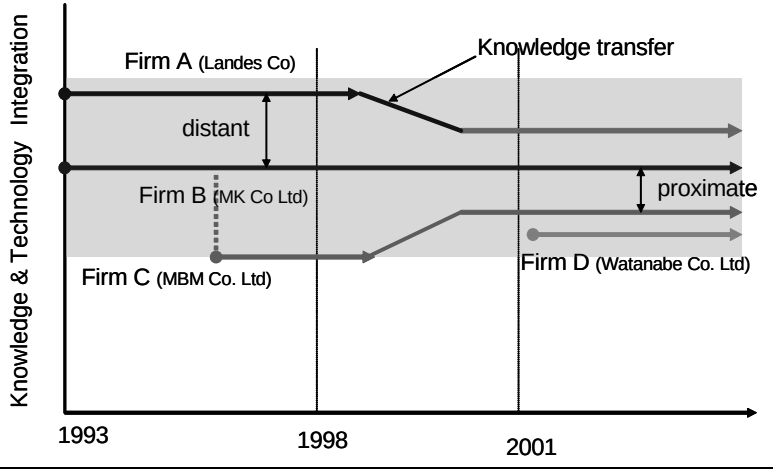


Figure 3.2.9 Increased Proximity of Firms due to Social Capital

Weakness: Fragmented Policies and Patchy Markets

Lack of coherent policies delayed the evolution of inter-firm networks in Maniwa or realizing its full sustainability potential. Wood shavings produced in the bark stripping process are currently regarded as industrial waste in Japan. Among all the advanced and developing countries of the world, Japan may be the only country that regards bark as industrial waste rather than agricultural waste. The waste management policies and programs of sectoral ministries are not integrated in a manner and the time that should be. Considering virtual absence of policy coordination at macro-level, necessary technical and economic assistance, the expectations of local governments lacking in financial resources, capacity and expertise is unfairly high to effectively support eco-industrial cluster initiatives.

Fragile supply chain and markets are another major weakness for the Maniwa cluster. The trading price of timber in Japan is the lowest in the world, and continued to decline as illustrated in Figure 3.2.11. The price has gone down by a factor of about ten in twenty years time.

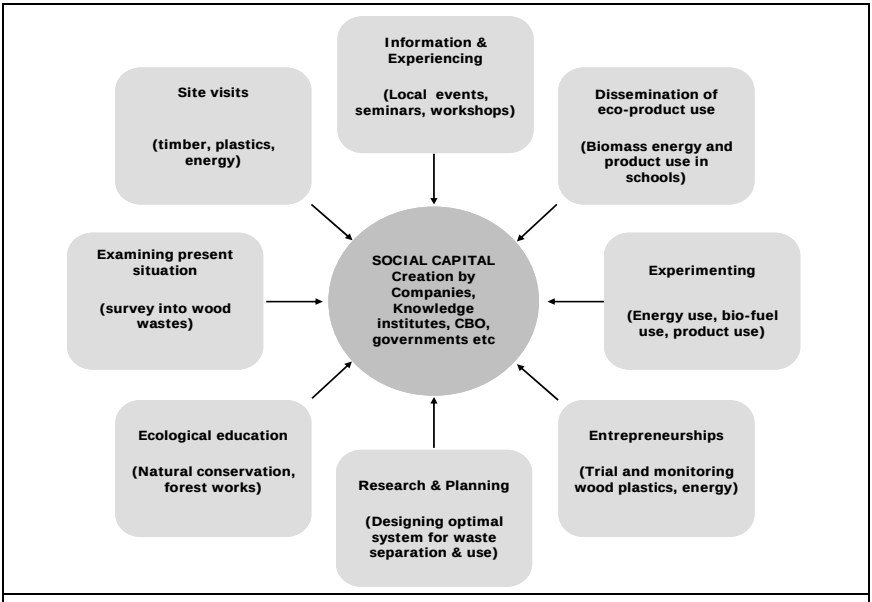


Figure 3.2.10 Interactive Components of Social Capital Creation

There is always fluctuation in the volumes of wood waste becoming readily available for energy as result of changing world market prices for saw logs and pulp logs, and for local fossil fuels and electricity. Hence, there always is an uncertainty in predicting the market potential with any degree of accuracy. If the commodity price rises, some woods may be harvested earlier to capture the high returns; if the price drops, some plantations will be left standing for longer with the hope it will rise again within a year or two. The actual market potential for eco-products and green energy is also variable. When the cost of fossil fuels and conventional products increase, the energy and products from Maniwa eco-industrial cluster also become more competitive as the market potential changes. Since, the wood waste is only a by-product and is relatively low in value compared to logs, there is some degree of risk that sufficient supplies will not always be available. For this reason, a new entrepreneur within the cluster would tend to first secure reliable supplies by setting up long-term supply contracts with other companies.

Opportunities: Growing Markets and Technological Advancement

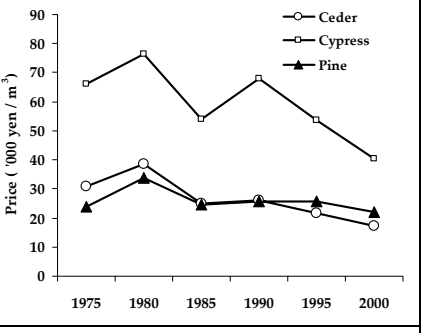


Figure 3.2.11 Price of Major Wood in Japan (METI, 2001)

The Maniwa industrial cluster can also take advantage of opportunities with growing markets and technological advancements to improve scale effects. The markets for green energy and eco-products is closely related to growing concerns over climate change by the public and society's increasing willingness to pay more for sustainable sources of energy than for fossil fuels and accept the use of eco-products as way of life rather than exception. Integrated government policy initiatives and incentive mechanisms for change in lifestyle will then need to be created. This will create markets for specialists, dealers for green energy, consultants, and eco-products and brokers who will improve the overall market performance. Larger adoption of advanced machinery and equipment, results in economic scale of production and reduced costs. More incentives are being provided for spending on research and development, product standardization, and marketing. Due to considerable research and development efforts, cost of energy production from wood biomass is generally decreasing and in many cases today, is comparable with fossil fuel energy (Anbumozhi, 2005). The amount of money spent by developed countries through International Energy Agency on research and development of renewable energy has increased dramatically to US$ 11 billion (OECD, 2004) and more technologies are in the pipeline. The growing market will eventually lead to reduced costs at different stages and every possibility is there to create a positive loop.

For an eco-enterprise like Maniwa Biomaterials Company, a plant that produces heat and power from wood waste, the key to achieving competitiveness is to increase productivity from all factors of production, reduce costs, improve product quality and to intensify marketing efforts. A particularly important type of cost at the early stages, when the business still is defining itself and the market is generally 'thin', are the transaction costs, i.e. the costs for market search,

measurement, negotiation, contracting and contract enforcement. As the opportunities for environmental business grows, innovative technical and organizational solutions are normally found that increase productivity and reduce costs, including transaction costs.

In the case of fluctuating supply of input materials, there is a potential for cheap feedstock to be obtained from urban areas like domestic wastes and also from some other industrial sectors like construction wastes. Potentials are there for new contracting practices and quality standards, improved market efficiency and well coordinated. The success of such innovations will depend on better coordination of policy measures on the national, regional and local level to get tangible benefits.

Potentials: Economic Instruments for Overcoming Barriers

There exist policy instruments in Japan that have the potential to further accelerate eco-innovation to take place in Maniwa cluster. The widely discussed green taxes imposed at national level, would increase the cost of non-renewables and therefore make energy and eco-products more competitive. Since being carbon neutral, the products from Maniwa eco-industrial cluster would be exempt. Carbon levies on electricity sales at national level would also have the potential both to provide revenue and to create awareness if the revenue were used to encourage the use of wood-based biomass at business level. Companies within the eco-industrial network shall be exempted and this, together with the growing demand for green energy from outside cluster companies will create demand for more capacity of the cluster. Carbon trading between the cluster companies and outside companies is also an incentive for cluster companies. Long-term feed-in tariffs also have the potential to stimulate the eco-product market, which should include business-to-business and business-to-government contracts. Other grants, subsidies and green purchase programs offered by governments could encourage further uptake of eco-products but these would need careful consideration as to the long-term reliance on them and how future removal of special assistance programs would affect the cluster-based companies. Increased depreciation rates on plant and equipment for tax purposes has the opportunity to reduce the investment payback period. This will also help to alleviate barriers on capital investment and long payback period, allowing new enterprises like naplus plants etc to flourish. Reduced excise taxes, especially if

benefits can be shown to offset the loss in government revenue, may be applied to the use of products coming out of Maniwa eco-industrial cluster.

3.2.8 Lessons Learned

The benefit that an eco-industrial cluster located in an urban-rural fringe area offers is a reality as evidenced by the Maniwa cluster. From a sustainable development point of view, this is the amount of waste that has been actually transformed into energy and materials, business expansion and employment, and improved living conditions. The surveys also indicate, local health benefits as a result of better use of waste material or of reduced pollution. Better levels of home and industrial heating were feasible. For individuals, communities and business who value achieving sustainability, it could help to meet their objective of becoming self-sufficient and being recognized as environmentally aware and responsible. However, unlike their hardcore manufacturing counterparts in urban areas, bio-based industrial clusters in rural fringe areas very much depend on dispersed small scale suppliers and uncertain markets. Locating, securing and collecting sufficient raw materials and waste itself can be a logically difficult and costly process unless a common economic purpose or environmental agenda is fixed.

The experiences of Maniwa illustrates that the benefits coming out of inter-firm networks seems to be successful, if they are focused on a cluster already strong and set in a location, where good flow of raw materials is secured. As illustrated by Figure 3.2.12, Maniwa experiences indicate that cluster based environmental initiatives are more triumphant if they are a part of the broader development strategy of the region that also improves micro-economic business environment in the locality. Isolated approaches have less impact. Maniwa also exemplifies that eco- initiative seems to be victorious, if they are based on a shared visionary framework of innovation and market competitiveness. The operational strategies of Maniwa also points out the need for a comprehensive entity to manage cluster based eco-industrial operations and a reasonable budget to finance the office of a dedicated facilitator. If such resources are not available in any form, eco-initiatives are very hard to sustain over time. Interestingly no negative effect of government support or financing is found in Maniwa. As long as local business are heavily involved in cluster based eco-actions, government seems to have a positive role in providing technical and economic support joint actions plans,

especially in the early phases of eco-initiatives. These lessons learned from Maniwa eco-industrial cluster initiative shall be summarized as

- The ecological performance of a cluster is closely related to the locality's strength in using locally available resources and community's commitment to optimize it
- The foundation of local economies is a group of inter-related companies and not collection of unrelated forms
- Successful integrated environmental and economic planning strategies are usually those that extend, refine or combine the clusters strength, not those indiscriminately chase companies
- Identifying a cluster's competitive strengths and innovative capacity requires an ongoing dialogue with firms, knowledge institutions and other decision makers at different levels
- It is more important and fruitful for technology and service providers to work with group of interrelated companies on common problems than to work with individual firms
- Economic instruments that support eco-innovation efforts should aim at inter-firm networks than individual firms, if at all should be focused on selected firms that fit within the cluster
- It is difficult for a single policy instrument to create an eco-industrial cluster deliberately within a locality. Instead integrated policy frameworks should create an enabling environment for companies to come together and work on a common agenda. Such an environment should focus on strengthening entrepreneurship skills, development of new markets and improving the availability of capitals physical, economical and social

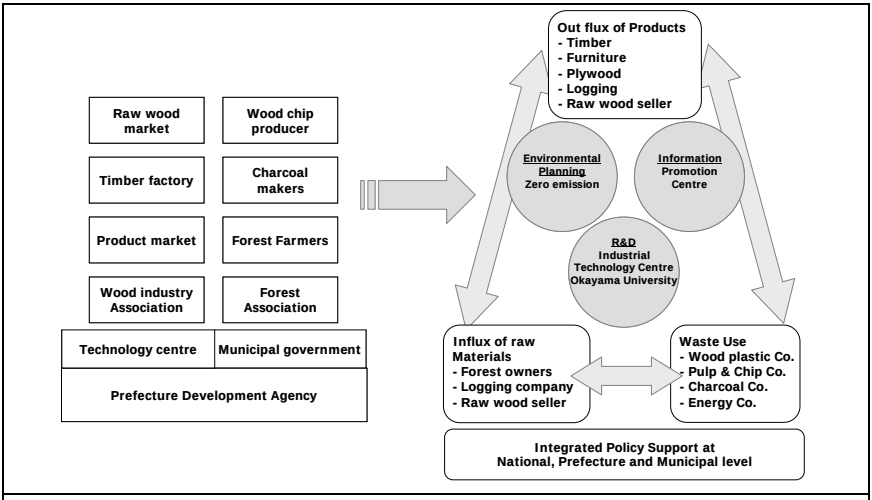


Figure 3.2.12 Business agents in the transformation of Maniwa EIC

3.3 Rice and Livestock Clusters in Thailand

Thailand enjoyed commendable growth rates of about 9% annually from 1985 to 1995. Subsequently, the 1997 Asian Economic crisis brought the growth to a halt thus revealing the weaknesses of long-term plans in the country. With a strong currency rate of about THB 25 / US$ in 1995, the Baht reached its lowest of 56 in January 1998. In the same year the economy contracted by 10.2%. However, Thailand entered a recovery stage in 1998, expanding 4.2% and grew 4.4% in 2000, largely due to strong exports which increased about 20% in 2000. Growth in 2003 and 2004 was over 6% annually.

Thailand exports over US$ 105 billion worth of products annually. Major exports include rice, textiles and footwear, fishery products, rubber, jewelry, automobiles, computers and electrical appliances. Thailand tops the world rice export market with about 6.5 million tons of milled rice annually. Rice is the most important crop in the country. Thailand has the highest percent of arable land, 27.25%, of any nation in the Greater Mekong Sub-region. About 55% of the available land area is used for rice production (IRRI, 2006).

Popularly known as "Detroit of Asia", Thailand is in a phase of rapid industrialization. Though development priorities are focused on the economy-uplifting manufacturing sector, the zeal towards agriculture and local resource based small and medium industries is all pervasive. With vast landmasses devoted to cultivation Thailand ranks top in the global market for its various agricultural and food products. The country capitalizes on its rapid growing agribusinesses and the famous Thai food, which has attracted food lovers all over the world.

Availability of appropriate technology, ability to supply agricultural produce and the international passion for Thai food in addition to quality ingredients and highly skilled workforce have helped Thailand to establish itself as a leading producer and exporter of ready-to-eat food. The geographical position of Thailand, a potential hub of the Southeast Asia, well connected by air and sea routes helps it in realizing its dream of becoming the "Kitchen of the World".

As in any developing country, agriculture and livestock is the predominant source of income and key pin of the rural economy. Chachoengsao, a province to the east of Bangkok metropolis is one of the major rice bowls of the country.

Figure 3.3.1 presents a key map of the Chachoengsao Province. Not to mention the presence of the huge number of livestock farms with swine and poultry occupying a major share. Agricultural and livestock products do not reach the markets in their native form, but undergo various process to add more commercial or market value. Value addition of these products, also called value chain, has several side effects of varying degrees; some beneficial and some adverse. Figure 3.3.2 presents an overview of the various environmental issues arising during value addition to rice.

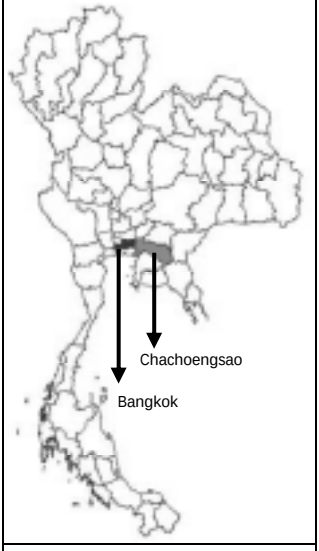


Figure 3.3.1 Location of Chachoengsao Province

Considering the vast paddy fields, rice and rice based industries, and the many swine farms in Chachoengsao, this case study focuses mainly on the rice and swine value chain. In addition, focus is also made, to a small extent, on the poultry sector that plays a small but significant role in the local economy.

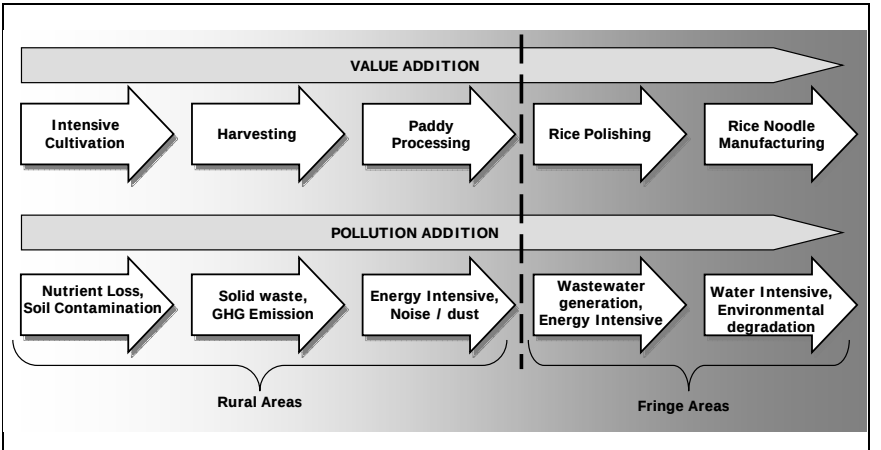


Figure 3.3.2 Rice Value Chain and Environmental Issues

3.3.1 Environmental Baseline of Chachoengsao Province

The research objectives necessitate an understanding of the environmental and social profile of the region to make informed conclusions. With this background the following subsections present an overview of the environmental and social datum of the region.

Topography and Physical Setting

The area of Chachoengsao Province is 5,400 km^2, the second vastest of Eastern Thailand next only to Chanthaburi Province. It reaches over Nakhon Nayok and Prachinburi in the North, Chonburi and Chantaburi Province in the South, Bangkok Metropolis, Samutprakarn and Pathumthani in the West. Figure 3.3.3 presents a map of Chachoengsao Province and neighboring Provinces.

Figure 3.3.3 Map of Chachoengsao

The terrain of Chachoengsao is predominantly wet, with corrugated plains, highlands and hills alternately recurring. The flat terrain is bounteous for cultivation, and along the ridges are seen valuable forests with wild animals. Bang Pakong River, the vein of Chachoengsao originating here, whirls through enriching the soil before moving seaward into the Gulf of Thailand. The River, flowing into the sea at the Bang Pakong district has a coast of about 12 km embraced by rich mangrove forests. Abutted to the sea, the city is influenced by land and sea breezes moistened by the northeast and southwest monsoons which carry with them seasonal rainfall.

Meteorology

The Eastern region of the Gulf of Thailand is influenced by the seasonal Southwest and Northeast monsoon and occasional cyclones. The Southwest monsoon brings rain to this region from May to October. In addition, tropical cyclones and low pressure depressions bring heavy rains in October. Figure 3.3.4 presents the meteorology of the region.

The Northeast monsoon brings with it cold and drought weather from China from November to February. However, this region has a less cold weather than the Northeastern region of Thailand owing to the landscape of the Sankhampang and Phanomdongrak Mountain and its proximity to the sea.

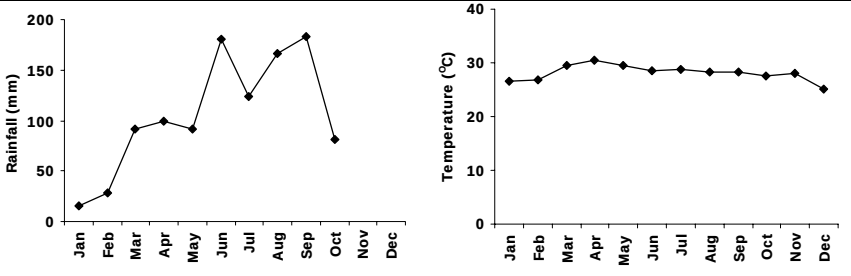


Figure 3.3.4 Meteorology of Chachoengsao Province
(Source: Provincial Statistical Report, 2005)

Administration and Population

The province is subdivided into 10 districts, one minor-district, 93 sub-districts, 870 villages and 22 municipalities. One provincial and 91 district organizations administer the entire province. Figure 3.3.5 presents the administrative map of the Province. Figure 3.3.6 presents the population growth pattern in the region.

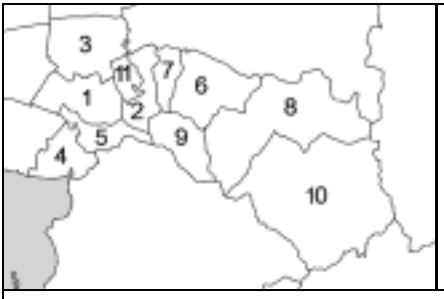
It could be observed from Figure 3.3.6 that the population growth in the recent years (2003 and 2004) follows a negative trend, indicating a population decrease. In a developing country like Thailand, especially in rural areas, population always tends to increase. Decreasing population trends are subject to speculation with two possible reasons either the spread of epidemics or population migration. No life-threatening epidemic has been reported in the region during the recent years. Outward migration of the population to other parts of the province (or country) in search of employment opportunities and other amenities is expected to be the principal cause of population decrease.

Economy

Gross Provincial Product of Chachoengsao is about 55 Million Baht with 90,000 Baht/capita/year and ranks 10th among the Central region and the 12th of the whole country in GPP. Economic growth rate was estimated at 4.17% in 2004.

The relative contribution of various sectors to the local economy, clearly indicates the key role played by the agricultural sector in the region. The manufacturing

sector contributes to a higher degree in the economy of the region, by virtue of the nature of the products which have more market value. Agriculture stands second only to the manufacturing sector.



1. Muang Chachoengsao
2. Bang Khla
3. Bang Nam Priao
4. Bang Pakong
5. Ban Pho
6. Phanom Sarakham
7. Ratchasan
8. Sanam Chai Khet
9. Plaeng Yao
10. Tha Takiap
11. Khlong Khuean

Figure 3.3.5 Administrative Map of Chachoengsao

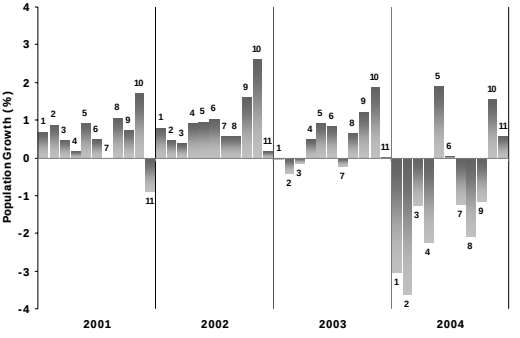


Figure 3.3.6 Population Growth Trends in Chachoengsao Province
(Source: Provincial Statistical Report, 2005)

Agriculture and Livestock

The topography of the region enables the well irrigated plains of Muang Chachoengsao, Bang Khla, Bang Nam Priao, Ban Pho and Bang Pakong district to practice paddy cultivation and cattle farming. The undulated lands of Phanom Sarakham and Plaeng Yao district support farm plantations and ranches. Presently, cultivation lands exceed 60% of the province area; half of which is rice, the major economic crop with a yield of about 3.5 tons/ha. Due to efficient irrigation systems Chachoengsao's paddy fields are highly productive and support upto 5 harvests over a period of 2 years.

Betel nut, coconut, sugar cane, maize, rubber, cashew, pineapple and eucalyptus are the major cash crops. Chachoengsao gives best yields of mangoes, especially in Bang Khla district. The Province also ranks 2nd in the country in tapioca cultivation. Coconut and betel nut are common in Chachoengsao Muang and Bang Khla district. Figure 3.3.7 presents the agricultural land use pattern of Chachoengsao. From the figure it is evident that agricultural land use has been declining over the recent years posing threats to food security and local economy.

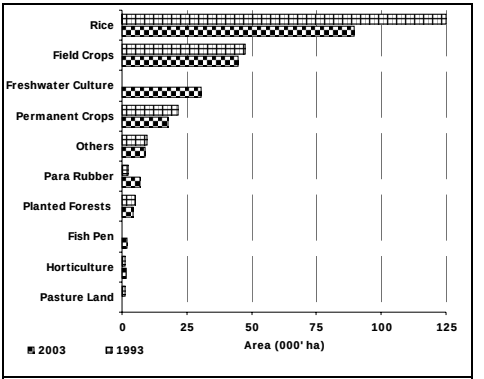


Figure 3.3.7 Land use of Chachoengsao Province
(Source: Agricultural Census of Chachoengsao, 1993-2003)

Water Sources and Quality

The Bang Pakong River, Kong-Thalad Canal and about 750 small streams flowing through the Province are the major water sources in addition to some wetlands. Most of these rivers are perennial and flow even during dry seasons. About nine springs provide water even in the dry season. Around 180 lakes and ponds also serve as local water sources. The large wetlands in the province are Bang Pakong, Khao-ang-rue-nai Natural Reserve and the low-lying areas in the central part of the Province.

Surface Water Sources

The Bang Pakong River flowing across a distance of 122 km is the main source for about 10 districts of Chachoengsao Province, six districts of Chonburi Province, one district of Prachinburi Province and one district of Saraburi Province. The Bang Pakong River Basin is divided into four sub-basins as Bang Pakong River,

Wastewater disposal from rice noodle industry

Nakhonnayok River, Klong-Thalad and Klong-Luang. About 180 million m^3 of water is used for domestic, agricultural and industrial purposes.

Piggery waste waiting for disposal

Water Quality

Increasing industrial and agricultural activities have contributed to serious water quality concerns in the Province. From Figure 3.3.8 it could be observed that most of the parameters exceed the limits prescribed by the Ministry of Health. While all legislative measures have been taken to ensure better quality, water pollution still remains a major concern for the civic bodies.

Bang Pakong river water quality is periodically monitored and has been categorized under Class 3 and 4 of the standards (Class 3 water can be used for agriculture and domestic consumption, but needs to be treated before usage. Class 4 is not appropriate for consumption unless other sources are available. However, adequate treatment and quality control is required before supply). Bang Pakong River water has dissolved oxygen of 2.4-3.5 mg/L and is categorized under Class 4. Bang Khla and Bang Nam Priao districts are under Class 3 with 1.0-1.9 mg/L and Fecal Coliform bacteria of about 40-2,400 MPN/100 mL. In Ban Pho and Muang districts, Lead concentration has been reported exceeding the standards with 0.059 and 0.089 mg/L, respectively.

Bang Pakong River faces seawater intrusion in the dry season, especially in the months of February to June when the regions needs high amount of water for domestic, industry and agriculture purposes.

Piggery waste disposed in water body

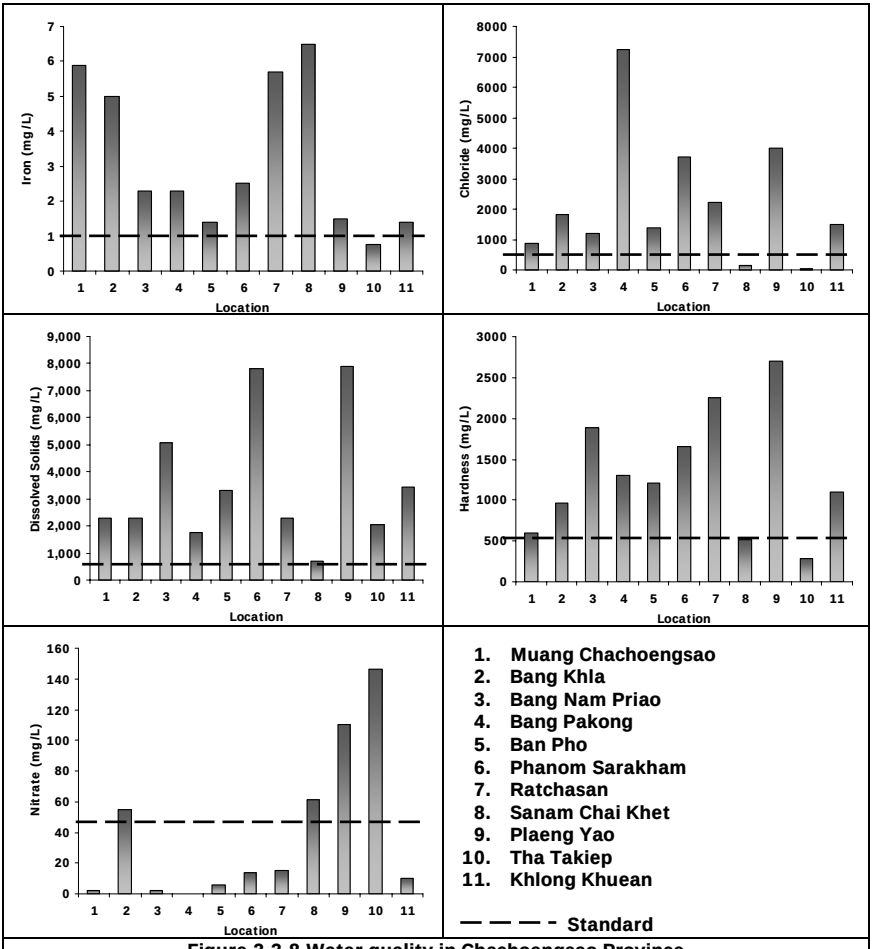


Figure 3.3.8 Water quality in Chachoengsao Province
(Source: Ministry of Public Health,2005)

Table 3.3.1 Bang Pakong River Water Quality

Parameters	Bang Pakong	Class 3 Standard
pH	6.6-7.1	5-9
BOD (mg/L)	0.5-1.0	2.0
DO (mg/L)	3.5-5.9	4.0
Salinity (ppt)	0-0.3	-
Ammonia Nitrogen (mg/L NH_3-N)	0.006-0.110	0.5
Heavy Metal (mg/L)		
▪ Hg	Non-detectable	0.002
▪ Pb	Non-detectable	0.05
▪ Cr	Non-detectable	0.05
▪ Cu	0.013-0.069	0.1
Total Coliform Bacteria (MPN/100 ml)	460-24,000	20,000
Total Fecal Coliform Bacteria (MPN/100 ml)	240-9,300	4,000
(Source : Provincial Statistical Report, 2005)		

Sources of Water Pollution

Sewage

Community wastewater in Chachoengsao Province is about 26,500 m^3/day leading to a BOD of nearly 2,500 kg/day. Chachoengsao Muang municipality contributes the highest BOD of 1,100 kg/day discharged to Bang Pakong River. The second is the Bang Pakong District municipality (180 kg/day) and Bangkhanak District Municipality (50 kg/day). The Chachoengsao Muang Municipality is in the process of constructing a sewage treatment plant with a capacity of 24,000m^3/day.

Agriculture

Rice cultivation areas of the province normally settle near the river or canal. Bang Pakong, Ban Pho, Chachoengsao Muang, Bang Nam Priao and Klong Khuen districts are largely paddy fields. Water pollution problems are mostly observed in the post harvesting period. The paddy stubble and agricultural residues left after harvesting are flooded with the runoff water and discharged into the local water course. In addition, intensive

Piggery waste polluted water source

agricultural practices with huge amounts of pesticides and fertilizers have lead to contamination of both ground and surface water sources.

Aquaculture

The Province is host to tiger prawn farming. A survey conducted in 2001 reported the presence of about 8,590 farms occupying about 10,000 ha which has been continuously increasing in the recent years. The highest concentration of farms is seen in Ban Pho district and Chachoengsao Muang. Wastewater from shrimp farms amounts to 37,500 m^3/ha/year with an average BOD of 5,625-7,500 kg/ha/year and a maximum of 15,000kg/ha/year. Total Kjeldahl Nitrogen (TKN) has been reported at 9 kg/ha/year. Almost 80% of the farms are small scale family owned, which have not been permitted by the Department of Fisheries due to inappropriate environmental management practices such as, unscientific feeding, absence of clarifying ponds, sludge pits, inadequate wastewater treatment systems and discharge of sludge into water sources.

Livestock

Many cattle and livestock farms are present in Chachoengsao Muang, Bang Khla and Phanom Sarakham district. About 900,000 pigs are grown in 1,750 farms in these districts. On an average, a farm with about 200-2,000 pigs generate wastewater at the rate of about 12.5 L/pig/day with a BOD of about 1,400 mg/L - 4,750 mg/L. The average BOD is about 17.65 g/pig/day with a maximum of 58 g/pig/day. Waste generation from pig farms is about 5 kg/pig/day of which nearly 70% is sold. About 75% of the pig farms have composting pits, but in reality the waste is discharged into nearby water sources. Pig farms in Muang Chachoengsao and Bang Khla district cause havoc in water quality, especially in the upstream areas of the Bang Pakong Barrage.

Rice Noodle Making in Chachoengsao

Industries

In 2004, Chachoengsao Province had about 1,153 industrial establishments distributed through out the region as industrial groups. Currently Chachoengsao Muang, Bang Pakong and Bang Khla districts are the centres of industrial

activities. Almost all industries requiring water for the production process are located near water sources. Lack of sound environmental management practices and discharge of wastewater without appropriate treatment into natural resources has given rise to pollution problems.

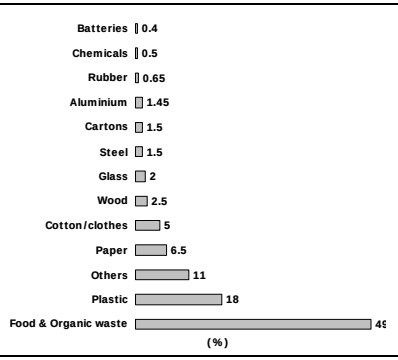


Figure 3.3.9 Solid waste composition of Chachoengsao Muang
(Source: Provincial Statistical Report, 2005)

Solid Waste

Solid waste management is the responsibility of the local administration such as municipality and the sub-district administration. A solid waste study conducted by the Regional Environmental Office shows that the total solid waste generation in the Province is about 400 tons/day of which 175 tons is from the municipality and 225 tons in the district. Chachoengsao Muang with 67tons, Bang Khla (18tons) and Phanom Sarakham (15 tons) are the municipalities which generate the highest waste in the Province. See Figure 3.3.9 Solid waste composition of Chachoengsao Muang.

Tambon Bangwua in Bang Pakong district, Tambon Sanphudad in Ban Pho district and Khoh khanoon in Phanom Sarakham district generating wastes of 20, 12.5 and 11 tons/day, respectively, are the sub-districts with the highest generations. Collection and transportation of solid waste within the municipality is by trucks with capacities of 8-11 m^3. The efficiency of the collection system has been reported to be between 70-90%.

In sub-districts, the quantity of waste generated is small at about 2-3 tons/day. In such places solid wastes are disposed and managed by the households in small open dumps or through burning.

Municipal solid waste, on one side is partially if not fully, taken care by the civic bodies in the best possible way. Industrial waste generation does not pose much threat as no hazardous waste is indiscriminately dumped in public and protected places. However, agricultural residues such as rice straw and rice husk are found in large quantities in the region. Management of these wastes has been a major concern. In addition to this is the solid waste arising from the many pig and

poultry farms. Though some instances of appropriate treatment of piggery and poultry waste exist, it has not been widely practiced on a profitable way. The potential of these wastes to be resources is little known in the region.

Table 3.3.2 Solid Waste Generation in Chachoengsao Muang

Quantity of Solid Waste	67 tons/day
Generation Rate	1.20 kg/person/day
Disposal Method	Open dumping
Area of Disposal Site	5 ha
Location	Bangkwan sub-district in Muang Chachoengsao
Type of Waste	Industrial, Commercial and Agricultural

(Source : Provincial Statistical Report, 2005)

3.3.2 Background of the Rice and Livestock Clusters

Chachoengsao Province is one of the less urbanized and industrialized regions of the country evidenced by the presence of traditional agro industries. The eastern districts of the Province, also the fringe areas of the Bangkok urban, are well irrigated by the Bang Pakong River and support paddy cultivation to a large extent. Soil conditions favorable for paddy cultivation, abundant water supply through out the year and availability of labor promotes agriculture as a mainstream occupation.

The Bangkok metropolis has been fast growing with a drastic increase in migrant population everyday. Added to this is the huge export potential for Thai foods across the world. A positive spin-off is, livestock farming, precisely, swine and poultry becoming a parallel source of income in the recent years. Many poultries (chicken and duck) and pig farms are found in the region. Considering the material flow and economic linkages in the rural urban fringe areas, the study focused on the five urban fringe districts; Muang Chachoengsao, Bang Khla, Bang Nam Priao, Bang Pakong, and Ban Pho. Table 3.3.3 presents a summary of industrial profile of the five study districts.

Typically, all or most of these units are run at the family or small and medium scale. Many units are operated and managed directly by the members of the family though offering employment to a handful of local residents for minor jobs. It is worth mentioning, that entrepreneurship is common in the region; people often find their own family level businesses anywhere within the rice and livestock value chain. Members of the family have clearly defined responsibilities

in the successful operation of their business. In some cases it was observed that the various administrative, technical and financial functions of the business units were divided among the family members. See Box 3.3.1 for a typical example.

Table 3.3.3 Industrial Profile of the Study Area

Type of industries	Number of industrial establishments	Total Capital (Million Baht)	Number of employees
Agro-industry	200	3,700	3,400
Food industry	108	4,400	4,370
Chemical products	41	1,800	1,060
Plastic products	94	6,700	8,730
Metallic products	163	7,500	7,970
Machinery	71	26,000	2,580
Electric devices and appliances	58	15,000	15,550
Automobile products	104	24,000	11,600

Evidently, the nature and scale of agriculture and livestock farming in the region is well connected to the local economy. Unlike in many other sectors and places, proceeds from the business units fuel the native community's lives.

Box 3.3.1 Rice Noodle Estate in Chachoengsao Muang

The Rice Noodle Estate in Chachoengsao Muang district is special in itself that it is a group of neighboring small noodle industries. About 15 small scale noodle industries operate at household levels. Members of the family share the different responsibilities of running the industry. The target markets of these household industries are the urban areas of the Bangkok metropolis.

Raw material, mainly rice, is sourced from local markets. Members of the family and few external laborers form the man power. Waste wood from scrap dealers and small furniture industries are used as fuel for steam generation. Packing materials such as plastic baskets are collected back from the retailers during the next day's supply. Most of the environmental friendly operations in the industry have evolved as cost saving measures.

Though the small industries operate as a community, their collective bargaining power has not been put to use until now. Each business unit has its own markets, both for raw material and finished products.

3.3.3 Components of the Eco-Industrial Cluster

The industrial profile of Chachoengsao Province clearly indicates the role of agriculture and livestock in regional development. Both agriculture and livestock are resource dependent except that one is a major resource consumer, the agriculture sector while the other is a major source of pollution, the livestock.

Clusters, as traditionally defined are small and medium scale industries operating on the same value chain. In this case study, the focus is on the networking of two different clusters to yield better environmental and economic results. The study attempts at analyzing the potentials of creating a network of clusters in solving environmental problems and increasing the resource efficiency of the entire system.

More precisely, the system under consideration is the predominant agriculture sector with rice as the major product, its value chain, the scattered piggery sector, and the small number of poultry farms. An understanding of the clusters in these sectors clearly indicates that tremendous potential exists in networking these clusters. Figure 3.3.10 presents an overview of the components of the cluster network.

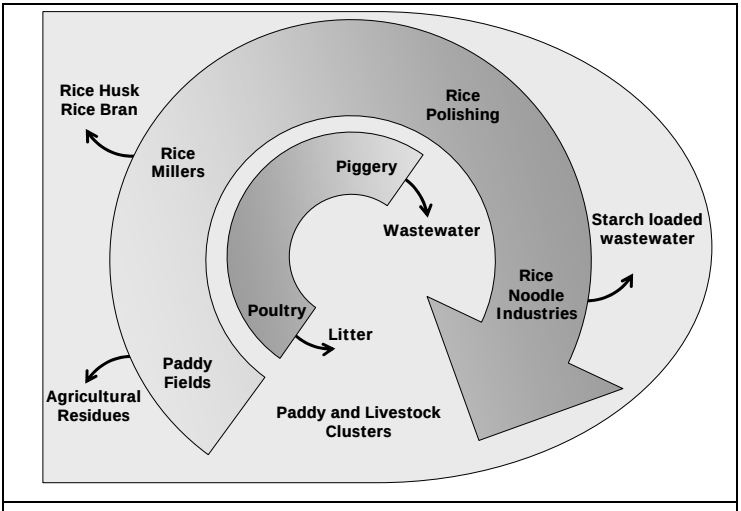


Figure 3.3.10 Components of the Eco-industrial cluster

3.3.4 Material Balance and Flow

The rice and livestock clusters of the study districts are the lifeline of many communities in the region. The simple, yet significant linkages in the sector support the economy in more than one way. With no clear starting point, the material flow among the clusters is rather cyclical than linear. Almost all materials, by-products and wastes or residues find use on one or other component of the entire system.

For the purpose of illustration, the material flow starts with paddy cultivation in and proceeds as many steps as possible until all the products and by-products are completely utilized. Similarly, the piggery and poultry sector which at the first glance do not seem to have a linkage with the agriculture sector are also latently connected through vital material flows. Figure 3.3.11 presents a simplified version of the proposed eco-industrial network. Figure 3.3.12 presents the quantitative material flow pattern in the region. From the figure, it is evident that though a near-perfect material flow occurs, pollution problems due to unrecognized value of materials still exist.

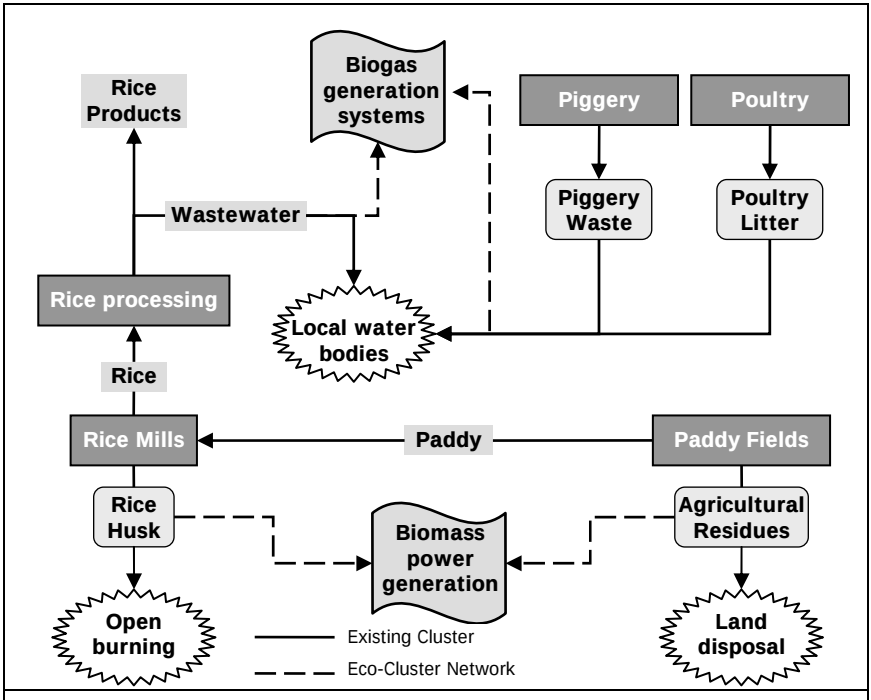


Figure 3.3.11 Eco-industrial cluster network in the Study Area

Rice Clusters

The rice clusters starts with paddy cultivation and consists of individual units of, milling, polishing and parboiling. Edible rice, as a final product is obtained after passing through all these stages. Figure 3.3.13 presents the various stages of rice processing. Table 3.3.4 presents information on rice mills in the region.

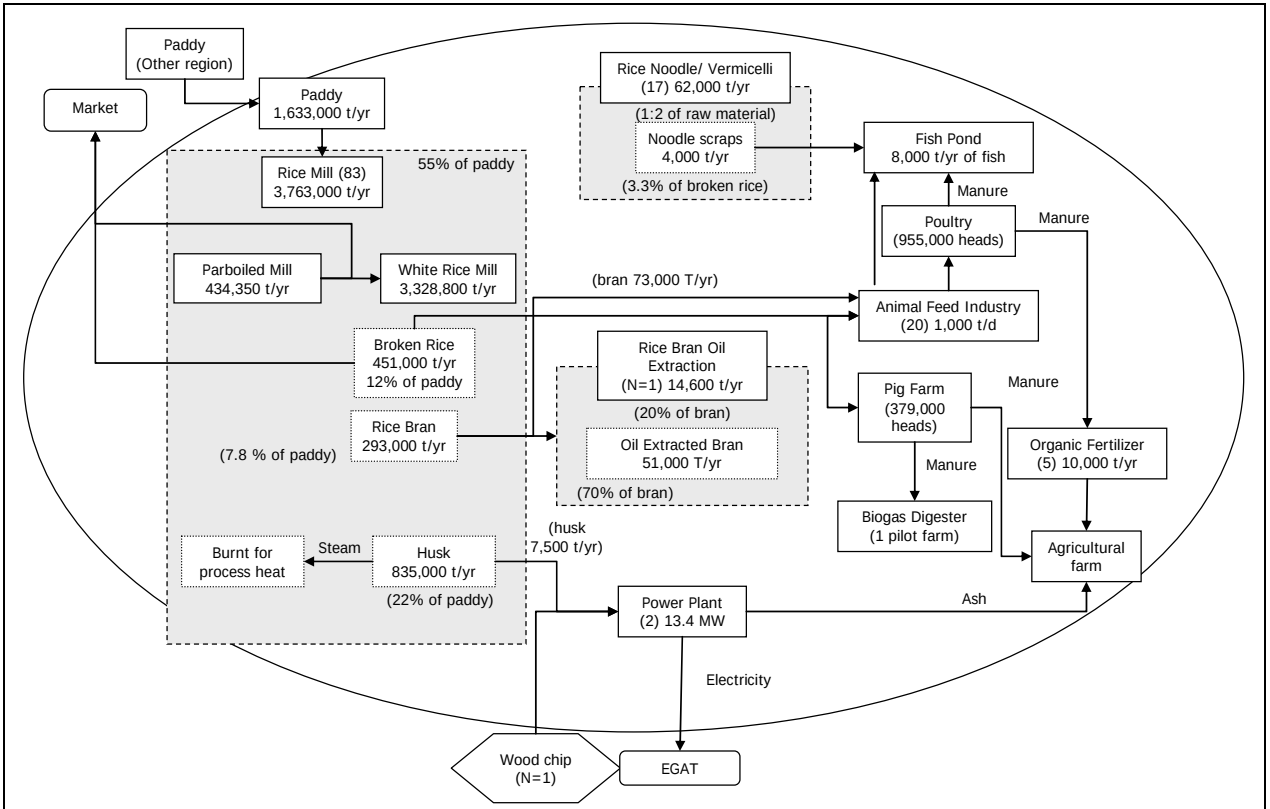


Figure 3.3.12 Material Flow in the Study Area

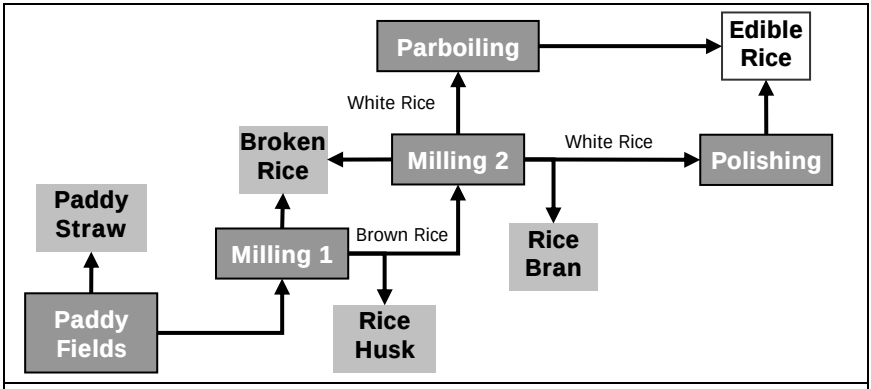


Figure 3.3.13 Rice Processing Stages

Table 3.3.4 Rice Mills in the Study Area

District	Size of Mill			Total
	Small (<18 tons/day)	Medium (18 – 30 tons/day)	Large (>30 tons/day)	
Muang Chachoengsao	5	3	11	19
Bang Khla	2	2	3	7
Bang Nam Priao	8	4	17	29
Bang Pakong	4	1	7	12
Ban Pho	8	3	4	15

Paddy Straw

Straw is a major residue in the rice value chain. Commonly, rice straw is used as animal feed. In some cases, it is used as a field cover to retain soil moisture, and as protection from heat in addition to weed control and providing humus to the soil. In most cases, rice straw is burned in the fields and the ash is used as organic fertilizer.

Rice Husk

The outer cover of the paddy grain, often brown in colour is first removed to expose the rice. With a Lower Heating Value of about 15 MJ/kg, rice husk is often combusted in uncontrolled conditions for thermal energy generation in the rice mills. The ash from the combustion is used as an organic fertilizer. In some cases, not all the rice husk is used for thermal energy generation. In such cases, the rice husk is often discarded as waste.

Table 3.3.5 Rice Based Industries in the Study Area

District	Rice Husk Mills	Rice Boiling Units	Vermicelli Noodle / Units	Rice Husk Grinding Units
Muang Chachoengsao	19	2	14	2
Bang Khla	7	-	5	-
Bang Nam Priao	29	5	1	-
Bang Pakong	13	-	1	-
Ban Pho	15	1	1	-

Rice Bran

Rice bran is an intermediate layer between the inner white rice grain and the outer hull. Comprising about 8% of total weight, Rice Bran accounts for close to 60% of the nutrients found in each rice kernel. Rice Bran is rich in dietary fiber and contains significant quantities of starch, protein, fat, vitamins, and dietary minerals. Rice Bran has multifaceted uses in the food industry as below:

- Enrich bread and breakfast cereals
- Supplement dietary fiber intake (beta-glucan, pectin, and gum)
- Bran Oil used for cooking and in paint manufacturing
- Contains antioxidants that impart beneficial effects on human health
- Contains highly unsaponifiable components such as tocotrienol, gamma-oryzanol, and beta-sitosterol known to lower plasma levels of the lipid profile
- Widely used as a major component in pet foods for rabbits and guinea pigs

Broken Rice

Removal of husk and bran in the rice mills is done through mechanical processes and hence considerable portion of the rice kernels are broken. This broken rice is mechanical sieved and separated. Though broken rice does not carry the same commercial value as that of the whole rice, still a market exists. Broken rice finds various uses in the production of rice

Waste wood as fuel in rice noodle making

noodles, rice flour, rice starch, rice paper, rice glue and many other products which use rice in powder form.

Livestock Clusters

While the rice clusters on one side are highly resource-dependent, the livestock sectors are resource threatening. The environmental impacts of piggeries and poultries are vicious and have been well documented. The study districts in Chachoengsao are home to a number of pig and poultry farms, owing to its proximity to the Bangkok metropolis and the availability of abundant water from the Bang Pakong River. While the proximity to the Bangkok urban ensures steady supply chains and stable markets, the nearness to the Bang Pakong River provides copious water needed for maintenance of Piggeries.

As a consequence of the 1997 economic crisis, Thailand opened up new avenues in the export market to stabilize its economy and increase national income. Exports of pigs and poultry rose sharply in the last few years and contributed significantly to national export earnings. Many spin-offs of such exports were felt, such as savings in feed-grain imports, creation of jobs, increase in incomes of the rural population, and development of other related industries. Consequently, the benefits experienced by the livestock industry were surpassed by social conflicts and negative environmental impacts resulting from intensive livestock rearing near urban areas. Intensive pig farms located close to metropolitan Bangkok resulted in enormous waste disposal problems and aroused the concern of the urban population living close to such production areas.

Piggeries

The main concern in the piggery sector is the uncontrolled discharge of waste from rearing and processing operations into the waterways. In addition, the air in pig farms is laden with dust and noxious gases produced as the animals' urine and feces builds up inside the sheds. Huge amount of water is required to flush these feces and urine from the sheds. Absence of proper drainage systems to collect the feces and urine leads to heavy water consumption for flushing. Eventually, the marginal pig farms of the region do not have proper wastewater treatment plants and hence drain them into local water bodies. Piggeries which have appropriate systems to collect the feces do not have sludge pits to safely dispose them; instead they are allowed to decompose in nearby open lands thus creating odour problems. Individual pig farms have become a serious source of

water pollution, foul odour, noise, infectious diseases and annoying insects to the residents in surrounding areas. Table 3.3.6 presents information on the pig farms in the study area.

Table 3.3.6 Pig Farms in the Study Area

District	Size of farm				Total farms	Number of pigs
	Household (<50)	Small (50-200)	Medium (200-1000)	Large (>1000)		
Muang Chachoengsao	11	32	33	23	99	74,000
Bang Khla	17	46	90	38	191	276,000
Bang Nam Priao	0	2	1	1	4	3,000
Ban Pho	0	4	13	8	25	26,000

Poultries

The poultry sector, similar to the piggery directly causes serious water pollution. The heavy nitrogen and phosphorus content of poultry litter harms local water bodies by causing excess algae growth, oxygen depletion, and the overall degradation of aquatic ecosystems. Severe oxygen depletion usually results when large quantities of organic matter, such as animal manure, pollute waterways. This results in a decrease Dissolved Oxygen content in the water body thus threatening aquatic life.

Besides manure, the decaying carcasses of chickens and ducks that die before reaching the slaughterhouse presents a huge waste management problem for the poultry industry. Poultry growers often have difficulty disposing of the birds' bodies on the farm. Table 3.3.7 presents information on the poultry farms in the region. As pits dug to accommodate dead birds overflow, farmers dispose the dead and dying birds to the nearby open dumpsites. Decaying of dead birds causes odor problems and serves as breeding spot for rodents and insects.

Table 3.3.7 Poultry Farms in the Study Area

District	Number of poultry farms			Total
	Duck	Broiler	Layer	
Muang Chachoengsao	1	4	30	35
Bang Khla	15	3	8	26
Bang Nam Priao	0	1	39	40
Bang Pakong	0	0	4	4
Ban Pho	42	20	35	97
Total farms	58	28	116	202
Total birds ('000)	149	659	5,164	5,971

3.3.5 Technology Needs for EIC formation

The present level of modernization in the cluster could be rated as primitive or in some cases intermediate. Most of the small and micro business units in the region are driven by raw material availability and income generation than for capturing business or increasing markets. Therefore the need to shift to advanced technologies has not yet been felt by the entrepreneurs.

An understanding of the material flow provokes thoughts on the efficiency of the processes in the business units. The issues on resource use and waste disposal pattern in the region can be thought of under two different perspectives.

- Lack of awareness on reuse / alternative use of materials
  Careless disposal of resources in the form of waste is commonly observed in the region. The latent value of such discarded materials is often unknown or unrealized.
- Lack of awareness on best possible use of materials
  In some cases, though materials are reused and recycled, it still does not happen in the best possible way. In other words, materials that could be used for much better are put for ordinary purposes.

Whatever be the issue, in both cases lower material/resource efficiency of the business unit affects the whole system and the region in various ways. With this background, the following technologies are essential for the transformation of the cluster into an eco-industrial cluster.

Rice cluster

Paddy straw and Rice Husk

The transformation of the rice cluster as a part of an eco-industrial could be achieved by making the best possible use of the materials. Ideally, these agricultural residues, paddy straw and rice husk could be used to generate electricity for in-house consumption or for exporting to the grid. For example, the 15 MJ/kg of energy potential of rice straw is used for thermal energy generation. This could be more efficiently used to generate electricity and save budgets on importing fossil fuels in addition to the environmental benefits. Table 3.3.8 presents the common rice-based industrial waste disposal methods in the region.

Energy consumption in rice mills varies depending on whether the mill produces parboiled rice or white rice. While the former consumes more energy due to parboiling, the latter requires relatively less. A study performed by EC-COGEN estimates that white rice milling may require 30 kWh/tonne of paddy, while parboiling requires up to about 60 kWh/tonne.

Table 3.3.8 Agro Waste Disposal Methods in the Study Area

Material	Rice Mills			Parboiled Rice Mills		
	kg/ton paddy	Disposal method	Sale price (Baht/ton)	kg/ton paddy	Disposal method	Sale price (Baht/ton)
Head rice	522	Dealer (market)	12,000	600	Dealer (market)	10,400
Broken rice	125	Dealer (market)	7,500	100	Dealer (market)	7,500
Bran -Fine -Coarse	100 -	Animal feed Mixed in husk	6,500 -	100	Rice bran oil industry	8,250
Husk	300	Power plant	650	100	In plant used, Sale as fuel, Chicken farm	800
Dust	-	Mixed in husk	-	-	Mixed in husk	-
Dirt and mud	16	Land disposal	-	46	Land disposal Use for agriculture	-
Straw	2	Agriculture	1,000	2	Agriculture	1,200
Ash	-	-	-	25 of husk	Planting and cultivation	500

The energy required for the rice mill can be obtained from the utilisation of the husks. In many mills, rice husk is burned under very low efficiency furnaces leaving black ash with high percentage of unburned carbon. Assuming that all rice husks are utilised for power generation, and a specific consumption of 2 kg/kWh the theoretical power potential is considerable that it cannot be put to any simple use. Nevertheless, a consistent and stable supply of paddy for milling and rice straw is essential to establish and operate the electricity generation system. Therefore, the size of the individual mill and its supply chain are key factors in determining the feasibility of generating power. Box 3.3.2 presents an alternative use of Rice Husk Ash

Box 3.3.2 Green Concrete - Rice Husk Ash in the Construction Industry

Rice Husk contributes about 22% by weight of paddy and is often used as fuel in the in rice mills to generate steam. During combustion about 75 % organic volatile matter is burned and the balance, about 25 % is left over as ash. This ash contains around 85 % - 90 % amorphous silica.

As a rule of thumb, for every 1000 kg of paddy milled, about 220 kg (22 %) of husk is produced, and when this husk is burnt in the boilers, about 55 kg (25 %) of ash is generated. This ash is often land applied or simply disposed off without recognizing its potential.

Rice husk ash has a particle size of about 25 microns. Interestingly, technologies exist for the use of this ash as a super-pozzolanic material in the construction industry. With cement having a particle size of about 35 microns voids are formed in concrete mixes. This reduces the strength and quality of the concrete. Rice husk ash is finer than cement and can be used to fill the interstices in between the cement in the concrete mixture

Presently, silica fume or micro silica imported from Norway, China and Burma are used as super-pozzalanic materials. With 85-90% amorphous silica, rice husk ash can be used in the in the production of special cement and concrete mixes, high performance concrete, high strength, low permeability concrete for use in bridges, marine environments, nuclear power plants etc. Research in this direction has been accelerated in many institutions.

(Source : www.ricehuskash.com, 2007)

Rice Bran and Broken Rice

In the present scenario, bran and broken rice from the milling process are used to produce various other edible products. The commercial value of these products is questionable and need to be thought about. The present industrial setup and socio-economic profile of the entrepreneurs does not allow the formation of high-tech industries which can make better use of these materials. While broken rice is observed to be put to its best use, rice bran can be used to produce other commercially valuable products thus securing more value for it. In this regard, it is essential that new supply chains need to be identified and business models devised to divert the bran for better use in the pharmaceutical sector.

Rice Processing Units

The rice processing units in the region are typically small and medium enterprises with limited funds and relatively intermediate technology. Some industries have been using superior technologies, most of them are limited to improving productivity, reducing energy and raw material consumption, and thereby increasing profits. Little or no industries have implemented waste recovery or wastewater treatment systems. Table 3.3.9 presents information on the networking potentials in the study area.

All or most of the rice products, require extensive water in the process. Wastewater streams arising in the various stages of processing contain large amounts of starch dissolved in it. Almost all industries in the study region, simply discard the starch laden wastewater in their backyards or in nearby water bodies. Starch, typically consists of high amounts of carbohydrates and is organic in nature thus imparting very high BOD.

Essential technologies for rice processing industries include recovery of starch from wastewater and (or) biogas capture systems. To a small extent, research has been carried out in the production of ethanol from rice processing wastewater.

Table 3.3.9 Industrial Networking Potentials in the Study Area

Type of industries	Industries related to eco-industrial network	Production Capacity per industry (Ton/year)	Whole industries Ton/year (paddy)
Rice Mill:	82		3,763,150
Parboiled mill	7 (170 t/d of product)	62,050	434,350
White Rice mill	75 (120 t/d of product)	43,800	3,328,800
Noodle/vermicelli	17 (10 t/d of product)	3,650	62,050
Seed Oil Extraction	1 (42 t/d of product)	15,330	15,330
Wood shaving mills	21	-	-
Organic fertilizer	5	2,000	10,000
Maize/soy bean powder	2	30	60
Animal feed mill	20	50	1,000
Small Power Producer	2	10.4MW + 3MW	-

Livestock clusters

Piggery

The environmental problems associated with the Piggery sector have been well debated and documented on a multitude of occasions. Technologies have been constantly evolving to provide low-cost and efficient solutions for solving the waste disposal concerns of the piggery sector.

The piggery cluster of the study region are predominantly owned and operated at the family level, giving little room for technological advancements owing to financial constraints. However, the environmental issues rising from this cluster are so serious that they cannot be sidelined under any circumstance. The common business models followed in the piggery sector are presented in Figure 3.3.14.

The piggery sector in the study region has been following various innovative and modern business models. Nevertheless, all these models have been formulated, tested and implemented in improving productivity. Very little focus has been made on waste disposal issues and environmental concerns.

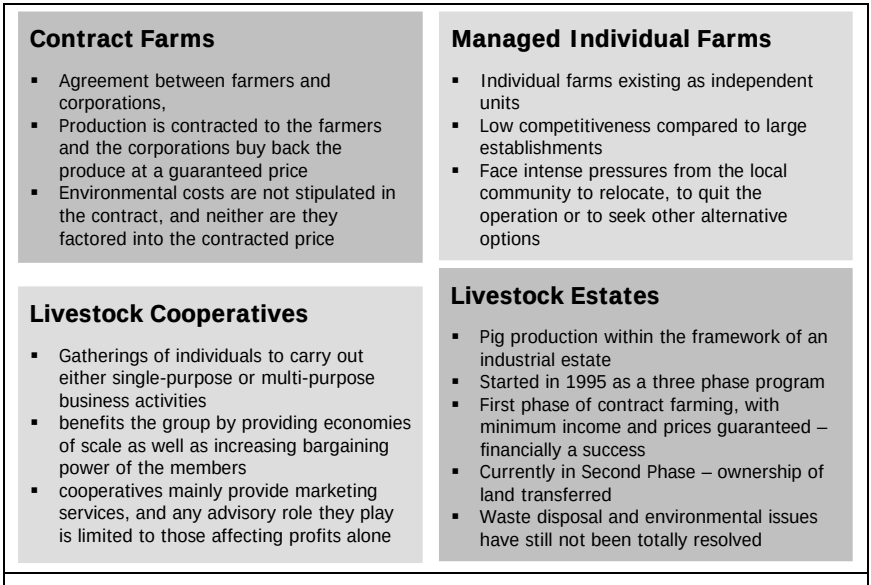


Figure 3.3.14 Livestock Farming Models in Chachoengsao Province

Integration of waste handling and treatment systems in the business models is essential to favor growth and ensure sustainability.

Anaerobic digestion of piggery waste has been widely tried and tested in many countries across the world. The results are appealing in most of the cases. The piggery sector needs to be familiarized with this technology as a means of reducing cost through parallel businesses of electricity generation from biogas generated in anaerobic digesters. The digestate and wastewater resulting from

the digestion process can be used as organic fertilizer in agricultural fields. Box 3.3.3 presents information on biogas generation from piggery waste.

Box 3.3.3 Bio-Towns : A Route to Rural Revival

Reynolds, a small town in the US state of Indiana is a milestone in clubbing environmental issues and social upliftment.

Like any rural area in the world, the town is surrounded by pig farms and soy and corn fields. The pig farmers in the town do not enjoy favorable climate round the year to land apply the piggery waste. This led to cesspools foul smelling piggery waste during most of the cold weather seasons.

The solution to the problem came in the form of using anaerobic digestion at the community level to treat the waste and generate energy. Pig manure is mixed with waste like leftover food and wood waste. As it decomposes, it produces methane which is burned to produce electricity used for lighting and heating. The byproducts from the process are a natural fertilizer and carbon dioxide when the methane is burnt.

Recently, a paper recycling company has showed interest for a new plant in this town owing to low power costs. In addition, the paper dust, the main waste from paper recycling can be mixed with the piggery waste to generate power. This way the company can save money through lowered power costs while solving waste disposal concerns.

(Source : www. sonnenseite.com, 2006)

Poultry

Unlike the piggery sector the environmental issues posed by the poultry sector are confined to the farm. Poultry litter or bird droppings are the feces of the birds, chicken and ducks mainly. The open dumping of this poultry litter releases huge amounts of methane due to uncontrolled anaerobic digestion. This creates a bad environment for the birds, farm workers and local residents. Technology for high rate bio-methanation, as illustrated in Box 3.3.4, is essential in this region to recover resources out of the so-called waste.

Apart from avoiding/reducing waste disposal crisis, these technological interventions can also aid in getting additional income through sale of a carbon credits under Clean Development Mechanism of Kyoto Protocol. This applies to all technological interventions recommended for the study area, such as biomass based power generation from agricultural residues, anaerobic digestion for piggery waste management and high rate bio-methanation for poultry waste.

3.3.6 Policy Implications for EICs

In a country like Thailand where rural businesses and communities are driven by livelihood enhancement, environmental conscious development can be imparted only through policies and government initiated programs. After the 1997 crisis,

Thailand has restored its economic position among the Southeast Asian countries through various policy reforms. This demonstrates the role pro-development policies can play in the upliftment of a nation.

Box 3.3.4 Poultry waste and CDM – The case of Poultry town in Tamil Nadu, India

Namakal a small town in the central part of peninsular India is colloquially known as the Poultry town. The huge number of poultry farms catering to the needs of the entire South India and in some cases meeting export markets has its place in the Climate Change mitigation projects under the Clean Development Mechanism of Kyoto Protocol.

The district houses more than 500 poultries with a bird population of around 20 Million. The bio-methanation plant collects litter from twelve poultries with a population of about 1.5 million birds. These farms produce about 200 tons of litter per day cumulatively. All these farms are within the radius of 4 - 12 km from the project site. The collected litter is transported to the project site where the litter is processed in a bio-methanation digester under controlled conditions for realizing optimal methane generation. The gas is then used for power generation which is sold to the state utility. The digester residue is processed further to produce organic manure.

The project claims GHG emission reductions through the capture of methane which is otherwise emitted to the atmosphere. The emission reductions claimed are traded in international carbon markets and serve as an additional income on top of the sale of electricity.

(Source : UNFCCC, 2007)

The transformation of a cluster into an eco-industrial cluster through formation of resource-efficient networks can be initiated, accelerated and implemented only through well-formulated policies. With this assumption, the following sections present an overview of the prevailing policies in the study sectors and suggest measures for their reformulation and integration.

Thai SME Policy

The clusters studied in the region, by their mere nature and scale of operation, fall into the Small and Medium Enterprises category. Thailand, after its many lessons from the recent economic crisis has realized the need and potential of its SMEs and has made strong policies in accelerating their growth. Various institutions have been formed to foster the growth of SMEs. Figure 3.3.15 presents the policy commitments of these agencies in encouraging clusters.

Incentives by Board of Investment

The study area, Chachoengsao Province is classified under Investment Zone 2 of the Thai Investment Promotion Zones. New industrial activities in these regions qualify for the following fiscal rebates:

- 100% waiver of import duty on machinery for industries in estates

- 50% waiver for industries outside the estate
- Corporate income tax exemption for 7 years for industries within industrial estate and 3 years outside the estate
- Exemption on import duty for raw material for 1 year in both cases

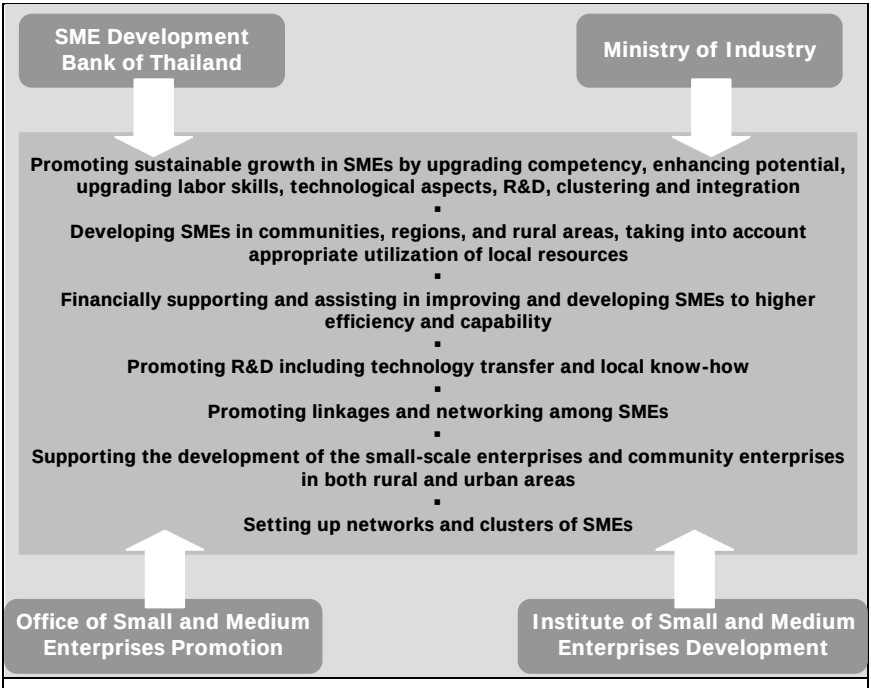


Figure 3.3.15 SME Policies Favoring Cluster development

In addition to the Promotion on Investment Zones, the agro processing industries namely, livestock, slaughtering, meat and food processing, animal feed, agriculture products and waste re-processing have been identified as priority activities. Special incentives are granted for Agro processing Zones. Agriculture and related activities in the agro processing sector classified as priority activities receive the following rebates:

- Machinery import duty exemption
- Corporate income tax exemption for a period of 8 years regardless of zone with no limits
- Other rights and benefits according to BoI announcement

National Economic and Social Development Plan

The 9th National Economic and Social Development Plan (2002-2006) was based on the philosophy of "sufficiency economy" bestowed by His Majesty the King. The philosophy of sufficiency economy is foresees to (a) overcome the economic crisis brought about by unexpected change under conditions of rapid globalization, and (b) achieve sustainable development. The key strategies and action points of the Plan are presented in Figure 3.3.16 and Figure 3.3.17

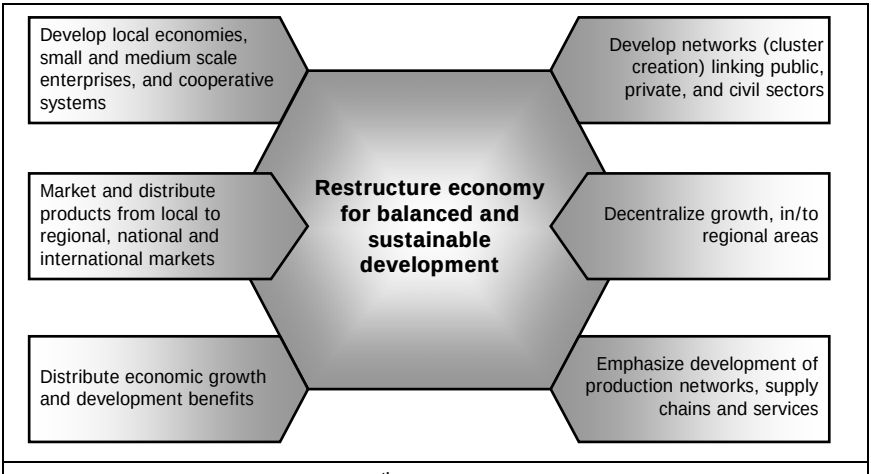


Figure 3.3.16 Strategies of the 9th NESD Plan – Thrust on Rural development

Though the 10th Plan for 2007-2011 is still under deliberation, the main strategies, both directly and indirectly favor rural development and environmental protection. The five main strategies envisaged under the 10th plan are:

- *Enhance human and social development* - A knowledgeable and virtuous Thai society with resiliency of the citizens to meet changes
- *Build strong communities* - Develop a dependable community-level economy and co-exist harmoniously with nature and surrounding environment
- *Strengthen national economy* - Improve production methods to be competitive on the global scale. Create value-added goods while retaining Thai identity. Improve economic and investment infrastructures
- *Resolve Environmental issues* - People to co-exist happily with the environment to ensure good quality of life and to preserve, as well as, protect nature for the future generations

- *Implement good governance* - Strategic management sustainability for long-term national development. Superior government management and good governance to distribute income and authority to the rural communities

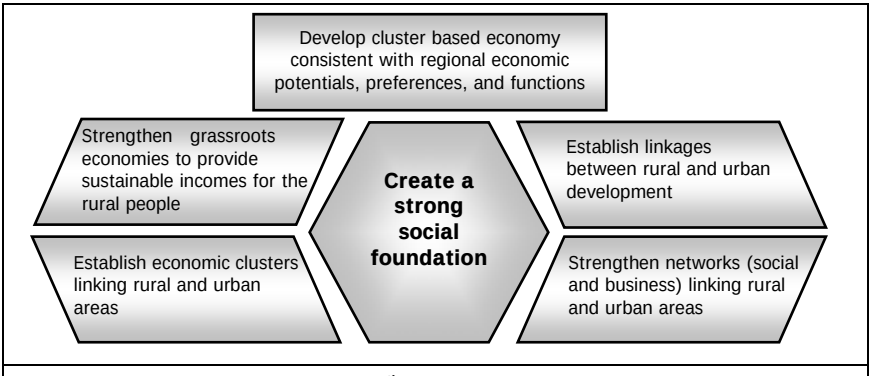


Figure 3.3.17 Action Plans for the 9th NESD Plan – Thrust on Cluster development

Power Generation Policy

Electricity Generation Authority of Thailand (EGAT) is the sole body responsible for the generation, transmission and distribution and sale of electricity in Thailand. Realizing the threats to the national energy security, however, EGAT allows private promoters, technically referred to as Independent Power Producers, to establish and operate power generation projects and buys the electricity at nominal rates. The power generation sector is usually categorized under the large scale business and is subject to significant investment and market risks. Nevertheless, the EGAT has also realized the power generation potential from biomass sources and allows generation at relatively smaller scales under special arrangements known as Small Power Producers (SPP) and Very Small Power Producers (VSPP). Table 3.3.10 presents an overview of the concessions for SPP and VSPP in Thailand. Box 3.3.5 presents information on Renewable Portfolio Standard, an innovative power purchase policy. Essentially, power generators under these special arrangements use biomass and biomass residues as fuels for power generation. In most cases, combined heat and power generators utilize the thermal energy and part of the generated electricity for in-plant purposes and sell the excess to EGAT.

3.3.7 SWOP Analysis

A thorough understanding of the physical setting, industrial profile and policy situation relating to the clusters has yielded through provoking results. The material flow pattern in the region has a positive touch on the resources in the region. Materials and natural resources are used to the benefit of the community thereby increasing income generation opportunities and improving the lifestyle of the rural, though not on par with the urban, yet considerably better.

Table 3.3.10 Small and Very Small Power Purchase Agreements in Thailand

Small Power Producers	Very Small Power Producers
▪ Co-generators or facilities using renewable energy fuels, ▪ Sell power to EGAT of not more than 90 MW for each project. ▪ Minimum purchase guarantee – not less than 80% ▪ Allows direct sale to industrial estates near the power plants	▪ Installed capacity of less than 1 MW ▪ Agricultural residues and wastes from agro industries (e.g. rice husk) ▪ Products converted from agricultural residues, and wastes from agricultural or industrial production processes. (e.g. tapioca wastewater) ▪ Municipal waste: RDF, Bio-methanation

(Source : EPPO, 2007)

Box 3.3.5 Renewable Portfolio Standards

The Renewable Portfolio Standard (RPS) is a flexible, market-driven policy that can ensure that the public benefits of wind, solar, biomass, and geothermal energy continue to be recognized as electricity markets become more competitive. The policy ensures that a minimum amount of renewable energy is included in the portfolio of electricity resources serving a state or country, and by increasing the required amount over time the RPS can put the electricity industry on a path toward increasing sustainability. Because it is a market standard, the RPS relies almost entirely on the private market for its implementation. Market implementation will result in competition, efficiency and innovation that will deliver renewable energy at the lowest possible cost.

Thailand aims to increase renewable energy production of 0.5% in 2002 to 8% in 2011 by following RPS of 5%. Accordingly, new power plants need to generate 5% energy from renewable sources (solar, wind, biomass, solid waste and hydropower).

(Source : EPPO, 2007)

Subjecting the qualitative results of the study to a Strength, Weakness, Opportunities and Potentials (SWOP) analysis is essential to arrive at valid conclusions regarding the transformation of the cluster into an eco-industrial cluster. The environmental setting of the sector and study region was first understood through a baseline study. The material flow pattern of the region was then analyzed at a broader horizon. Considering the waste generated in the

individual clusters, various technological interventions were suggested. Understanding that both the study sector and the region are relatively weaker, the need for policy as a tool to force the transformation was realized and all relevant policies analyzed. The results at all stages were convincing in that the transformation is possible with the introduction of appropriate technologies. However, it is vital that the potential merits and demerits of the transformation are looked upon before arriving at conclusion. Table 3.3.11 presents a summary of the SWOPs of the eco-industrial cluster over the present cluster. The following sections present, at a broader perspective, the various aspects of the transformation.

Efficient sharing of Resources

The present cluster is poised to deliver the core benefits of income generation and employment opportunities to the entrepreneurs and communities, respectively. Owing to various, such as market competition, lack of awareness, low affordability, absence of cost-effective technologies, the cluster has not turned towards sharing of resources. Competition among alike businesses in sourcing raw materials and retaining identified markets finds prominent places in the business agenda. Concern for depleting natural resources was almost absent. The transformation of the cluster into an eco-industrial cluster with appropriate agendas that protect the best interests of the business units can help in increasing material efficiency through sharing.

Gains in Environmental Quality

Evidently, the clusters are the foremost sources of environmental quality deterioration of the region. For various reasons, businesses have not focused on maintaining the integrity of natural resource and the environment. Most polices and programs implemented by the Provincial and National Governments were focused at improving productivity and community livelihood enhancement. Very little effort was placed on environmental protection. Legislations and policy reforms were mostly command and control based stating permissible pollution levels rather than guiding towards pollution reduction.

The transformation to an eco-industrial cluster is an attempt in this direction. One of the main objectives of suggesting technological interventions is to reduce environmental pollution and improve environmental quality along with protection of natural resources.

Table 3.3.11 Rice and Livestock eco-industrial clusters – SWOP Analysis

	Strength	Weakness	Opportunities	Potentials
Present industrial clusters	• Raw material and waste sharing between agriculture and livestock • Access to Bangkok areas leads to a broad spectrum of markets for agricultural and livestock products • Rapidly improving infrastructure facilities such as roads, water supply and electricity in the Province attracts new investments • Cleaner Production potential at individual firm level, SMI level (e.g. Rice Noodle Industry)	• Use of intermediate technology in farming, harvesting and rice processing • Unscientific methods in livestock farming • Pollution of local water sources from high organic livestock wastes • Lack of awareness on technologies and possibilities in resource recovery from agricultural and livestock wastes • Excessive migration of population towards urban Bangkok • Indiscriminate disposal of paddy residues and excreta from piggeries and poultry farms	• Increase employment rate by way of creating new business (e.g. small & medium scale power generation using biomass/biogas) • Increase the local income of the Province leading to improved living standards	• Biomass power generation from agricultural residues • Biogas generation from piggery waste • Community level or decentralized power generation • Organic farming practices - poultry Litter as organic fertilizer
Ideal eco-industrial clusters	• Creation of new business that utilize disposed resources as raw materials– rice husk/biomass power generation; piggery waste biogas • Increase competitiveness of business by reducing production costs; cost reduction in waste disposal + income generation through resource recovery from waste	• Increase in inward population migration from additional employment – pressure on local resources • Creation of more businesses may exert pressure on natural resources for raw materials	• Create additional jobs in rice industry, piggery and poultry through new businesses, services and products in Chachoengsao Province • Prevent outward population migration, a prevailing social issue in Chachoengsao Province, and sustain rural growth • Chachoengsao Province is classified under Zone 2 and hence attract new investments thus increasing the share of the region in the national economy • Cluster formations in Chachoengsao Province, will make the economy of scale more attractive	• Enhance pollution control through biogas systems in piggery • Community participation in local industrial and rural development • Develop resource conscious agriculture, pig and poultry farming • Environmentally friendly business practices in agriculture and livestock waste management • Lower production costs through consumption of locally generated clean power

The transformation to an eco-industrial cluster is an attempt in this direction. One of the main objectives of suggesting technological interventions is to reduce environmental pollution and improve environmental quality along with protection of natural resources.

Socio-Economic Benefits

Given a clean environment with near-ideal material flow, the community can enjoy maximum benefits. The eco-industrial cluster aims at equitable distribution of resources to all stakeholders of the community and all generations of the region. Thus the transformation to an eco-industrial cluster can lead to striking benefits in the long run, though not immediately. Improved local environment, living conditions, fair distribution of income and natural resources, availability of clean air and water becomes possible with the appropriate integration of new technologies to the existing cluster.

Technology Enhancement

Evidently, the level of technology in the present cluster is predominantly intermediate. In some cases it is even primitive. Therefore, a switch towards advanced technologies is vital to improve competitiveness and sustain markets. In addition to improving the financials of the businesses through reduced raw material consumption, lowered waste generation and treatment costs. Technology switching can also result in better working conditions thereby reducing occupational health hazards.

In the present cluster, adopting advanced technologies for waste handling and treatment such as installation of biomass fuelled power generation systems, anaerobic digestion systems, and high-rate bio-methanation systems can lead to benefits such as lower power costs to the entire community. New industries tend to locate themselves at place where power and infrastructure facilities are easily accessible. Elsewhere in the world, there are proven cases where community level power generation systems have attracted many small and medium scale investments, thus enhancing employment opportunities in the region. Therefore, it could reasonable to argue that the introduction of newer technologies in the present cluster, in addition to the transformation can also foster sustainable development in the region.

Community Engagement and Social Agenda

An understanding of the baseline of the region clearly indicates the relationship the clusters have with the local community. The Noodle Estate at Chachoengsao is an ideal example. Natural resources are the property of the indigenous communities. It is essential that their legitimate rights are protected through prudent use of resources. Eventually, all development activities are for the betterment of the native communities and need to be planned accordingly. With this rational, it is logical that newly planned investments should provide direct benefits to the communities.

In the case of the clusters under study, the suggested power generation systems should be designed considering the requirements of the local community. After all, it is the resources of the community which the industries utilize to run their business.

Policy Integration

The proposed clusters are unique in their nature of businesses. While the resource constraints of the rice clusters are different, the environmental problems of the livestock sector are unique on their own. The policies governing these sectors may not overlap, though their impacts overlap on the community. Hence it becomes essential that this shadow effect is considered while policies are made.

When policies and programs for the improvement of a particular sector are considered, it is imperative that those policies do not essentially focus on enhancing the core business values alone. Instead, policies should envisage at a broader scale the whole system which takes part in the activity. Policies should be proactive in nature. It is essential that the policies act as guiding documents of the citizen rather than maze of ambiguous clauses.

Finally, integration of policies of different sectors is essential for the successful transformation towards and eco-industrial cluster. Though, almost all relevant policies for the eco-industrial cluster appear favorable, lack of coherence and consistency clearly exists. Clearly defined policies with specific clauses on latest technologies and business models need to be formulated and constantly updated depending on the increasing pressure on the environment and growing needs of the community.

Inter-firm and Intra-firm linkages

The present cluster activities in the region are fragmented, meaning that no exchange of material, human and natural resources takes place. Given the fact that all materials have some form of value associated with them, it is vital that they are used to the fullest extent before they are disposed of as wastes. Such a sharing of resource of exchange of materials is possible only with the existence of appropriate linkages between firms of a sector and within sectors.

Inter-firm and intra-firm linkages play an important role in the transformation to an eco-industrial cluster. It is through these linkages that the various benefits of sharing resources and their associated environmental and social gains realized.

Barriers to Eco-Industrial Cluster

The Chachoengsao industrial clusters studied are unique in their kind and do have certain characteristic features. However, the age of technology in use in the cluster is assumed to be a major barrier in its transformation. In addition, fragmented or disjointed linkages between and within business units reduces the opportunities for cooperation and enjoying collective benefits. Though all individual policies are attractive, no separate policy adequately addressing all issues in a holistic way exists. Once the above barriers are overcome, the transformation to an eco-industrial cluster can be successful.

3.3.8 Lessons Learned

The material flow in the rice and livestock clusters of Chachoengsao indicates the potential for its transformation to an eco-industrial cluster. Introduction of new technologies are essential for a successful transformation. Appropriate policy reforms considering all related issues of the eco-industrial cluster and rightly integrated with national and local development priorities is essential.

3.4 Fishery Clusters of An Giang Province, Vietnam

With highly unstable governance system for over 100 years, Vietnam has been facing tremendous losses in terms of both human life and natural resources. After its bifurcation into the communist North and the anticommunist South through the 1954 Geneva Accords and the subsequent reunion in mid 70's Vietnam experienced little growth due to conservative leadership policies. Vernacularly known as "Doi Moi", literally meaning "change and newness", was the Vietnamese Communist Party's term for the 1986 economic reform and renovation; transition from a centrally planned command economy to a market economy with socialist direction – also referred to as market socialism.

Under the "Doi-Moi" Vietnamese authorities committed themselves to accelerate economic liberalization and enact structural reforms needed to modernize the economy and produce more competitive, export-driven products. Capitalizing more on its natural resource, focus was made on the rightful utilization of local resources to fuel economic growth. Blessed with abundant water from the Mekong River, Vietnam, especially the southern region, has been thriving mainly on the fishery sector. (See Box 3.4.1)

Box 3.4.1 Skyrocketing Seafood Exports of Vietnam

According to the Vietnam Association of Seafood Exporters and Processors, Vietnam had exported 740,000 tonnes valued at US$ 3.05 Billion, by the end of November 2006, an increase of 29% in quantity and 23% in value over the same period last year

The high growth rate of frozen product exports in general, and tra and basa in particular, has been the decisive reason for the increase in export turnover.

With about US$ 775 Million worth of products, an increase of 2.8% compared to the previous year, Japan has been the leading market for Vietnamese seafood exporters. Meanwhile, exports to the EU have seen a considerable growth rate of 66%, thus allowing the EU to bypass the US and become the second-biggest importer of Vietnamese seafood products.

The fisheries sector expects to reach an export turnover of US$ 3.6 Billion in 2007, a year-on-year increase of 7.02%.

(Source: VET, 2007a)

This section discusses on the rapidly growing fishery sector of the An Giang Province; where the Mekong River enters Vietnam. This region has become the hub of fish farming, processing and exporting in the recent years thus helping to bring in considerable foreign exchange. Associated to this growth is the alarming pollution load. An attempt has been made here to focus on the technological,

management, environmental and policy aspects of developing fish based eco-industrial clusters as a means of reducing pollution and increasing the competitiveness of the fishery sector in international markets.

3.4.1 Environmental Baseline of An Giang province

Fishery sector, which fuels the economy of the region is also the cause of various environmental problems prevailing in the region. Tra and Basa fish, the most widely exported species from Vietnam are raised in large quantities in rivers using fish cages and fish pens and in aquaculture ponds as well. These types of freshwater fish culture have been in practice for many years now. Most of these fish farms are managed by small families in rural areas following unscientific methods of cultivation, disease prevention and feeding. Harvested fish is processed further using various techniques and is exported. During these processes, the pressure exerted on the environment in terms of pollution and resource consumption is so enormous that it becomes unsustainable. In addition, such unscientific methods of fish raising and processing result in more waste streams. Hence, understanding the environmental setting of the region becomes inevitable to arrive at plausible solutions through eco-industrial clustering.

Topography and Physical Settling

An Giang province located in the southern part of Vietnam has an area of 3,425 km^2 . Can Tho, Kien Giang and Dong Thap provinces surround An Giang in the South, Southwest and East, respectively, while Cambodia borders the Northwest. Figure 3.4.1 presents the location map of An Giang Province.

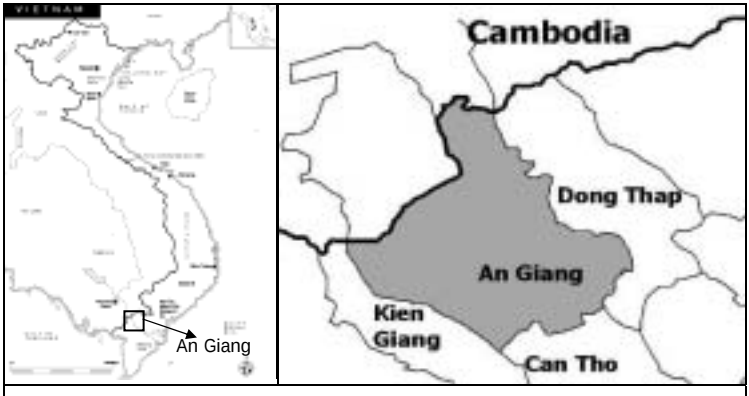


Figure 3.4.1 Location of An Giang Province

An Giang province has the credit of being the point of entry for the Mekong River into the country. Long Xuyen City, the provincial capital and Chau Doc Town, located on the Hau Giang River, a distributary of the Mekong, exist as independent municipalities and are the relatively urbanized areas of the Province. In addition to the fertile Mekong delta, An Giang province also has mountainous terrains in the Phu Huu commune, Phu Xuyen district, Vinh Te commune and Chau Doc Town. The unique topography with both mountains and plains opens a diversified economic, social and cultural setting in the province.

Dwellings along the Mekong River

Meteorology

As in the case of any tropical region, the province has both rainy and dry seasons. The rainy season is from May to September while the dry is from November to March. An annual average rainfall of 1,500 to 1,600 mm, a maximum of 2,100 mm and lowest of 900 mm have been witnessed in the past. Rainfall during the dry season from December to April rarely exceeds 100mm.

The average ambient temperature in An Giang province is around 25°C with a peak of about 40°C. The lowest temperature recorded is about 15°C in the delta area and 13°C in the mountainous area.

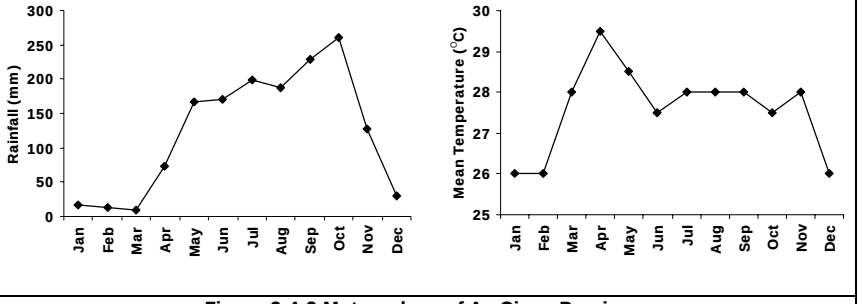
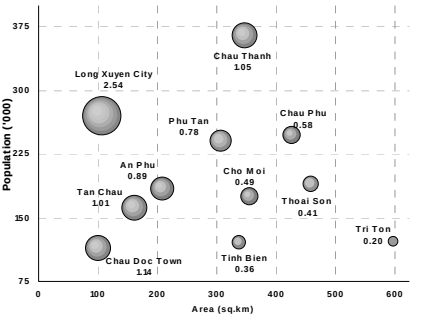


Figure 3.4.2 Meteorology of An Giang Province
(Source: Provincial Statistical Report, 2005)

Administration and Population

An Giang province is subdivided into one secondary level city, one town and 11 districts. Figure 3.4.3 presents the administrative map of An Giang province. Long Xuyen city and Chau Doc towns are the centres of economic activity in the Province. Figure 3.4.4 presents information on the land area of the districts and their population. The figure clearly shows that population density (represented by the size of the circles) is relatively higher in Long Xuyen and Chau Doc. Increasing economic activities and improved infrastructure and living conditions have contributed to very high population densities in these areas.

Figure 3.4.3 District Map of An Giang Province



Note: Size of the circle denotes the population density.

Figure 3.4.4 Demography of An Giang Province
(Source: An Giang Province Statistical Report, 2005)

Economy

The Province is strategically located in the Lower Basin of Mekong Delta where the Mekong Rivers first enters Vietnam. The Mekong branches into 2 rivers, Tien and Hau, which form interlacing waterways and irrigation networks thus favouring the fishery sector. The average flow of these rivers is 13,800 m^3/s with a peak of 24,000 m^3/s during floods and 5,020 m^3/s in dry seasons. With the advantageous rivers, agriculture and fishery developed rapidly and promoted the developing of various allied industries in the province. In the first half 2006, An Giang Province exported about 37,000 tons of basa and tra fish, a 7.7% increase compared to 2005.

Even in the current years of rapid industrialization and modernization, the largest share of economy is from agriculture, fisheries and fish processing. With

contributions from diverse sectors, the Gross Domestic Product (GDP) of An Giang Province is close to US$ 1200 with an annual per capita GDP of about US$560.

Agriculture and Livestock

An Giang province has a diversified agriculture and livestock system owing to its unique topography. The fertile delta and availability of copious water round the year has favored rice cultivation to a large extent thus making the Province one of the leading producers of rice. Beside paddy cultivation, other agricultural crops in An Giang province are maize, coconut, sugarcane, vegetables and cassava making agriculture a key sector in the economy of the region.

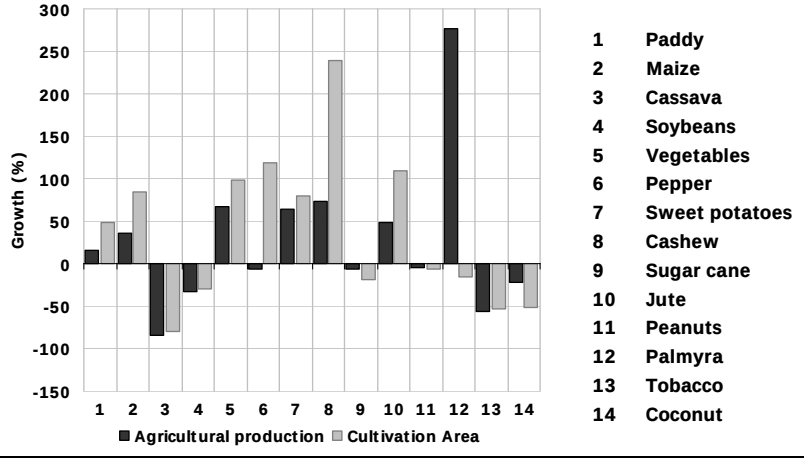


Figure 3.4.5 Agricultural production and land use in An Giang province 2001 – 2005
(Source : An Giang Province Statistical Report, 2005)

Water sources and water quality

The entire river system of An Giang province branches into about 280 minor and major distributaries with a density of about 0.72 km/km^2, the highest in the Mekong delta region. Interlacing canals, arroyos and irrigation systems are plentiful water resources not only for domestic but also for agricultural activities in the province. The whole province has about 7000 wells, 23 water supply stations and 96 water supply plants that can be used for industrial production and domestic consumption.

In the past, several big water reservoirs such as O Tuc Sa, Soai So, An Hao, Cay Duoc were built for domestic supply but were not upgraded to meet the increasing water demand. So, An Giang province had to construct new water supply plants in city, town and district centers and populous areas. More reservoirs were constructed on mountains for water storage in wet season.

Surface water

Alarmingly, the quality of water in Tien and Hau Rivers does not meet the Vietnamese Standard 5942:1995, both in the dry and rainy seasons (Table 3.4.1). The possible reasons for these problems are as follows:

- Fishery Cultivation along the rivers
- Discharge of industrial effluents
- Absence of sewage treatment plant

Fish Cage Culture

Ground water

In An Giang province, wells are concentrated in Vam Cong Area, My Thoi Ward with depths varying between 250 – 300m and flow of about 50 – 70 m^3/h. According to the Eighth Geological League, ground water table is observed at about 100 m along the Hau River and in the Northwestern part of the province. About 30,000 m^3/day at a depth of 80 – 100 m and 85,000m^3/day at 250 – 300 m can be exploited.

From Table 3.4.1 it could be observed that flood plays a major role in maintaining the water quality in the region. In the dry season, waters of Hau river are more contaminated than Tien river because most of fishery activities (cultivation and processing) are practiced in this river. Besides, wastewater from industrial zones and residential areas are discharged in Hau river thus causing serious pollution problems. Consequently, surface water quality in the fish cage areas need to be monitored regularly in order to ensure safe conditions not only for aquatic life but also for other economics that are connected closely with the river system. The possible causes of deteriorating water quality are:

- High fish cage density as in Da Phuoc, My Hoa Hung and Chau Phu
- Absence of appropriate sanitary facilities for sewage treatment.

- Wastes and wastewater habitations along the river
- Chemicals, solid wastes and wastewater from activities in fish cages, fish ponds and fish pens disposed to the rivers

Table 3.4.1 Surface Water Quality in An Giang Province

Parameter	Area	Dry season		Rain season	
		Lowest	Highest	Lowest	Highest
Temperature (°C)	Tien River	30.1	31.1	29.8	30.4
	Hau River	29.4	30.2	28.8	30.1
	Canal- arroyos	28.6	31.0	28.2	30.1
pH	Tien River	6.30	6.80	6.3	6.5
	Hau River	5.74	6.30	6.3	6.6
	Canal- arroyos	5.73	7.98	5.46	6.6
	TCVN 5942:1995	***6 – 8.5***			
SS (mg/L)	Tien River	9	38	170	230
	Hau River	13	61	24	112
	Canal- arroyos	10	84	24	102
	TCVN 5942:1995	***20***			
DO (mg/L)	Tien River	2.10	5.60	3.5	6
	Hau River	3.00	4.93	3.1	4.1
	Canal- arroyos	2.46	4.62	2.22	6
	TCVN 5942:1995	***≥ 6***			
NH_3 (mg/L)	Tien River	0.07	0.34	0.64	1.12
	Hau River	0.09	5.20	0.14	0.72
	Canal- arroyos	0.09	2.22	0.11	0.65
	TCVN 5942:1995	***0.05***			
BOD (mg/L)	Tien River	4	6	5	9
	Hau River	6	11	2	9
	Canal- arroyos	3	7	2	10
	TCVN 5942:1995	***< 4***			
Coliform total (*MPN/100 ml*)	Tien River	$93x10^3$	$2800x10^3$	64x103	$110000x10^3$
	Hau River	$70x10^3$	$4600x10^3$	$75x10^3$	$11000x10^3$
	Canal- arroyos	$0.7x10^3$	$4600x10^3$	$0.75x10^3$	$210000x10^3$
	TCVN 5942:1995	***5 x 10^3***			

(Source : An Giang Department of Natural Resources and Environment, 2006)

Flooding regime

Flood levels in An Giang province, especially during the rainy season is not stable and varies between 17 cm/day and 36 cm/day. When the flood runs into the field, water level decreases and becomes stable at about 2-4cm/day. The highest flooding slope is 5 cm/km for Tien river and 4 cm/km in Hau river. Every year about 2 - 5 months are marked flood-seasons in An Giang province. In this season, 70% of the province area is covered by water up to 1 – 2.5 m.

Wastewater

Domestic wastewater

Fish pens along the Mekong River

Domestic wastewater in the province is discharged directly to Hau river without any treatment. In Nui Sam ward Chau Doc town, The Sam Mountain Sanitation Project will construct rain water collection systems, wastewater collection systems and landfill for Ba Chua Xu Nui Sam area. This project is in the technical design stage and scheduled to be completed in the end of 2006.

Industrial wastewater

Fish processing industries are the major water intensive industries in the region. Wastewaters from these industries add biological pollutants to the water sources, rather than hard-to-treat physicochemical pollutants from other industries. Table 3.4.2 below presents the fish processing industries of the region and their wastewater generation.

Most of the wastewater treatment plants in the province do not meet their present production capacity of fish processing. This results in a huge amount of partially or untreated wastewater thus not being able to meet the Vietnamese Standards. For example, the Nam Viet Factory wastewater treatment plant can treat only 400m^3, while the generation is about 3000 m^3. Therefore, the remaining wastewater has to be discharged directly to the river.

Table 3.4.2 Treated wastewater quality from fish factories in An Giang Province

Factory Name	Wastewater Generation (m^3/day)	pH	BOD_5 mg/L	N-NH3 mg/L	COD mg/L	SS mg/L	Coliforms total MPN/100ml
TCVN 5945-1995		**6-9**	**20**	**0.1**	**50**	**50**	**10×10^3**
Afiex Factory	250	7.8	49	5.32	-	558	46×10^4
Antseco Fish Processing	500	7.9	15	0.003	-	1,028	46×10^3
Nam Việt Fish Processing	3000	8.1	19	1	-	1,397	64×10^3
Thuận An Fish Processing	500	5.5	23	-	9	11.3	24.10^3

Solid Waste Generation

Municipal solid waste

Solid waste generation at An Giang province is about 980 tons/day. In the recent years, domestic solid wastes are collected and are either open burnt during the dry season or sprayed with Effective Microorganism (EM) solution and lime in wet season so as to speed up the disintegration process. Most of the present landfills were built below the water level, so in the flooded areas the solid wastes collection and treatment systems are not efficient. Only 63 of the 288 markets are connected to the collecting system. The remaining solid waste is buried or disposed elsewhere or in nearby rivers.

There are 11 big open dumps for the major inhabitations of An Giang province while small dumpsites cater the needs of the markets and communes. Domestic and industrial solid wastes, mostly from fishery, vegetable processing factories, are collected and transported to the dumpsites. In the site, they are sprayed with EM or burned depending on the season. This often results in odor and smoke problems thereby causing serious pollution.

Waste Recycling

There are 73 small enterprises that trade the recyclable solid wastes in the province. The commonly traded solid wastes are metal, rubbish, glass, paper, leather etc. The capacity of each enterprise varies between 10-200 tons/year.

Social Development Profile

Organizations

Since 1995, many international NGOs operate in An Giang funding humanitarian and development projects/program. These international and national organizations play an important role in the development of the province in many fields such as agriculture, irrigation, infrastructure, education and training, social, health and sanitation etc. Most of the projects in the province are in irrigation and infrastructure development thus helping An Giang upgrade its the infrastructure and create the potential for development. An Giang government also calls for investment from international NGOs with favorable conditions in legislation, tax and other preferential methods.

Below are some projects in An Giang province funded by NGOs that participate with organizations and institutions in the province to support the development of An Giang province and the Mekong Delta as a whole.

Micro-Credit projects

Focusing on at-risk women in An Giang, Kien Giang and Dong Thap provinces, these organizations have committed for five year programs with contributions totaling US$ 500,000. The project is a microfinance program to assist disadvantaged women named SEED (Sustainable Economic Efficiency Development) with the support of the An Giang University. Under Project SEED, disadvantaged women will receive funding (in form of small loans) and training to start or expand businesses. The program is based on one principal premise: providing at-risk women with economic opportunities will lower their need for sexual trafficking. Project SEED aims to create opportunities as opposed to granting unconditional aid relief. With an opportunity and the right tools, disadvantaged Vietnamese women can secure a sense of well-being, self-reliance, and confidence which in turn will improve their status within their families and communities.

North Vam Nao Water control Project

This project assist An Giang Province in establishing and operating an effective water management system in North Vam Nao which is socially and environmentally sustainable and benefits the local economy by assisting in the alleviation of poverty. Other objective of the project is to strengthen the capacity

of provincial agencies in the An Giang Province to plan, operate, and maintain an integrated water control system in North Vam Nao that is efficient and effective and meets the requirements of multiple users.

Research Institutes

An Giang University situated in Long Xuyen City of An Giang Province was established by the Prime Minister's Decision No 240/QD-TTg dated December 30, 1999. It is administered financially by the People's Committee of An Giang Province and supervised technically by the Ministry of Education and Training of the Central Government. This university is the center of education, research that creates the sustainable human resources in the province.

Economic

In order to implement the economic structure changing task, An Giang government conducts many programs such as: "Eradicate Hunger and Alleviate Poverty", increasing investment on building infrastructure, developing handicraft traditional village; step by step increasing the industry and service components.

Industrial development status

Seafood processing industry

The province has 10 processing factories with a total capacity of 65,000 tons/year. With Tra and Basa fish as the main material, over 70 categories of value added products are being produced. Most fish processing enterprises apply the international quality control standards such as ISO, HACCP and HALAL Certificate, Permission Code to enter Europe. The export markets include 34 countries, mainly U.S, EU, Mexico, Australia, China, Korea, Canada, Japan, etc. Export turnover is over 120 million USD/year (accounting for nearly 50% of total turnover of the whole Province).

Animal feed processing industry

The development of aquaculture, animal husbandry, especially food for fish and processing food for animal/fish is strongly expanding. An Giang has invested in this technology since 1995 and has developed equipments continuously. Output in 2003 was over 27,000 tons, increasing 5.68 times in comparison with that of 1995 and that of 34,034 ton in 2004. It is expected to reach 50,000 tons in 2005 to supply the whole Mekong Delta Region.

Traditional villages

Traditional village products are famous in the country including Chau Doc salted-fish and dried fish, Thot Lot sugar, pictures decorated by Thot Lot leaf, fresh Thot Lot fruit flesh, home decoration and furniture products made from water hyacinth, local dried flowers, leaves, grass, and brocade of ethnic people (Cham and Khmer) as well as hand embroidered products.

3.4.2 Background of the Fish Based Eco-industrial Clusters

The environmental and social baseline survey clearly indicates that environmental pollution is a serious issue in the region. Especially, water sources are highly polluted and are facing severe threats from the fast developing fishery sector. The fishery sector completely dependent on the Mekong River is the fuel of the economy and its protection is of immense importance in sustaining both the environment and economy. The following sections illustrate how Eco-industrial clustering, as a tool, can be applied to the fishery sector in helping it to reduce pollution, protect natural resources, and improve its competitiveness.

3.4.3 Components of the Eco-industrial Cluster

The fishery sector has a relatively long and strong supply chain with various industries closely linked. The supply chain primarily starts with the fish farms and continues up to the frozen fish processing industry with various other allied production facilities and services connected.

Considering the role of various industries in the fishery supply chain, the following six main subsectors with fish breeding, feeding, processing, fish/animal feed processing, animal medicine, fish byproduct processing and waste treatment systems are proposed for the Fish-based Eco-Industrial Cluster (FEIC) are (Figure 3.4.6). The sectors interact among each other and form an eco-industrial network of material exchange.

The baby fish from the hatcheries are transferred to and fed in the fish farms. After 6 months, the harvested fish is sent to the processing industry where the final products are exported or consumed in the local markets. Byproducts like fish fat is used for fuel processing and the rejected parts such as skin, head, and bones are used to make fish powder or animal feed.

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Fish Hatchery in An Giang Province

Among the considered sectors in the eco-industrial cluster, fish processing and feed/powder processing units are located in Long Xuyen City while the others such as fish farms, hatchery and animal feed processing units are located in the fringe areas. The existing links among these sectors are quite weak. Better policies, technologies and social capital are required for strong interaction among the firms.

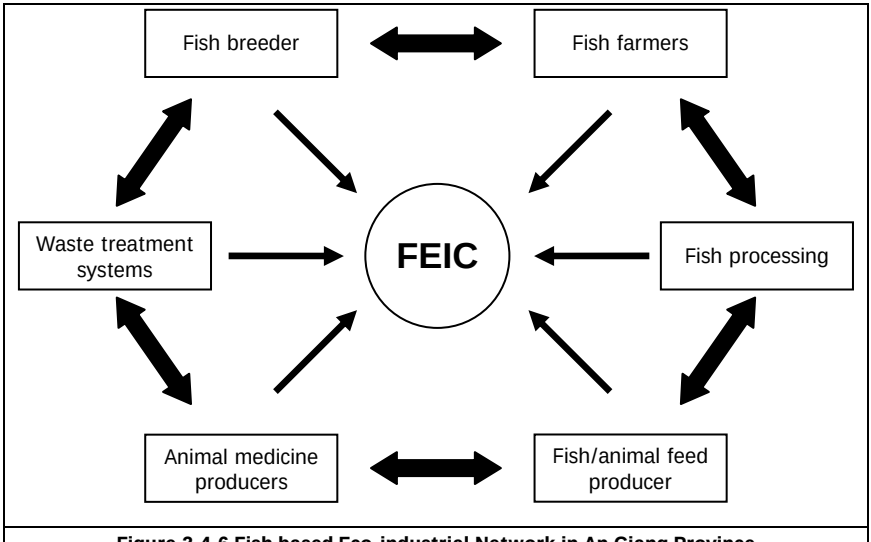


Figure 3.4.6 Fish based Eco-industrial Network in An Giang Province

3.4.4 Material Balance and Flow

In 2005, the demand for Basa and Tra fish was 167 million while for other fishes like snake fish and tilapia it was 117 million. The production of parent fish and baby fish was 155 million and 5 billion, respectively. After 6 months of feeding, these parent fish give a yield of 180,000 tons including 145,000 tons of Basa and Tra and 35,000 tons of other fishes.

In general, the agricultural products from the province were sufficient to meet the demands for fish feed processing. However, seafish powder had to be imported due to its high protein content compared to freshwater fishes.

Fish Feeding

The eco-industrial cluster includes all kinds of fishes. Low economic value fishes are also included in the network as they consume the by-products from the fish processing factories thereby reducing waste and increasing diversity in fish markets. The proposed eco-industrial cluster in An Giang provides 62,000 tons of by-products from fish processing factories and 17,000 tons of dead fish to animal feed processing factories.

Box 3.4.2 Catfish processing complex in An Giang Province by 2007

The An Giang Fisheries Import and Export Joint Stock Company (AGIFISH) plans to start an integrated industrial complex to process Tra and Basa catfish into operation in early 2007.

The project will be built at an estimated cost of US$ 6.25 Million, mobilized from AGIFISH members through shares and bonds.

The complex will be located in Binh Hoa industrial zone of Chau Thanh District in An Giang Province.

The complex is expected to include plants specialized in processing bone, skin and fat of Tra and Basa catfish into products serving industry, pharmaceuticals and food processing.

(Source: VET, 2007b)

Tra and Basa fish are rich in fat (more than 15%). About 145,000 tonnes of Tra and Basa fish produces 22,000 tonnes of fat and generates 25,000 L of bio-fuels, the equivalent of 57,500 kWh of electricity. This bio-fuel is supplied to fish

farmers for pumping water from the river to fish ponds. Other valuable products such as medicines, high- nutrient food for children, etc. are also produced from fish fat.

Fish Processing Factory in An Giang

There are around 10 fish-processing factories in An Giang province. These factories generate about 7,250 m^3 of wastewater and nearly three tonnes of sludge per day after appropriate treatment. Wastewater and sludge released from fish farms amounts up to 630 million m^3 and 250 tonnes, respectively. While the sludge generated is used to make fertilizer, the treated wastewater is used for various purposes such as irrigation and washing pig cages. Figure 3.4.7 presents an overview of the material flow in the region.

Production Methods in the cluster

The different methods followed by the sub-sectors of the cluster are summarized below.

Fish Breeding and Feeding

The fishery supply chain starts with the breeding of the fish which is more commonly done in traditional and unscientific ways. The environmental and health issues related to such type of breeding were realized through denied market opportunities in the recent years. Export markets and buyers insisted on practicing internationally recognized farming and breeding systems to ensure the quality of the fish. Considering the market stipulations, in the recent years, most of the fish farmers follow fish breeding and feeding procedures based on SQF 1000.

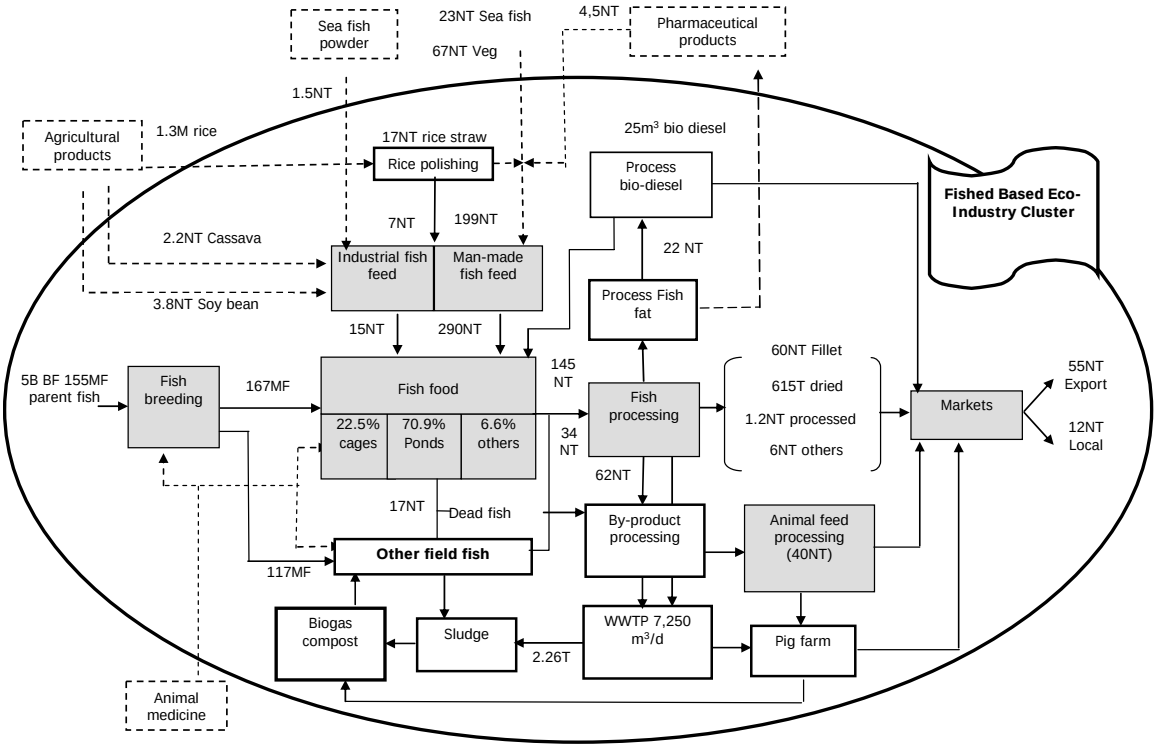


Figure 3.4.7 Material flow analysis in Fish-based eco- industrial cluster.

Box 3.4.3 Equations and Rates used for Material Balance

Fish food

1.6 – 1.7 kg food (95% is home-made fish feed and 5% industrial feed) will produce 1 kg fish meat,

Composition of industrial food

Wheat: 15%, Soybean: 25-30%, Fish powder: 5-10%, Bran: 50%

Composition of man-made food

Bran: 69%, Sea fish: 8%, Spinach: 23%, Vitamin: 1.5%

Processed fish components

1kg fish = 300 g fillet + 150 g fat + 170 g crushed meat + 358 g head and bones + 8 g stomach + 13.8 g bladder

Products from rice polishing

Rice : Husk : Bran : Broken rice = 1: 0.25: 0.14: 0.05 = 3.140 : 785 : 439 : 157

1liter oil = 2.5 kWh electricity, 25 m^3 oil = 57.500 kWh

Wastewater treatment plant with capacity of 500m^3/day disposes 155.58kg/day sludge.

Amount of fish feed required to produce 179,412 ton fish products:

179,412 * 1.7 = 305,000.4 ton (T), including:

Industrial food: 305,000.4 * 5% = 15,250.02 ton, in which

Cassava 15% =0.15 * 15,250.02 = 2,287.5 ton

Soybean 25% = 0.25 * 15,250.02 = 3,812.505 ton

Fish starch 10% = 0.1 * 15,250.02 = 1,525 ton

Bran 50% =0.5 * 15,250.02 = 7,625.01 ton

Man-made food: 305,000.4 * 95% = 289,750.38 ton

Bran 69% = 0.69 * 289,750.38 = 199,927.76 ton

Fish 8% = 0.08 * 289,750.38 = 23,180.03 ton

Spinach 23% = 0.23 * 289,750.38 = 66,642.59 ton

Rice husk: 5*10*199,927.76:600 = 16,660.65 ton

(Cooking 600kg fish feed needs 5 packs of rice husk, each of which is 100kg)

Nutrients 1.5% = 0.015*305,000.4 = 4.5 NT

Total mass of bran needed: 207,552.77 ton

Vegetable: 66,642.59 ton, Cassava: 2,287.5 ton, Soybean: 3,812.505 ton,

Fish powder: 1,525 ton, Sea fish: 23,180.03 ton; Rice husk: 16,660.65 ton.

Table 3.4.3 Fish Processing Methods

Smoked Tra and Basa Fish Fillets	*Procedure*	Filleting → Freezing → De-freezing → Washing → Adding spices in cold condition → Draining → Smoking → Vacuum packing → Storage
	Advantage	• New products for local and international markets • Commercial value products 1.5-2 times better than frozen fillets
Spiced and Dried Fish	*Procedure*	Washing → Removal of skin and bones → Adding spices → Drying to suitable moisture content
	Advantage	• Uses salvage fish which has low economic value to produce higher value products • Dried fish products have high quality and meet food safety standards.
Fish/Shrimp Meat-Pill	*Procedure*	Fish/shrimp pills are produced by machines with a production capacity of 100 – 200 pills/minute
	Advantage	• Comprehensive process, complete technology • Cheap, easy to install and operate • High productivity • Meets food safety standards
Canned Fish	*Procedure*	Raw material → Treating → Canning → Liquid addition → Disinfecting → Storing → Labeling → Final product
	Advantage	• Equipments suitable to household, medium and small scale enterprises • Less labor requirement • Less water and electricity consumption
Tra Fish Liver Pate	*Procedure*	Fish and poultry liver → Wash → Cut into small pieces → Mix → Spice, (Additive 1) → Freezing (5-10^{o}C, 12-24 hours) → A Fish and poultry meat → Wash → Cut into small pieces → Thermal processing → A A→ Grinding → Spice (Additive 2) → Weighing → Canning → Eliminating air → Combining liquids → Disinfecting → Freezing → Labeling →Storage
	Advantage	• Small and light equipment • Low investment cost • High reliability • Suits Vietnamese taste and economy

Fish, Shrimp and Eel Sausage	*Procedure*	Automatic machine based on pressing principle with capacity of 120 kg/h is used
	Advantage	• High capacity • Meets food safety and sanitation requirement. • Flexible, low cost and suitable for small- scale production • Easy installation.
High Protein Fish Sauce	*Procedure*	Vacuum condensing to evaporate water, increase protein concentration in fish sauce and retain natural odor of products
	Advantage	• Increases protein concentration in fish sauce to 50-60 g/liters. • Meet food quality and safety standards. • Equipments are locally made and cheap

Table 3.4.4 Fish / Animal Feed Processing Methods

Shrimp Feed processing	*Procedure*	Raw crushing → Pulverizing → Moisturizing → Mixing → Pressing → Thermal releasing → Cooling → Cutting → Drying Capacity : 200kg/h
	Advantages	• Low product price (about 1/3rd of the price of imported feed) • Products have high protein concentration (35%); time for self-decomposing in water is 4 - 7 hr. • Feed sterilized to avoid bacteria and fungus
Fish Feed processing	*Procedure*	Raw materials →Raw crushing → Pulverizing → Mixing → Shaping → Drying and sterilizing → Cooling → Packing → Preserving
	Advantages	• Low investment cost and high quality products • Meet quality requirements such as: floating, slow decomposing, less losing, high nutrient value and eco-friendly

Waste Treatment Methods

Fish Processing Factories

Wastewater from the storage tank is pumped to an anaerobic tank where the BOD is decreased by 40-50% due to the growth of anaerobic bacteria. The presence of these bacteria continuously decreases the BOD of wastewater to about 30-40%. Suspended substances and sludge produced during the bio-treatment process is collected in a primary sedimentation tank where flocculants are added. A secondary sedimentation tank is used to completely remove suspended substances and odd sludge. Wastewater from the secondary sedimentation tank is treated with chlorine to disinfect bacteria before further

disposal. The treatment process has a very low investment cost. Notably, the treated wastewater often meets Vietnamese standard TCVN 5945-1995 class B or class A. With very little labor and chemical requirements the treatment cost works to around 0.16 -0.19 USD/m^3.

Table 3.4.5 By-product Processing Methods

Cooking Oil and High Nutrient Food	*Procedure*	Basa fish fat (solid) → Cook → Liquid oil → Process fish oil (liquid part) → Neutralize → Wash → Dry → Eliminate odor → Basa fish oil or mixed cooking oil Fish fat (condense) → Neutralize → Wash → Dry → Eliminate odor → Mixing→ Shortening (fish fat composition of Margarine is -3, -6 (Decosa Hexaneoic Acid (DHA))
	Advantage	• Applicable in small-scale production and household scale. • Fish oil can be processed to cooking oil • Fish fat can be processed to make shortening margarine
Bio-Fuel	*Procedure*	Fish Fat→ Mixing→Trans-esterification→ Sedimentation→ Extraction→ Bio-fuel
	Advantage	• Reduce COx, NOx, dust emission by 40 - 50% • Low processing cost: 0.08 USD/litre, • Selling Price 0.52 USD/litre, • Profit 0.13 – 0.23 USD/litre • Creates job opportunity. • Reduces fish-fat disposal problems • Recover resources from waste
Margarine	*Procedure*	Basa fish fat and different types of oil → Heat to melting point → Mix with additive → Mix in low temperature (25 – 30°C) → Crush→ Product → Pack → Preserve in dry areas
	Advantage	• Products have stable quality • Increase the nutrient content in Basa fish fat.
Fish Powder	*Procedure*	Material → Classify → Purify → Steam → Dry →Crush → Pack. Products: 10-15 kg pack of fish powder, fish oil
	Advantage	• Use modern techniques for production. • Locally designed process, hence low initial capital investment. • Easy installation and maintenance of machinery

Fish Ponds

Fish pond aquaculture bloomed recently and hence a suitable technology for treating wastewater from fish ponds is not available. Wastewater is generally discharged directly to rivers or canals thus resulting in water pollution.

An Giang province has issued environmental regulations which require every farmer to set aside 10% of their land for treating wastewater using biological treatment ponds before discharging. After passing through biological ponds, the wastewater is discharged to wetlands, ponds or fields with hydro-vegetables such as elephant grass and water hyacinth for secondary treatment. If the treated water meets class B of the Vietnamese environmental standards for wastewater disposal it can be used for irrigation or disposed to water bodies.

Fish farmers also add biological products directly into fish ponds during fish feeding to stimulate the growth of organic-decomposing organisms, thereby reducing the frequency and amount of water exchange and sludge extraction.

Sludge treatment

Sludge from wastewater treatment plants and fish ponds are used as fertilizers after sun-drying.

3.4.5 Technology Needs for EIC formation

Green and clean technologies are the key tools to achieve the objectives of eco-industrial clustering. The material flow pattern in the region indicates that with the introduction of appropriate technology, the clusters in the region can be transformed into eco-industrial clusters. However, the study identifies the following technology interventions as important to the formation of EIC.

- Cleaner Production in fish processing, with special focus on reducing by-products and saving water and energy
- Reuse and recycling, e.g., production of bio-fuel, glycerol, dried-fat, alcohol, food additives from fish fat, fertilizer from sludge, animal feed from fish by-products such as, blood, skin, head, bones etc.
- Clean production models for fish feeding and processing. (e.g., HACCP, SQF 1000 and SQF 2000)
- Affordable and simple technology for treating wastewater and sludge from fish ponds

- New business models suitable for small-scale fish farms, e.g., aquaculture models for households with limited capital, access to market information and exposure to better fish feeding technology.
- Transformation from fish cage culture to fish pond culture and significantly reduce pollution problems

Technologies for waste treatment and reuse are very important to transform an industrial cluster to an eco-industrial cluster. Box 3.4.4 presents the expected environmental benefits from the eco-industrial cluster. In An Giang, technology for reuse of fish fat to make bio-fuel is one important linkage that can transform the existing cluster into an eco-industrial cluster. Sustainable development of the eco-industrial cluster can be achieved only when the wastewater and sludge treatment technologies ensure optimum water quality and environmental conditions in the fish feeding areas.

Box 3.4.4 Expected environmental benefits from fish based eco-industrial clusters in An Giang

A fish based eco-industrial cluster in An Giang may contribute to the reduction of about 118,000 tons of solid wastes per year; approximately equal to 35% of the solid wastes of An Giang province. The reduced solid wastes consists of about 17,000 ton of rice straw, 62,000 ton of head and bone of fish, 2,200 ton of pig faeces, and 37,000 ton of sludge.

In addition, the eco-industrial clusters will reuse about 3% of treated wastewaters from fish processing plants for pig feeding every year, amounting to about 36,500m3/year.

The eco-industrial cluster is also expected to reduce nearly 32,250 tons of CO2/year; equal to the amount of CO2 generated from the thermal power plant with a capacity of about 66 million kWh/year.

Fuel	Quantity (per year)	CO_2 (tons/year)	Equivalent Fuel		CO_2 emission reductions (ton/year)
			Volume (10^6 L/year)	CO_2 emission (ton/year)	
Bio-diesel	25 million litres	41,878	31.25	83,750	41,872
Biogas	11,440 million litres	13,483	8.58	22,994	9,511
Rice Straw	17,000 tons	21,893	1.02	2,734	-19,159
Total					**32,224**

Though some technologies already exist and are advantageous, there are some constraints for the development of eco-industrial cluster. For example, bio-fuel processing from fish fat was recently discovered and is being currently scaled up. It is necessary to set up special policies for extending use of bio-fuel. In fact, due to lack of regulations on quality standard of bio-fuel products, large-scale companies are not allowed to produce and consume bio-fuel.

3.4.6 Policy Implications for EICs

In a developing country like Vietnam, which capitalizes more on local resources appropriate policies are essential to sustain economic growth. The remote regions of the country are still impoverished and the fruits of science and technology have not reached the grassroots. When the goal is to make their livelihood, environmental protection often takes the last priority and hence imparting resource conscious development becomes the task of the government. Worldwide, successful environmental protection has been achieved through policy reforms and capacity building measures. The role of policies in developing an environmental friendly community needs no illustration.

The following sections discuss the role and implications of policies in the development of an eco-industrial cluster with fishery sector as the central axis.

Impact Analysis of Policies on EIC Formation

Table 3.4.6 lists the main policies related to the formation of eco-industrial clusters. With the triple bottom line in mind, policies have been approached as environment, economic and social policies. Though policies overlap among themselves, the segregation has been done qualitatively based on their major objectives.

Administratively, the Vietnamese Government follows a communist system where the Central Government holds the absolute power over all decisions and provides the final resolution to all issues. However, in the recent years, the Central Government has given powers to the Provincial Authorities to decide on local issues. In any case of dispute, the stance of the Central Government will be final. With this background an analysis of the polices, both at the Central and Provincial level has been made. That table also presents the key points of relevant policies while their key implications are presented in the following sections. A compendium of policies related to eco-industrial clustering such as for fisheries, industries, environmental protection, social development, waste management and food safety etc,.

Table 3.4.6 Policies influencing Eco-industrial Clustering in fishery sector

Policy Regime	Central Government	An Giang Provincial Authority
Economy *Fishery industries* *SME & rural industry promotion* *Production and export*	▪ Decree No. 59/1999/CT-TT ▪ Decision No.80/2002/QĐ-TTg ▪ Instruction No.24/2003/CT-TTg ▪ Decision No.10/2006/QĐ-TTg ▪ Instruction No. 24/2003/CT-TTg ▪ Decision No. 06/2003/CT-TTg ▪ Decree No.134/2004/NĐ-CP ▪ Decision No.132/2000/QĐ-TTg ▪ Decree No. 26/1999/CT-TT	▪ Decision No.1747/2002/QĐ-UB ▪ Decision No.894/2004/QĐ-UB ▪ Decision No.859/2006/QĐ-UB ▪ Plan No. 43/2005/KH-UBND ▪ Decree No.35/2003/CT-UB ▪ Decree No.28/2005/CT-UB ▪ Decision No.3368/2005/QĐ-UB ▪ Decision No. 668/2004/QĐ - UB
Environment *Sustainable development, Solid waste, Water and wastewater Energy conservation*	▪ Decision No.153/2004/QĐ-TTg ▪ Decree No. 199/2004/TTg ▪ Decision No. 64/2003/QĐ-TTg ▪ Instruction No. 06/2003 & 28/2005/CT-TTg	▪ Decision No. 717/2006/QĐ-UB ▪ Decree No.34/2004/CT-UB ▪ Decree No.05/2003/CT-UB ▪ Decision No. 1582/1999/QĐ-UB
Society *Safe food, Agriculture, Husbandry Vocational training*	▪ Decision No. 07/2005 & 26/2005QĐ-BTS ▪ Decision No.143/2004/QĐ-TTg	▪ Decision No. 83/2005/QĐ-CT.UB ▪ Decision No. 3458/2005/QĐ-UB

Policies for establishing EICs

Economic policies

The most important policies that stimulate EIC development are the economic policies, especially, those encouraging the development of fish industries. Recently, development strategies have emphasized economic structure transformation from agricultural to fishery development (e.g. Decision No. 59 and Instruction No.24/2003).

Following such strategies, a series of decisions have been issued related to the approval of fishery development Master Plan till 2010 (Decision No.859) and encouraging development of rural areas (No. 859). In addition, establishing an Executive Board for the transformation from an agricultural economy to fishery economy in An Giang province (Decision No. 1848) has also been emphasized.
All policies encourage development of small and medium enterprises and rural industries, growth of private sectors (Decision no.94) and establishment of goods

producing areas associated with market and processing industries. An Giang province has also issued a provincial criteria on Trade Villages through Decree No. 35/2003.

Policies also promote investment, production and trade, especially in enhancing export economy (Decree No. 26) and provincial strategies. Economic integration and promoting trade in international boundary areas has received special focus.

Recently, policies have been simplified and decentralized. Industrial clusters and industrial parks are divided into two management levels: provincial and district levels. The second level requires very simple procedure to establish industrial clusters and is suitable for small and medium enterprises. In 2005, the An Giang Provincial Authority has initiated a "one-door stop" policy in the administrative system.

Box 3.4.5 Implementation of Policies Encouraging Fishery in An Giang

In An Giang province, aquaculture licenses could be used to avail loans. Farmers could avail loan up to 70% of their capital for fish cage with their license. For instance, one ha of fish breeding license could fetch a loan of upto US$ 3000 or one ha of fish pond could loan up to US$ 2000, 5 times higher than the normal rate in national banks.

"One door stop" for license issue. License will be granted within three days of application and with a low registration fee of 0.02 USD/ton.

Financial support in the form of soft loans for fish farmers at a low interest rate of 0.45 % per annum.

No tax for using water resources. Need to pay only land use tax (38.7 USD/year) and license fee.

No income tax for fish farmers

Establish contingency funds to protect against market risks and fall of fish price based on the minimum exporting price of 2.9 USD/kg fish fillet.

Government issues irrigation bonds to encourage irrigation systems and use them to develop water drainage and supply canals to fish ponds.

Environmental policies

Policies for promoting sustainable development (Decision No.153), solid waste management (Decree No.199), water and wastewater management (Decision No. 67 on wastewater fee), save electricity, fuel (Instruction No.28 and No.6), etc., favor the formation of eco-industrial clusters.

An Giang has approved provincial environmental action plan in 2006 (Decision No.717) and issued regulations for protection of surface water quality in 1999, water use fee (Decision No. 2720) and environmental protection fee and

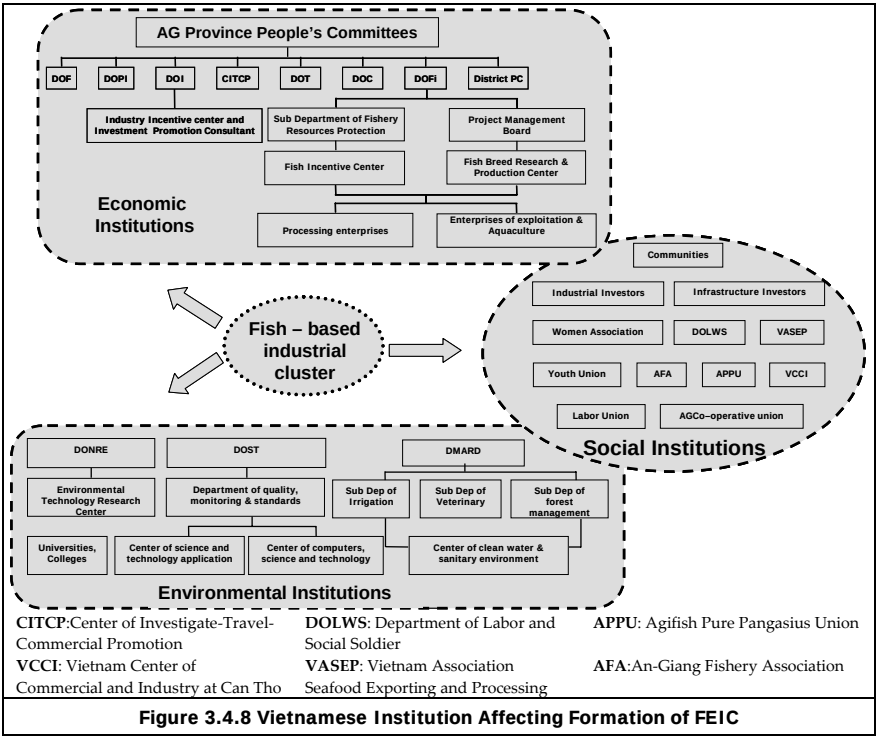
wastewater fee (Decision No.2718). Policies to save energy against fuel waste have been applied since 2005.

Social policies

More concern was given to policies on food safety, agriculture, husbandry, science research and vocational training. A list of banned chemicals in fish products was issued in 2005 (Decision No. 07 and No. 26). Policies on decentralization and other activities of fish associations were formulated.

Institutional Analysis for EICs

Various institutions, Government Departments and non-governmental organizations exist in Vietnam. Their role in the development of the fishery sector has been well recognized and clearly defined. Figure 3.4.8 below presents an overview of these institutions. Table 3.4.7 maps the role of the various departments in eco-industrial cluster development.



CITCP:Center of Investigate-Travel-Commercial Promotion
DOLWS: Department of Labor and Social Soldier
APPU: Agifish Pure Pangasius Union
VCCI: Vietnam Center of Commercial and Industry at Can Tho
VASEP: Vietnam Association Seafood Exporting and Processing
AFA:An-Giang Fishery Association

Figure 3.4.8 Vietnamese Institution Affecting Formation of FEIC

Table 3.4.7 Responsibilities of Governmental, Institutional and Social stakeholder of EICs in An Giang Province

Policies	Economic organizations								Organizations of science, technology and environment			Public and social organizations		
	DOF	DOPI	DOI	CITCP	DOT	DOC	DOFi	PC	DONRE	DOST	DMARD	Public and other social organizations	Fishery Association	Industrial Association
Development and protection of fishery resource	O	O			O		●	O	O		●	⊙	⊙	
Rural development	O	O	O				O	O	O	O	●	⊙		
Development of industry, industrial parks, industrial and handicraft clusters	O	O	●			O		O	O	O		⊙		⊙
Development of Trade Villages	O	O						O			●	⊙		
Development of cooperation in medium and small-scale enterprises	O	O	●			O		O			●	⊙		
Socio-economic development	O	O	O	O	O	O	O	●	O	O	O	⊙	⊙	⊙
Export incentive	O			●										
Investment and trade incentive	O			●				●						
Environmental protection	O	O						O	●	O	O	⊙		

Natural resource protection	O	O						O	O	O	●	⊙		
Science and technology	O							O		●				
Associations	O							O						
Training and job solving	O							O				⊙	⊙	⊙

● **Strong impact** O **Medium impact** ⊙ **Weak impact** **Blanks - Insignificant impact**

Provincial Institutions in the Formation of EIC

The Provincial People's Committee conducts investment programs for industrial parks and clusters. In addition, it also issues and approves policies, investment projects and assigns tasks to functional organizations as presented in Table 3.4.8

Table 3.4.8 Role of Provincial Institutions

Organization	Function/responsibility
Department of Industry	• Co-operate with respective department and organize investment programs in industrial parks and clusters • Report results and rate of progress to Provincial People's Committee. • Consult People's Committee to promulgate policies and incentive solutions for developing provincial industrial parks. • Integrate construction programs of industrial parks as one objective of master plan of industrial development of An Giang province.
Department of Planning and Investment	• Allocate annual budget for investing on construction of industrial parks and clusters. • Establish plans of calling for investment in industrial parks and clusters • Timely register for investors
Department of Finance	• Propose capital structure and support investors with low interest rates.
Department of Agriculture and Rural Development	• Establish projects of agricultural development which concentrates on association with processing enterprises to industrial parks and clusters
Department of Science and Technology	• Support technology transfer for enterprises in industrial parks and clusters.
Department of Resource and Environment	• Support investors to implement land use planning for industrial parks and clusters, carry out procedures of revoking, delivering and receiving land • Support enterprises to implement projects on environmental protection and waste treatment.
Department of Construction	• Approve infrastructure investment projects • Give permission to investors to construct industrial parks and clusters
Center of trade-tourism and investment promotion	• Promote investments in industrial parks and clusters based on the list of investment projects of the province.
District and City People's Committee	• Deploy to implement industrial parks and clusters in provinces, towns and cities according to program objectives.

3.4.7 SWOP Analysis

An analysis of the potentials of eco-industrial cluster formation with the fishery sector as the central axis appears to be lucrative in terms of resource conservation, pollution reduction and increasing competitiveness. The linkages between the various sub-sectors of fishery processing are promising in that they offer enormous potential for improvement and strengthening. However, linking the potential sub-sectors and strengthening the weak linkages depends on numerous factors which are often beyond the control of the entrepreneurs. Subjecting the findings of the research to a simple Strengths, Weakness, Opportunities and Potentials (SWOP) analysis becomes essential to arrive at valid conclusions. Table 3.4.10 presents the key findings of the SWOP.

Efficient sharing of Resources

The fishery supply chain has a diverse range of products linked in a complex manner. An understanding of the raw material consumption and resource use in the sector and its sub-sectors clearly indicates the possible extent of sharing resources. Need of raw materials at competitive prices rather than environmental and resource consciousness is the driving force of the sharing. It is evident that a strong potential for more efficiently utilizing the resources exists. However, making industries share resources more efficiently needs a push that could be given only through market forces and policy measures.

Gains in Environmental Quality

The existing cluster activities in the fishery sector are resource intensive and polluting. When the cluster is transformed into an eco-industrial cluster, the following benefits may be derived.

- Lesser burden on natural fish resources due to reduced fish catch
- Efficient use of centralized wastewater treatment system and other shared resources (water supply, energy and electricity systems)
- Reduced waste emission beyond the network
- Reduced transportation requirements
- Reduced fossil fuel dependence by producing bio-diesel from fish fat
- Produce high quality products and protect consumers' health
- Contribute to environmental protection activities in the locality

Table 3.4.9 Fish based eco-industrial clusters – SWOP Analysis

	Strength	Weakness	Opportunities	Potentials
Present industrial clusters	• Perennial Mekong river flows with copious water throughout the year • Tremendous international markets for Vietnamese fish and fish products • Existing material flow between and within sectors related to fisheries • Presence of community, district and provincial level business associations	• Unsustainable fishing practices • Generate huge amount of wastewater and sediments discharged from fish ponds • Environmental policies for wastewater treatment are weak, e.g., lack of environmental standard for wastewater from fish ponds, lack of implementation of the rule to save 10% fish aquaculture area for waste treatment • High risk of ground and surface water pollution • Weak financial setup to invest and encourage the development of new industries and supply chains	• Reduce pressure on natural fish resources by reduced amount of baby and mature fish catch. • Produce high quality products and protect consumers' health.	• Sustainable fish productions meeting international market requirements • Enhance development of local economy and stimulate the integration process into local, regional and international economy.
Ideal eco-industrial clusters	• Open new markets by increasing competitiveness through reduced production costs • Income enhancement through new products and by-products • Reduce waste emission and pollution problems • Reduce pressure on fish resources • Able to apply integrated water resources management	• Additional markets developed through improved fish product range resulting in over-fishing and thereby increasing pressure on water resources	• Increase efficiency of water use, centralized waste treatment systems and administrative and information systems • Reduce waste emission outside the network .Reduced transportation requirements. • Reduce the energy consumption by producing bio-fuel from fish fat and increasing indirectly gas production from pig farms, located in or out side FEIC, by reusing rice straw for cooking man-made fish feeds • Contribute significantly to environmental protection activities in local areas	• Generate better income by increasing fish products, product quality, product brand name, save energy, • Reduce waste treatment cost • Foreign exchange savings for government, e.g., save US$ 14million/year of subsidies for importing 1000 000 m3 of diesel • Increase incomes from by-product processing (livestock feeds and glycerol, etc).

Socio-Economic Benefits

Fishery sector in An Giang Province is intricately connected with the local community in that it serves as the main source of livelihood. Most fish farms are family owned and the entire family survives only on the income generated from the fish farms. Therefore, preserving and sustaining the water sources to have a continuous yield in the long run becomes vital. Creating employment opportunities under different but linked sub-sectors is essential to sustain the economy. This way the sole dependence of the community on fish farms for income can be reduced and livelihood sources diversified. Developing new businesses in the fishery supply chain can result in various other direct and indirect benefits to both the society and its economy (Table 3.4.10).

Table 3.4.10 Socio-economic Benefits of the Fishery Eco-Industrial Cluster

Society	Economic
• Development of rural and urban areas • Better job opportunities • Establishment of fishery associations such as Fishery Incentive Centers, Fish-Breeding Centers, Clean-Fish Producing Cooperation, Tra-Basa Producing Management Board of Mekong Delta, Vocational Training Centers, etc • Maintaining balance between producers and processors. • Helping to solve the conflicts in fish aqua culture areas. • Utilizing traditional fish cage to attract tourism	• Ensure sustainable fish production to meet international market requirements. • Lower production costs due to increased recycling and reuse, reduced waste treatment and waste disposal concerns. • Higher income through increased market share reflected through product quality, savings in energy and cost of waste treatment. • Savings in subsidies for government and foreign exchange due to reduced import of fossil fuels. • Increase in income from by-product processing (livestock feeds and glycerol, etc).

Technology Enhancement

An Giang is one of the rapidly developing provinces in the southern Vietnam. The fish culture areas of the province are mostly situated in the remotest areas of the Province. The Province headquarters, Long Xuyen City is itself classified at the secondary level with very little services available for its citizens. Though regional universities and academic institutions take measures to bring science and technological advancement to the reach of the local communities, very few

are implemented in the field. The mere nature of the industry and skill level of the owners/operators is a deciding factor in the successful implementation of advanced technologies. Table 3.4.11 and 3.4.12 present the anticipated financial benefits and social gains from the eco-industrial cluster. Innovative businesses and business models are currently being introduced by various stakeholders of the sector. For example, producing bio-diesel from fish fat is one such initiative which has been successfully promoted, though barriers exist. Significant scope exists for the commercialization of various technologies in all the sub-sectors of the study.

Table 3.4.11 Anticipated Financial Benefits from the Eco-Industrial Cluster

By product / waste	Quantity (ton/year)	New products	Quantity	Profit unite		Profit (Billion VND/year)	
				Without subsidies of Govt.	With subsidies of Govt.	Without subsidies of Govt.	With subsidies of Govt.
Head + bone of fish	62,000	Animal feed	12,400 tons	720 VND/kg		8.93	
Fish Fat	22,000	Bio-diesel	25 Million litre	2000 VND/L	4,000 VND/L	50	100
		Glycerin	2,200 tons	10 million VND/ton		22	
Rice straw	17,000	Fuel	1.02 Million litre	216,000 VND/ton	336,000 VND/ton	3.672	5.712
Pig faeces (2000 heads)	2,190	Biogas	109,500 m^3	229,000 VND/ton	373,500 VND/ton	0.502	0.818
Sludge of Ponds and WWTP	36,966 + 678	Compost	19,000 tons	135VND/kg		2.565	
Total						**87.669**	**140.025**

Community Engagement and Social Agenda

The An Giang fishery sector is observed to be more of individual business units than community oriented. Though water sources are common to all citizens, the riparian rights of fish farmers has been established with mutual consensus among communities. However, conflicts do arise at times. The present legal system has empowered the Provincial Peoples Committee to handle such

situations. This itself is an example of the Governments desire to infuse community participation in the fishery sector. Appendix VN-2 presents a list of policies related to community participation in fishery sector and water resources management.

Table 3.4.12 Anticipated Social Gains from the Eco-Industrial Cluster

Enterprise	Average annual production	Labour requirement	No of labourers
Fish feeding	1916 ha	13persons/ha	23,870
Fish processing	179,000 tons	28.125 tons/person	6,365
Fish food processing	15,000 tons	120 tons/person	125
Animal food processing	2,200 tons	15 tons/person	147
Bio-diesel	22,000 tons	270 tons/person	82
Compost	19,000 tons	70 tons/person	272
Biogas	2000 pigs	100 pig/person	20
Total			**30,881**

Policy Integration

Vietnam is country which had to face the downside of economic development owing to policies inconsistent with priorities and needs of its citizens. After the Doi-Moi in 1986, the country experienced a revolution in policies governing the production and marketing of goods, services sector and international exports and imports. Being a communist country with strong control on power, Vietnam has the potential to implement any policy aimed at the welfare of the nation, amidst strong opposition.

In the present situation, the transformation of the existing cluster into an eco-industrial cluster involves significant policy reforms. An understanding of the current policies indicates that the Government insists on environmental protection and natural resource conservation. Policies laid down by various ministries and departments emphasize this. However, a general lack of coordination among sectoral policies exists. The paradigm shift from clusters to eco-industrial clusters, in order to be effective and smooth needs appropriate integration of sectoral policies. Including environmental protection and resource conservation into developmental policies is essential for a smooth transition.

Inter-firm and Intra-firm linkages

The An Giang fishery sector has a critical supply chain with various horizontal and vertical linkages. Business units in the supply chain are linked to units both within and outside the sector. For example, the fish processing units, one of the prime in the supply chain depends on the transportation sector for faster transfer of its perishable goods. This linkage is seen both in the upstream and downstream side of the supply chain. This is an example of a vertical linkage in the system. An ideal example of a horizontal linkage is the fish waste processing units. These units derive many other useful fish products from the residues of the mainstream fish processing units. All such linkages need to be strengthened to make the eco-industrial cluster functionally strong and environmentally sound and economically robust. Inter-firm networks in the sector:

- Aid in efficient use of resources through product diversification
- Reduce production costs by making appropriate use of all materials in the supply chain
- Increase competitiveness by adding more value to products at a relatively lesser cost
- Ensure stable market and international demands.
- Strengthen relationships among sectors as well as individual enterprises by integrating each others rights and responsibilities.
- Maintain and enhance activities of association or cooperatives

Barriers to Fish based Eco-Industrial Cluster

The An Giang fish based industrial network faintly exists, but their functions and contributions to both the environment and society will be recognized only through a formally organized fish-based eco-industrial cluster. The following barriers need to be overcome to form a fully functional eco-industrial cluster.

- Lack of capital for investing on infrastructure and relocating enterprises.
- Require significant resources and efforts – financial, technological, attitudinal
- Excessive fish aquaculture may lead to the generation of huge amount of wastewater and sludge from fish ponds
- Conflicts among the fish processing plants and between fish processor and producers.

- Limited chances for small producers, e.g., only producers with more than 500 ton/year production could join the Clean Fish Association.
- Risk of release of confidential economic and market information can affect the competitiveness of enterprises.
- Absence of clean and new technologies for waste treatment and pollution control.

Policies and Institutional Arrangements

- The Development Master Plan for industrial parks has not yet been approved.
- No specific guidelines to setup EICs is available
- Lack of environmental standards for wastewater and sludge discharged from fish ponds
- No regulations and mechanism for water resource exploitation, waste recycling and wastewater reuse.
- Though a good administrative system prevails , lack of fair cooperation decelerates growth
- Lack of policy integration among various sectors in the FEIC.
- No policies to force enterprises to join fish associations or cooperatives to protect their rights and responsibilities and to ensure equal sharing resources among them.

3.4.8 Lessons Learned

The An Giang fishery sector is a typical example of a cluster where material efficiency is partially attained with significant scope for further improvement. The material flow pattern in the region clearly indicates the potentials for increasing the efficiency of processes in the supply chain. Technologically, the fishery supply chain of An Giang province is not well placed. There is a need to introduce advance technologies with higher efficiencies. The existing linkages between units in the supply chain need to be strengthened to improve product range and make better use of resources.

Policy scenario in the country, though appears to be progressive and with a long term vision, needs to be reformulated though. Inter-sectoral and cross-sectoral integration of policies are the need of the hour to transform the cluster into an eco-industrial cluster.

3.5 Stakeholder Consultations

Eco-industrial clusters are believed to be closely associated with the local communities and are supposed to bring direct environmental and economic benefits and social gains. With multiple dimensions, involving various sectors such as businesses, communities and policymakers it is essential that their views be considered in designing eco-industrial clusters. As in the case of any development project involving the business and the community at large a stakeholder consultation was conducted to ascertain their views. Figure 3.5.1 through 3.5.3 present the views of the stakeholders.

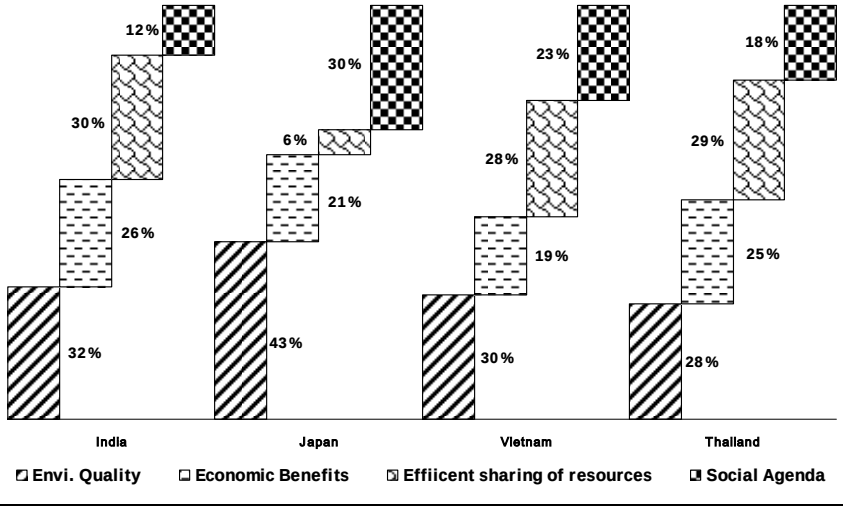


Figure 3.5.1 Stated objectives of Eco-Industrial Cluster initiatives

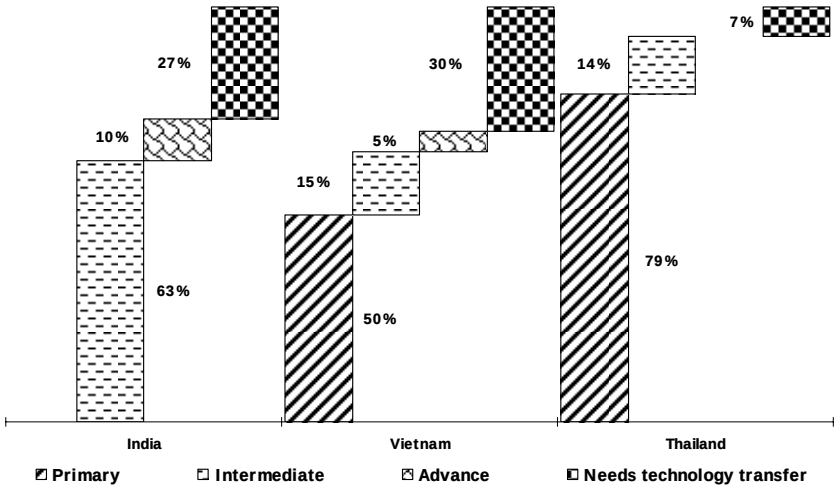


Figure 3.5.2 Level of Technology base in Case Study Clusters

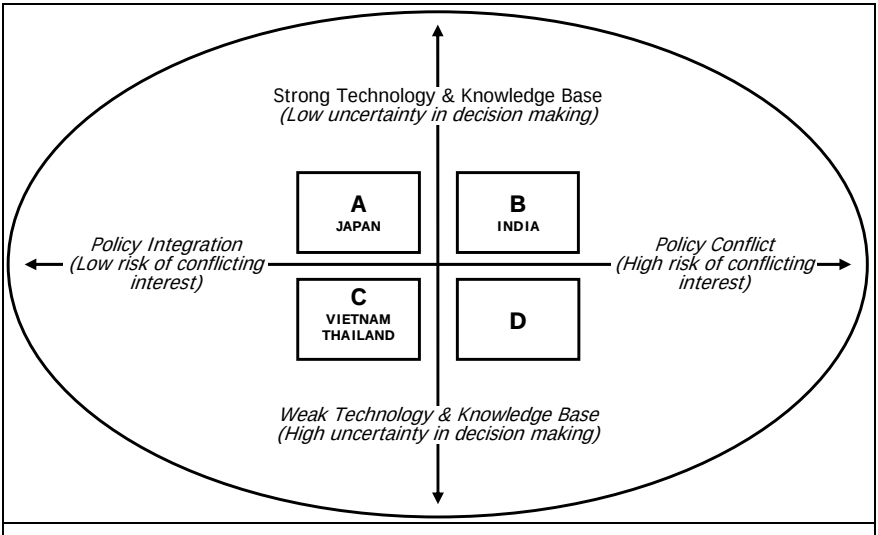


Figure 3.5.3 Positioning of Case Study Clusters

4 Opportunities and Obstacles in Eco-Industrial Cluster Transformation

4.0 Facts and Findings

Clustering of small and medium industries has often been inspired by the hypothesis that they can lead to environmental and economic competitiveness. This research is no different as far as the hypothesis is concerned. Nevertheless, this study is unique in that it was performed on the often forgotten sectors of the small businesses, the bio-based industries. Added to this is the geographical location of the studied industries. The rural urban fringe areas have increasingly been the centers of industrial activity in the recent years. Owing to various reasons, industries, businesses and services tend to locate themselves in the fringe areas than in the urban or rural. This has exposed the fringe areas to wide-ranging pressures, often environmental and resource constraints. This chapter compare and contrasts the eco-action performed in the study clusters to identify the opportunities and obstacles in the transformation processes. The clusters studied are unique in their inbuilt linkages and sectoral representations.

4.1 Comparison of Case Study Characteristics

The principal criteria in choosing the clusters were their relevance in contributing to the local economy and the intrinsic relationship with the environment. Industrial clusters owe a major share of resource constraints and environmental concerns. However, the constraints and concerns are inevitable in attaining and sustaining a stable economy. Notably, maintaining environmental quality is second only to ensuring the livelihood of the society in developing countries. The study sectors are from diverse domains with distinct threats to their sustainability, but for the common goal of fuelling the economy. Table 4.1 compares the characteristics of the studied sectors in the respective countries.

Table 4.1 Characteristics of the Research Clusters

Feature	India	Japan	Thailand	Vietnam
Study Sector	Small and micro-scale sericulture units	Small and medium sized wood enterprises	Paddy processing and Livestock	Fishery sector value chain
Location	Fringe areas of Hosur/ Bangalore region in Tamil Nadu and Karnataka	Urban fringe area of Maniwa region in Okayama Prefecture	Fringe areas between Bangkok metropolis and Chachoengsao Province	An Giang Province, Chau Doc rural and Long Xuyen urban areas
Core Product Lines	Mulberry Plantations, Silkworm rearing, Silk Reeling and weaving	Wood logs, furniture making, saw mills, wood processing units	Paddy processing, Rice products, Piggery and Poultry	Fish farming and processing, fish and animal feed, bio-fuel from fish fat
Community Interaction	Household units, woman headed enterprises	Visionary leaders, interested individual and community based organization.	Small and medium industries, family owned businesses	Family owned businesses, community and business associations
Employment potential	High, round the year	Out migration to large cities	High, seasonal	High, round the year
Environmental Concern	Resource inefficiency, loss of valuable materials as waste	Conversion of wood waste into useful forms in a cost effective manner.	Water pollution from rice processing and livestock farms	Water pollution from fish feeding, wastewater from fish processing
Social Issue	Gender issues, livelihood retention and poverty alleviation	Inequality in development opportunities	Outward migration of rural population, loss of farming land	Inequitable access to natural resources and social apathy
Relevance to Economy	Source of income for some communities, other sources include industrial employments	Reinvigorate the local economy by starting new business and associated job creation.	Source of income for some communities, other sources include industrial employments	Principal source of survival, contributes to provincial and national income
Threats to Sustainable Development	Social issues hold back survival and growth of local sericulture units	Disposal of wood wastes become a business and health threat	Environmental issues weaken the competitiveness of the businesses	Economy depends on fishery sector largely
Drivers for EIC formation	Official development and industrial polices to promote micro-enterprises	Social capital creation – attitude and networking of community for joint actions	Technology transfer to achieve better environmental quality	Policy integration to improve competitiveness

4.1.1 Environment - Economic Linkages

A quick run through of the profile of the clusters clarifies their resource dependence and the linkages between environment and economy. Analogous to all industrial systems, the clusters under study consume resources and deliver products. The linkages created between environment and economy through these clusters is remarkable and need attention.

India

The sericulture sector studied in India is an ideal example of natural resource utilization for the survival of communities. The sericulture value chain consists of mulberry farmers, silkworm raisers, silk reeling and to a small extent silk weavers. The economy depends on activities that have more than one linkage with the environment. As far as the sericulture sector is concerned, the biotic environment plays the role of a supplier of resources and raw materials. The biological nature of the clusters with plantations and silkworms does not pose environmental problems, rather causes resource concerns in the form of unrecognized value of disposed materials. Material efficiency of the sericulture sector is poor with huge volumes of resources discarded as waste. The economy environmental linkage, thus, needs to be strengthened by recognizing the commercial value of the materials disposed as waste, identifying appropriate measures to recover them thereby augmenting the resource efficiency of the system. This would ultimately result in a strengthened linkage between the environment and economy.

Japan

The wood industrial cluster studied in Japan typically exemplifies how an environmental risk shall be transformed into a business opportunity. It indicated the four factors that are needed to effect the transformation of wood waste into energy and material form and to unleash the synergy between developments an environment. They are business to business networks, innovative competitiveness, technology infrastructure and social capital as well as market integration. Policies implemented by governments have succeeded so far in inviting new companies and start new business and enhancing inter-firm networks. Two points however are required for further development. First, policy integration at different levels. To do this certain type of joint actions are needed and sectoral ministries should take initiatives. Second, business should be more competitive in developing eco-technologies for market orientation.

Thailand

The linkages between environment and economy in the paddy processing and livestock clusters are two-dimensional, intensive natural resource requirements and indiscriminate waste disposal. The paddy clusters, starting from the cultivation of rice, and with various processes throughout the product line, require enormous amounts of water, fertilizers, pesticides, and other resources. On the subsequent stages of processing energy is consumed at significantly large quantities thereby increasing resource dependence. In all these stages, materials discarded with unrecognized commercial value multiply the issues. All these activities aim at boosting the economy and adding more value to the products.

In the case of livestock clusters, waste disposal is the major concern among the environmental and economic linkages. Resource consumption in the livestock clusters is reflected in terms of water consumption. Other resources required fall outside the scope of the present study.

Vietnam

The fishery clusters of An Giang Province in Vietnam have simple, yet significant environmental – economic linkages. The nature of the fishery sector determines the linkages. Mekong River, the lifeline of many families living on its banks, provides the much-needed resources for local economic development. The units in the fishery clusters are diverse with varying resource needs. However, one basic environmental requirement for the survival of the economy and the community is water from the Mekong River. Deteriorating water quality arising from various actions in the fishery value chain poses severe, irreversible threats to sustaining the linkages.

In any industrial activity, the linkage between environment and economy assumes paramount importance. The same is true as far as the clusters in this research are concerned. The foremost criterion in choosing the clusters for the research is their inherent relationship with the environment and its influence on the economy. Striking a balance between environment and economy is vital to sustain growth.

In all the three case study clusters, the linkage is in the form of material flows and resource availability. When the material flow is interrupted or resource depletes the linkage fails and causes instability of the economy.

4.1.2 Voluntary and Regulatory Initiatives for Resource Conservation

All the three case study clusters are driven by resource availability. The amount of resources required is so enormous that the sustainability of the industry is at stake under improper resource conservation conditions. Developing Asian countries such as the ones in which this study was performed are presently experiencing a paradigm shift from resource consumption to resource conservation. Governments have started realizing that the present rate of consumption is highly unsustainable and the need to conserve resources.

One important aspect, here is that initiatives focuses at resource conservation are still at the planning and design stage and have not reached the implementation phase yet.

In India, as far as the sericulture is concerned, almost no effort has been observed towards resource conservation. Various initiatives have been taken by Governments, their departments, institutions and other multilateral agencies indeed. Polices and programs have been implemented on wide ranging models for the revival of the sector. However, all are most of these initiatives aim at improving product lines and market avenues. After analyzing the sericulture business in Hosur/ Bangalore fringe area, one could say with utmost confidence that no regulatory measure has been taken for resource conservation.

The paddy processing and livestock clusters in Thailand have significant potential for resource conservation. The central and provincial governments have insisted on resource conservation through various indirect initiatives such as encouraging electricity generation from agricultural residues. One of the model initiatives is the Very Small Power Producers policy that encourages private entities generating less than 1 MW of electricity from renewable sources and biomass. The generated power could be traded to the Electricity Generation Authority of Thailand or to any industry in the vicinity. Livestock farms also qualify under this model, obviously, with the availability of appropriate technology. Indirect regulatory measures, rather than direct, eventually resulting in resource conservation is observed in Thailand.

In Vietnam, the fishery sector is one of the fast growing sources of both the national and provincial economy. The scale of operations and the level of

modernization in this sector is relatively smaller with no serious concerns about threats of resource depletion. The need to conserve resources does not appear to have been felt seriously. However, in the fishery sector certain initiatives such as the ban on use of toxic chemical disinfectants and persistent compounds have been restricted. Use of homemade fish feed, reported to be prepared in unscientific ways has been discouraged. Cleaner production principles, focusing on resource conservation and reducing costs have been applied in some large-scale and modern fish processing factories.

Evidently, the commonality across all the clusters studied is the lack of integrated policies comprehensively addressing all relevant issues.

Voluntary initiatives in resource conservation have always been driven by the economic benefits it brings. Though no evidence, strong enough to make an argument exists, resource conservation measures appear to have been implemented in almost all the case study areas. The foremost reason for this is the lack of awareness on resource concerns by the grassroots involved in the enterprises. It is worth mentioning that regional research institutes and multilateral organizations have implemented various programs towards improving material efficiency. However, inculcating resource consciousness and conservation techniques is possible only by educating the entrepreneurs.

4.1.3 Local Development Priorities and Sustainability Issues

The clusters studied have all evolved based on local availability of resources and skills. All or most of the enterprises are owned by the members of the indigenous community. The driving forces of the businesses are often livelihood issues and survival pressures. Most of the enterprises have been started many years ago and their prime goal was income generation. In the recent decades, as business flourishes and competition increases the rate of resource consumption has also increased drastically. Governments also started recognizing the economic contribution of these industries and initiated various steps for their strengthening considering the local development priorities and sustainability issues. Figure 4.1 presents the sustainability issues of the clusters.

Sericulture business depends largely on the local climatic conditions favoring the growth of mulberry plantations and silkworms. The development priority of the region is the improvement of the sericulture sector as a key industry through providing a wide range of products at competitive prices. However, social issues

such as gender related, livelihood issues and poverty alleviation etc, prevent the progress of the sector. The key sustainability threats to the sector are from social issues.

The paddy and livestock clusters of the study area in Thailand assume greater significance in terms of local resource consumption. The provincial and national governments have identified these regions as the priority areas for rice based industries and livestock farming. Both local and national development priorities are aligned at making these sectors the thrust of the economy. Issues such as environmental degradation from agricultural residues and pollution from wastewaters of pig and poultry farms are the threats to sustainability.

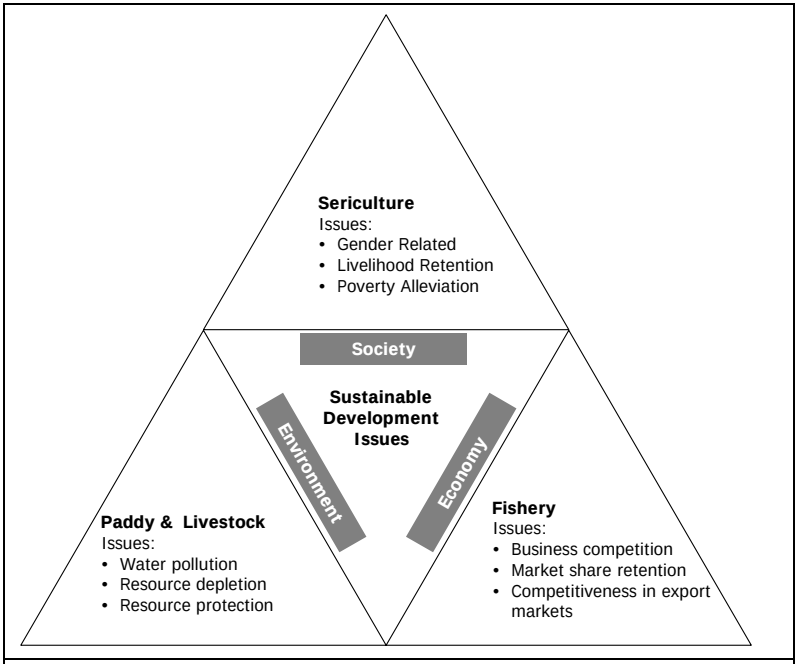


Figure 4.1 Sustainable Development Issues in the Clusters

In Vietnam, the fishery sector is fueled by the abundant water available from the Mekong River. An Giang province leads in fish production at the national level and is the major producer. The commendable numbers of business associations and community organizations have been lobbying for uplifting of the sector and have been quiet successful in their attempts. Local and regional development

priorities aim at utilizing the fishery sector for national and regional economy upliftment. With fierce market competitions from other provinces and other countries, the An Giang fishery sector needs to be competitive in terms of product quality and pricing. Attaining and sustaining high market shares thereby contributing to the economy as a whole is a serious issue for the An Giang fishery sector.

4.2 Cross-case Analysis of Probable Success Factors

Clusters, though defined in many ways, are business units aimed at income generation for the entrepreneur. The business ethics and value systems of the entrepreneur reflect in the performance of the enterprise. Eco-industrial clustering as a tool towards integrated environmental and economic development could be beneficial in more than one way. The success of the eco-industrial should not be measured only in terms of financial performance, but in many other dimensions. A holistic performance evaluation of the cluster with perspectives on resource requirements, material flow pattern, community interaction, employment potential, environmental friendliness and technology relevance is needed.

Eco-industrial cluster are not cookie-cutter projects and cannot b replicated for other sectors directly. Instead an under standing of the lessons learned from experiences and their comparison is essential to arrive at valid conclusion. The following sections attempt at evaluating the success of transforming the existing clusters into eco-industrial clusters.

4.2.1 Efficient sharing of Resources

Clusters are defined as a geographic concentration of interconnected companies. One of the key strengths of being interconnected and geographically concentrated is the possibility of sharing material, physical and human resources. Figure 4.2 presents the possible sharing options in clusters.

Sharing resources in clusters has proven to be beneficial in many ways. The clusters focused in this research are not monolithic. The research was on a group of clusters working on the value chain of the same product. The special feature of these clusters is that they interact among themselves and can form a network of clusters. In such case, two possibilities can arise as far as sharing of resources is concerned.

- Sharing of material and human resources within individual units of the same cluster
- Sharing of raw materials, exchange of by-products and waste among the cascading units of the clusters

Sharing of resource reduces costs and provides collective benefits that cannot be realized when the units operate individually.

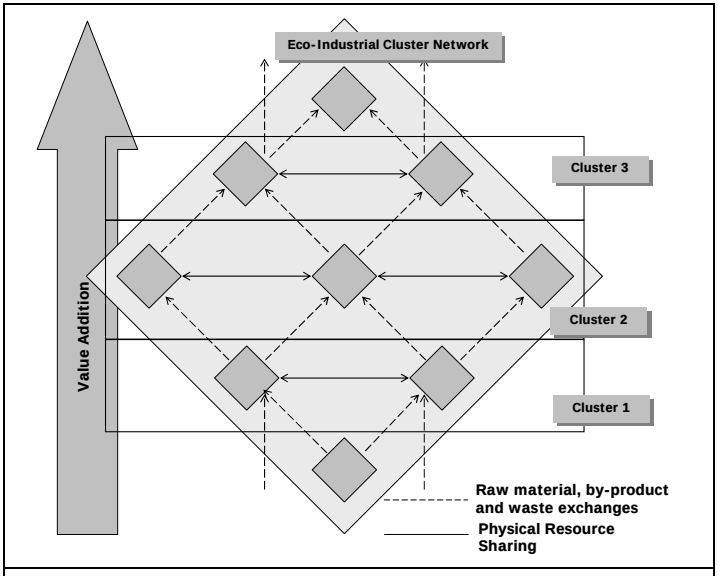


Figure 4.2 Sharing of Resources in Clusters

4.2.2 Gains in Environmental Quality

Industrial clusters are poised for positive effects on the overall environmental quality of the system within which they operate. Ideally, improving environmental conditions is one the objective of eco-industrial clusters. Often, environmental quality improvements result from the collective action and collaboration of the industries within the cluster. Gains in environmental quality are achieved in two primary modes,

- Reduced resource consumption due to cascaded use of resources,
- Reduced pollution from finding alternative use for discarded materials

Both these aspects result in significant environmental benefits. For example, in the paddy and livestock clusters of Thailand considerable portion of material

with potential for energy generation was disposed in unscientific ways. Such disposal poses threats in the form of pollution. In the absence of appropriate technologies for the best possible use of these materials, fresh and virgin material would have to be mined to serve the purpose. Alternatively, using materials that were otherwise disposed without recognizing their value are now put to better use. Thus, the transformation from cluster to eco-cluster has reduced concerns of waste disposal and resource availability thereby resulting in environmental gains to the cluster and the community.

Table 4.2 Cross-cluster analysis of Environmental Gains

Feature	India	Thailand	Vietnam
Environmental quality Issues	No specific issue observed	Water quality issues from piggery and rice processing	Water quality issues from fish breeding and feeding
Nature of threat	Poor efficiency in resource use	Environmental Pollution	Environmental Pollution
Source of threat	Disposal of mulberry waste and silkworms; inefficient heating systems used in processing	Wastewater from rice processing and pig farms, solid waste from poultry litter, husk from paddy processing	Excess feeding of fish, use of homemade fish feed, disposal of fish processing waste
Eco-clustering activity	Resource recovery from disposed waste, installing biomass systems for thermal applications	biomass power generation from rice husk and agricultural residues, biogas systems for poultry and piggery waste	Bio-fuel from fish fat, use of scientifically made industrial fish feed,
Expected environmental gains	Efficient resource usage, reduced waste disposal concerns	Generation of clean power using biomass and biogas, reduced pollution	Supply of clean fuel, reduced water pollution

4.2.3 Socio-Economic Benefits

Clusters in Asian developing countries are intertwined with the society and functions for its well-being. The principal benefit enjoyed by the society is the enormous employment potential and income generation opportunities from the clusters. Labor intensive and less modernized clusters provide employment

opportunities for large masses of population. Resource dependence and pollution concerns of the clusters studied create a range of socio-economic concerns.

The sericulture clusters are dominated by gender related and livelihood issues. The transformation to an eco-industrial cluster in this sector warrants the need of creation of social capital; a shift in terms of value, attitudes and relationships governing the industry and the community.

The paddy and livestock sectors of Thailand are invaded more by environmental issues. The primary result of eco-industrial clustering is the improvement in the overall environmental quality of the region. The socio-economic benefits realized from the cluster are those associated with reduced odor problems from decomposition of piggery waste, protection of water sources from piggery and poultry wastewaters, clean air due to controlled combustion of rice husk and agricultural residues.

In Vietnam, the fishery sector faces threats from increasing competition in marketing and higher production costs. The transformation to an eco-industrial cluster leads to reduced production costs, waste disposal concerns and pollution problems. A parallel effect of this is an increase in the competitiveness of the fishery sector in the Province.

Table 4.3 Cross-cluster analysis of Socio-economic benefits

Feature	India	Japan	Thailand	Vietnam
Eco-industrial cluster strategy	Create Social Capital	Pressure for optimized used of local resources	Enhance Environmental Performance	Increase Economic Competitiveness
Socio-economic issue	Gender related, livelihood retention and poverty alleviation	Consensus on cluster wide environmental agenda and economic priorities	Inequitable access to water sources, health hazards from pollution	High production costs, waste disposal concerns
Outcome of eco-industrial clustering	Reduced social conflicts, gender equity, poverty alleviation and income generation	Employment opportunity through market diversification and product differentiation	Cleaner living conditions, reduced health hazards, equitable access to natural resources.	Reduced cost of production due to alternative use of waste, supply fish products at more competitive prices

4.2.4 Technology Enhancement

Asian industrial cluster use intermediate or primitive technologies for their production processes. The choice of the technology depends on various factors such as affordability, availability, accessibility and the need to shift. The transformation from conventional industrial clusters to eco-industrial clusters is inevitably accompanied by a shift towards modern technology. Choosing the right technology has to be done judiciously without creating disturbances to the present system. Transfer and management of appropriate technology determine the success of an eco-industrial cluster. Figure 4.3 presents the technology enhancements required for the transformation.

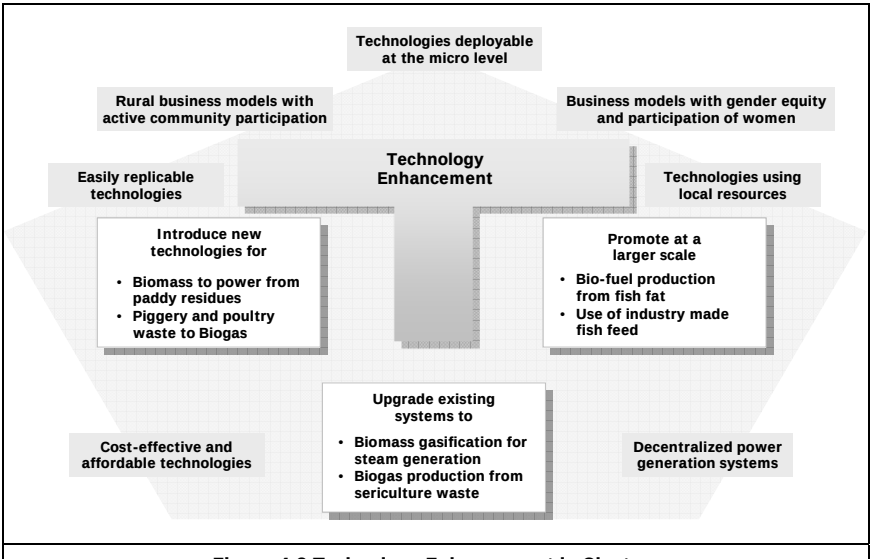


Figure 4.3 Technology Enhancement in Clusters

In the context of sericulture clusters of India, the real transition is favored through the formation of a social capital. However, technology enhancements are necessary to reduce dependence on work generally done by unskilled labor. Work force requirements for these kinds of works are mostly laborers from the weaker sections of the community. Hence, upgrading the technology is likely to have parallel effects on both increasing resource efficiency and partially resolving social issues.

Paddy and livestock clusters of Thailand face threats in the form of environmental pollution and waste disposal concerns. Introducing appropriate technologies rightly targeting the concern areas aids in achieving the goals of eco-industrial clustering.

The fishery sector of An Giang Province utilizes updated technologies for most activities in the fishery value chain. Processed fish is exported to various countries and hence advanced technologies are used to meet the food safety and legal requirements of the buyers. Nonetheless, modern technologies are used only for the core production processes. Waste and wastewater treatment systems often adopt conventional technologies focused on end-of-pipe treatment systems. The catch in these systems is that recovery of resources is not factored into their design. Promoting, at a larger scale, technologies that focus on resource recovery such as production of bio-fuel from fish processing wastewaters are essential to reduce costs of production. In an attempt to conserve resources, emphasizing the use of scientifically made industrial fish feed is another aspect which needs attention. In essence, the introduction and enhancement of appropriate technologies greatly accelerates the transformation towards eco-industrial clusters.

4.2.5 Community Engagement and Social Agenda

Clusters in developing Asian countries are mostly, small and medium enterprises, owned and operated at the family level. The interaction of the clusters with the community is at a relatively higher degree compared to their large-scale counterparts. Clusters have evolved based on local resources and skills. This clearly demonstrates their relationship with the community.

In all the three studies clusters, the interaction with the community is significant in all components of the value chain. From providing work force to marketing the products, supplying resources to receiving wastes the role of the community is important.

The sericulture clusters of India are threatened by social issues that could be revamped only by creating awareness among the communities and entrepreneurs. Creating ideal social capital through reforms in the value systems is possible only by educating the community and engaging them in the decision-making process. A social agenda with top priority on intergenerational and intra-generational equity and equitable distribution of wealth needs to be created and cultivated in the minds of entrepreneurs and communities.

The paddy and livestock clusters of Thailand and fishery clusters of Vietnam require community engagement in pollution abatement. Creating and involving community-based organization in local environmental protection has proved effective in many places across the world. Public participation in environmental quality monitoring and decision-making is another avenue that can bring in significant benefits to the community.

The transformation to eco-industrial clusters is effected through the introduction of innovative technologies and new businesses such as renewable energy generation options. This clustering option could be developed following a participatory approach where the communities own and operate the facilities. Thereby, the direct benefits of the eco-industrial cluster can be experienced by the communities as well. Figure 4.4 presents the various stages of community engagement. Irrespective of the status of community engagement, all required initiatives to move the current level of participation to at least one step ahead in the hierarchy is essential to make the eco-industrial cluster a success.

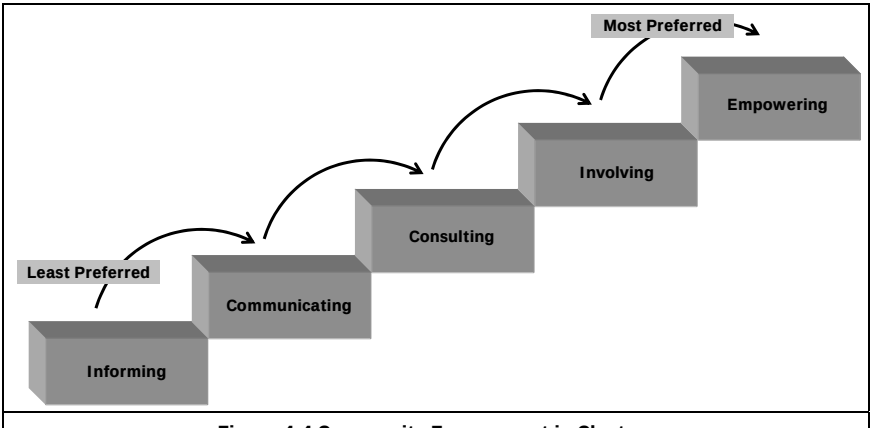


Figure 4.4 Community Engagement in Clusters

4.2.6 Policy Integration

Essentially the clusters considered in this study are small and medium businesses often run at the family level. Most of these enterprises operate with limited working capital and need external forces to bring changes and implement innovations. Repeatedly, these external forces are in the form of policy measures offering incentives and fiscal rebates. Clusters are governed by polices relating

to their mainstream products and resource they consume. Integration of different policies governing the sector is the key to achieving the fullest benefits.

In the case of sericulture clusters, they are governed predominantly by the State sericulture policy and national textile policy. Other policies do exist with hairline linkages. The bearing these policies have on the sericulture is infinitesimally small that they are rarely considered when making strategic decisions. Moreover, other policies such as the National Environmental Policy and National Agricultural Policy do not address issues related to the sericulture sector, though the sector is intrinsically connected to the environment and agriculture.

In Thailand, cross-sectoral integration of policies is observed largely. While the local and national development plans address issues on clustering, the national energy policy promotes renewable energy generation from decentralized sources. A critical review of policies in Thailand clearly indicates that policies are integrated reasonably.

Evidently, Vietnam has achieved it major development goals only through various policy reforms. The country now has a strong administrative setup with good command on policies. The country has a decentralized administration with decision-making powers vested also at the provincial level. However, the sectoral scopes addressed by the policies are still confined to the core issues and do not address broader issues connected to the sector. For example, policies and regulations concerning fisheries address issues on the developing the markets of the sector, imposing restrictions on the usage of certain chemicals etc. Integration of policies to attain broader goals of environmental protection and resource conservation do not appear to be adequately addressed. Cross-sectoral and integrated policies are rare. Overlapping of policy goals in achieving environmental protection and resource conservation through innovative technologies is uncommon.

4.3 Working with Complex Linkages

The universally accepted definition of industrial clusters clearly indicates the role of linkages. At the micro level, these linkages successfully exist in the form of sharing of resources within the cluster and with the local community. At the macro level, it is also essential to identify and understand the other linkages that exist in the cluster. These are rather different from the inter-firm linkages arising

out of resource exchanges; the linkages with other realms of the world closely related to industries and their development. It is widely believed that eco-industrial cluster can forge improved businesses, livable environmental conditions and high social values. With this belief, it is essential that their interactions with other realms also be understood to supplement their effects.

4.3.1 Technology Needs Assessment

The clusters studied are representative of the technology position of the respective countries. As far as the agro-based sector is concerned, technology modernization has not been taken up in full swing in Asian countries.

One common aspect among all the clusters studied is that the level of technology could be categorized as primitive or intermediate. In Thailand and Vietnam, especially where environmental pollution and economic competitiveness are the key drivers of the eco-industrial cluster, it is vital that advanced technologies be employed.

In the paddy and livestock clusters of Thailand, technology need is felt in both the upstream production processes and the downstream waste treatment and management systems. Upstream production processes require technologies that can reduce resource consumption and improve productivity. The paddy value chain consists of various processes that are water and energy intensive. Appropriate technologies that reduce resource consumption are required. Whereas, in the pig and poultry farms, the need is in the form of best practices for livestock farming systems, such as scientific feeding systems, manure collection and management systems etc.

Under present conditions agricultural residues with high calorific value is disposed in unscientific manner thus leading to environmental problems and loss of valuable resources. Piggery and poultry waste, with high organic content is disposed in local water bodies. Options to recover energy from these wastes through the implementation of appropriate biomass and biogas power generation systems are still under realized. Micro level and replicable technologies meeting the requirements of smaller farms need to be promoted to develop an eco-industrial cluster.

4.3.2 Policy Needs Assessment

The fishery sector of the An Giang Province in Vietnam is the foremost source of livelihood for many rural communities. Many small enterprises and family level

units thrive on various parts of the fishery value chain. The fishery sector of this province has been facing fierce competition both from within the country as well as outside. In such a situation, the fishery sector has to supply its produce at a relatively lesser price but with better quality to sustain the markets. In addition to the core production, waste treatment and disposal costs more to the businesses. Efficient systems for waste handling treatment are in now place. Technological advancement and research in this direction has been accelerated long back. However, the scale of operations of these industries is so small that any innovation can be implemented only with the right policy.

At present producing bio-fuel from fish fat is found to be attractive in terms of financial returns and waste disposal techniques. Pilot scale plants have been setup and have found to be successful. However, the replication or scaling up of these systems has not been ventured.

In Japan also creating synergies between different sectoral policies like industry, agriculture, energy etc and avoiding policy conflicts becomes a necessary condition. It is likely that different integrated environmental and economic policy measures will be appropriate for different EICs at different times, as they should be judged on a case by cases.

4.3.3 Social Capital Needs Assessment

The sericulture clusters in the Hosur/ Bangalore region of India are haunted by social issues such as gender related livelihood retention and poverty alleviation. This region is most famous for its intricate designs of silk materials. The core silk products have been able to retain the markets. However, the scale and extent of poverty and low wages in the sector has made them infamous in international markets.

The sericulture sector is governed by policies that focus on improving product range and quality. An analysis of the relevant policies of the sector clearly indicates that they are rather disjointed and do not address the social issues. The transformation of the clusters to an eco-industrial cluster can be driven only be creating social capital that reflects the values attitudes and relationships of the sericulture sector and the community. Embedding responsibility and equity among all classes of the society is essential for freeing the sector from its issues. This can be achieved only through formation of social capital and its appropriate integration in sectoral policies.

5 Strategies for Establishing Eco-Industrial Clusters

5.0 Planning for Eco-Industrial Clusters

Moving from an existing setup to a new one calls for adequate planning for the transition to be smooth with fewer disturbances. The transformation from industrial clusters to eco-industrial clusters is no exemption. Community interactions, economic contribution, market competition and business retention make sudden changes rather impossible. Industries and enterprises would not wish to compromise on production and marketing in the race towards attaining environmental sustainability and resource conservation. Therefore, establishing eco-industrial clusters necessitates strategic planning to minimize production risks on participating enterprises. The following sections present and discuss the various factors to be considered in establishing eco-industrial clusters.

5.1 Crafting Eco-Industrial Systems

The set of issues considered strategically important for an eco-industrial system is expanding from those closely associated with the business, those driven by government policies and to those that payback the community. Therefore, eco-industrial cluster development means balancing the interests of wider group of stakeholders and strategically managing the interconnected social, engineering, environmental and economic impacts. This does not mean that all issues have an equal weight in eco-industrial cluster's strategic direction but does mean that they all have effects and should be considered appropriately.

A successful eco-industrial cluster is not a 'cookie-cutter' project imported from outside and directly replicated; but includes a nuanced view of various factors. Figure 5.1 presents the various performance issues that need to be addressed in designing an eco-industrial cluster. Unlike the design of industrial estates and parks, crafting eco-industrial clusters cannot be done with a purely mechanical approach. Eco-industrial clusters are living systems blended with active material flows from ever increasing environmental performance of clusters. The transition also involves technology transfer and improvements to eco-efficiency.

Figure 5.1 Performance Issues in the EICs

5.1.1 Material Flow Patterns

Evidently, clusters contain critical linkages, both lateral and transverse, formed from the flow of materials. These linkages add life to the system to which they belong and make them more environmentally benign. Therefore, material flow patterns within the cluster, the sector and the geographical region assume highest importance in their establishment as eco-industrial clusters.

Industrial parks and estates are envisioned to provide the infrastructure such as water, power, communication, transportation and labor necessary for the functioning of the host enterprises. Very little focus on the symbiosis or material flow is factored into their design thus making them monolithic production driven units of businesses. Moreover, in industrial estates and parks, environmental protection, resource conservation and pollution reduction are determined by the members at the enterprise level. Resource sharing is almost unimportant and is limited only to utilizing common infrastructure.

In an eco-industrial cluster, the focus is on sharing and collaboration between and within member enterprises. The first step in crafting an eco-industrial cluster is understanding the possible material flow within and outside the cluster. Figure 5.2 presents the various stages of analyzing the material flow pattern of a cluster activity.

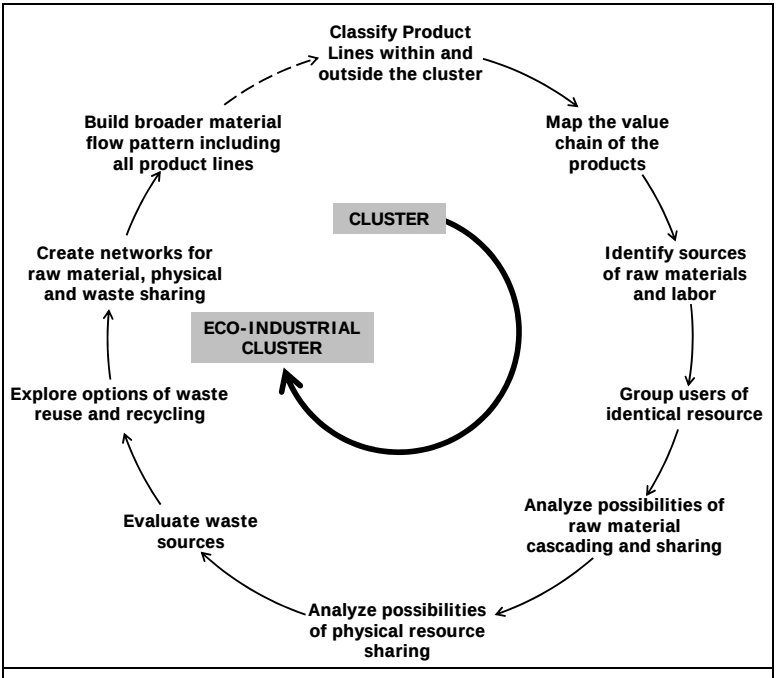


Figure 5.2 Understanding Material Flow in Clusters

Documenting the material flow pattern of the cluster and product lines, removes the complexities on the face of its transformation to an eco-industrial cluster. The material flow brings to limelight the following aspects related to clusters.

- Scale and nature of products and enterprises
- Supply and value chain of raw materials and products
- Options and opportunities for clustering enterprises with alike products
- Choices for cascading and sharing of materials and resources
- Waste streams and potential alternative uses

Once information on these aspects is available, creating the network of clusters becomes straightforward. Essentially, an ideal eco-industrial cluster has a cyclical or closed material flow with almost zero wastes. The material efficiency of the cluster is at its maximum with fullest usage of all resources.

The real eco-industrial design starts with an attempt fine-tune the material flow linkages in the cluster. This is done be creating new linkages that make use of materials that are disposed without any commercial value. Waste streams in the existing cluster are analyzed for possibilities of linking them with other businesses that use similar materials. Raw material consumption is expected to reduce through increased recycling and reuse within the cluster. When the waste stream comprises of materials that do not fit in the raw material chain of the cluster, then alternative best possible uses of the material needs to be identified.

An eco-industrial cluster established with a thorough understanding of its material flow pattern reduces consumption and increases its productivity. The next step in the process of establishing eco-industrial clusters is assessing the environmental performance of the enterprises in the cluster.

5.1.2 Environmental Performance of Clusters

Industrial clusters are resource intensive and consume enormous amounts of materials and energy. Assessing their environmental performance is essential to fine-tune the material flow in the cluster and optimize resource use. An eco-industrial cluster becomes commercially successful and environmentally benign only if it conserves or at least consumes fewer resources. An eco-industrial cluster merely does not mean that it is environmental friendly by way of reducing pollution. It is poised to reduce resource consumption and make the best possible use of materials.

Improving material efficiency begins at the enterprise level and has to be extended to all members of the cluster. The level of openness of business to innovative management and technological measures determines the success of improving material efficiency. Businesses, to be able to reap the collective benefits, need to see the neighboring enterprises as complementing rather than competing. This involves a change in the outlook of the entrepreneur and the enterprise. Collectively solving common problems needs an open mind and open culture among businesses.

The first step in this direction is to unleash the strengths of cooperating by way of exchanging materials, resource, infrastructure and knowledge. While sharing of resources and infrastructure to improve environmental performance can be attained through mutual agreement and consent, sharing of knowledge and materials requires the understanding of the enterprise. Figure 5.3 presents the factors that can help clusters improve their environmental performance.

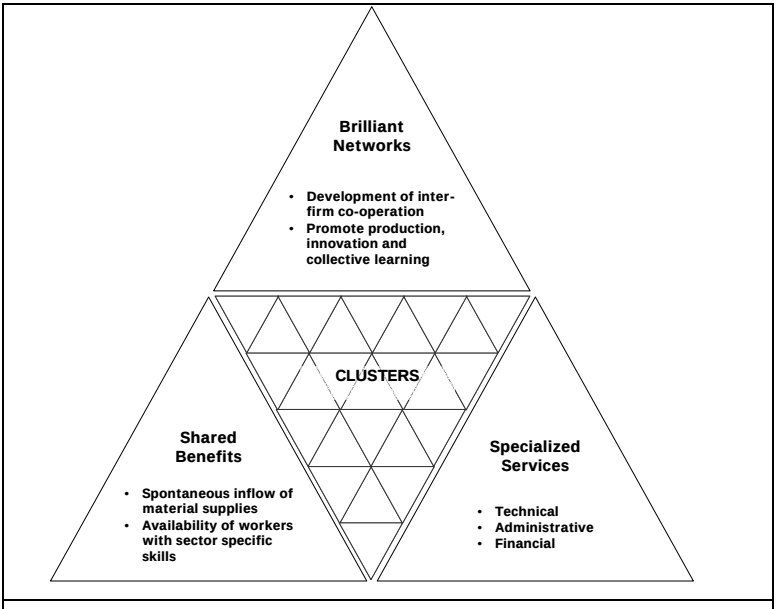


Figure 5.3 Factors favoring better environmental performance in Clusters

5.2 Economic Context of Clustering

Each cluster operates in a particular socio-economic context. This context which is known to be critical to the performance of individual firms, should be important to the growth and development of EICs. Three elements are important, nature and size of the product, available economies of scale and the institutions governing exchange relationship.

5.2.1 Nature and Size of the Market

The nature of EIC's products obviously has an important impact on the way they are marketed. Some eco-products of EICs are inferior goods for which demand

can be expected to fall as consumer income increases in the long run. Pharmaceutical, bio-ethanol, rice-bran oil, energy have different markets and require different marketing strategies. The relationship between production process and the acceptable quality is another consideration. Figure 5.4 presents the various steps in cluster formation as observed by the Industrial Cluster Program of the Ministry of Economy, Trade and Industry, Japan. Some products can be equally made well by employing modern technologies. The point to be emphasized here is that nature of clusters product and performance directly depends on the technology, which has direct bearing on whether an EIC is likely to be highly successful or not.

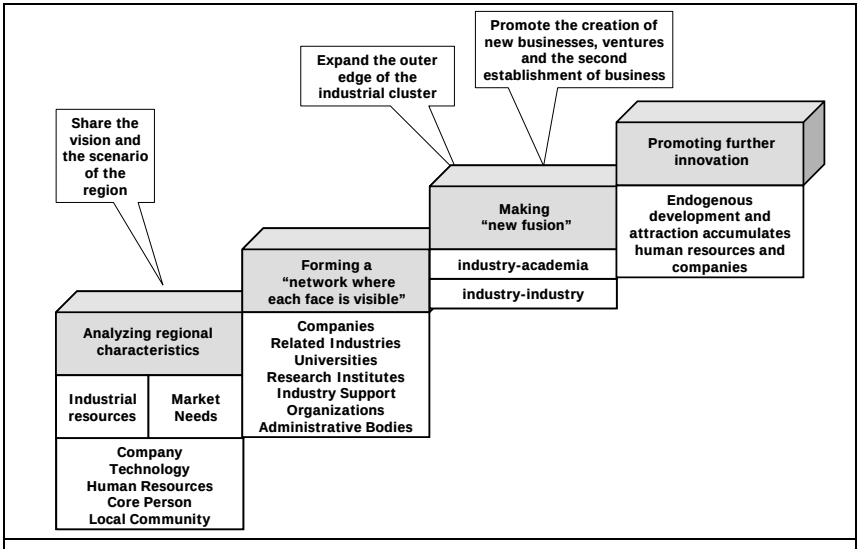


Figure 5.4 Steps in Eco-industrial Cluster Formation

Market size, both the number of participants and geographical spread, is also critical to cluster development and the large process of industrialization which it is a part. EICs give rise to successive rise of specialization provided that the over all scale of demand grows. The simplest conceptualization of market size is that it is definitely by the size of the population in the fringe and urban areas and the level of their purchasing power. By this measure, markets in towns are small and access to foreign markets are difficult, controlled by supplier environmental standards. Small population, low incomes, poor infrastructure, and trade barriers

are among the reasons for small domestic markets. Weak distribution systems help to keep markets small and segmented in many Asian countries. The lack of large well-functioning wholesale system, or where such system exist, their bias towards the products of large industry faces many small producers to sell their products retail.

This problem of small domestic markets is one that has to be faced squarely by individual enterprises and EICs, but it is not insurmountable. Two broad based strategies are available, firms can extend market geographically, or they can attempt to capitalize on the smallness of the market they face. The first option may involve expanding within the domestic market or entering international markets. The choice will depend on number of factors, including the nature of product, but generally speaking, broadening small markets coverage is easier for smaller clusters than exporting.

Barriers to entry into foreign markets include problems with products themselves (poor quality, poor packing etc), and environmental factors such as poor infrastructure for exporting (especially problematic for perishable goods like fish), lack of information flow, and red tape and corruption. Despite these EICs in URF can be competitive in some areas. Efficient small firms have another option open to them. They can attempt to capitalize on the small domestic market. Small size of most domestic markets in Asia can actually be a boon to small enterprises. Where markets are small and relatively specialized, producers who can manufacture small batches efficiently can cut complete large firms.

5.2.2 Available Economies of Scale and Scope

The size of the output is clearly related to the market size. The entrepreneur who can reach a larger market can produce more, and often gain more than proportionately from the increased output. This is the result of what economist call increasing returns. The most familiar form of increasing returns arises from scale of economics, but at least as important, especially in situations where the market for any given product is small, are economies of scope.

5.2.3 Institutions Governing Exchange Relations

Institutions are important to development in general and EIC in particular. It is important to draw attention in two interrelated issues that arise in all the four cases. The first is trust. Economic and material change will not take place without

a certain measure of trust between the firms. Trust involves shared expectation of the outcome of a transaction. Institutionally- based trust among the firms becomes important when the society is heterogeneous and more geographically dispersed. The second issue is contract enforcement. Much institutionally based trust depends on the existence of a third party, prepared and able to enforce contracts and prevent opportunistic behaviors. In Asia, however, such institutions often or either missing or seen unable to function. Passive collective efficiency is essentially for reaping the benefits of external economies. External economies exist when social benefits are higher than private benefits. At cluster level, three main types of economies exist. Labor market pooling, development of specialized local suppliers and services and technological spill over as well as market access.

5.3 External Economics

Market access is the first, and as we all see, grouping of producers in close geographic proximity facilities the meetings of buyers and sellers. By attracting buyers both from the immediate vicinity and more distinct places, it improves the access to the overall markets for a firm's products or services. Thus once cluster is established, market access is one of the potential benefits of location within its bounds. Figure 5.5 presents the common aspects of clusters located in urban-rural fringe areas.

Sectoral and geographical concentration of productive activities tends to create a pool of specialized skills that benefit both workers and firms. Such pools of industry specific skills are evident in many developing Asia. They are present in all investigated clusters.

Clustering of firms also gives rise to specialized suppliers of inputs and services. The concentration of producer firms with similar supply needs attracts suppliers offering raw materials or components, new or second-hand machinery and spare parts. Clustering seems to ease supply constraints, often found to hold back small-scale industry in Asia

Finally, clustering facilitates the diffusion of technological know how and ideas. It does this by permitting the spatial flow of technical information between producers operating near one another, and also by enhancing information flow patterns between traders, suppliers and others connected to clusters. Given that

one of the major characteristics of developing countries is their weak technological base, technological spillovers within a cluster could well be particularly important.

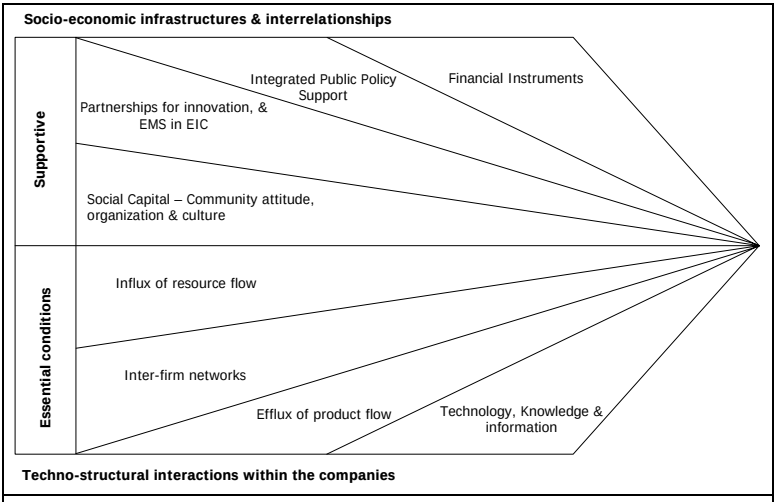


Figure 5.5 Commonalities in Eco-industrial Clusters

There is however, a downside of external economies. According to mainstream economics, the lack of match between social and private returns represents a market failure that affects investment. Specifically external economies can lead to under-investment because of lack of adequate reward for that investment. If this is true, then these disabling external economies may be a factor in the failure to grow of many EICs in urban fringe areas.

5.4 Joint Actions

Local external economies are necessary for the development of a strong cluster, but they are not sufficient. Pursued joint action must also be present for inter-firm networks flourish.

This emphasis on the joint action aspects of collective efficiency underscores the importance of inter-firm linkages and networks. One can identify four categories of joint action in clusters, based on two dimensions (Table 5.1). The first dimension has to do with the number of cooperators: the second with direction of cooperation. Thus, joint action may be bilateral or multilateral. In bilateral

cooperation, two firms work together as, for example, when they share an expensive piece of equipment. In multilateral action, groups of firms join together, often in association with other organization for some common purpose. Joint action may also be vertical or horizontal. Vertical cooperation happens when firms involved in different stages of the production distribution chain work together. Horizontal action refers to collaboration between/among competitors. Active cultivation of such inter-firm networks apparently contributed to the growth of enterprises. The active aspects of collective efficiency or social capital are a necessary ingredient for EIC success. It is also important to recognize that joint action has its costs. The opportunity costs of associational activity are probably the most obvious example. When business are very small, and joint action must be undertaken by the entrepreneur, he/she must carefully weigh the use of scarce time for attendance at meetings or other activities that do not bring immediate benefits. Joint actions may also have political costs, especially in situation where the authorities frown upon gross root initiatives.

Table 5.1 Linkages in Eco-Industrial Clusters

Dimension	Bilateral	Multilateral
Horizontal	Two firms at the same level in the production chain e.g. sharing equipment	More than two firms at the same level in the production chain e.g. a sectoral business association
Vertical	Two firms at different levels of the production chain e.g. a producer and user improving components	More than two cooperators at different levels of the position chain, eg an association or alliance composed of manufactures and distributors of product

5.5 Eco-Industrial Clusters in Urban Rural Fringe areas: An Analytical Framework

The discussion thus far suggests that EICs have the potential to facilitate sustainable development at regional level, but that such potential is not always realized. Many clusters are stuck at low levels of production and distribution. A clear understanding not only of clusters that have industrialized, but also of those that remain essentially small-enterprise agglomerations should provide

insights into steps that business associations, governments, and other interested pairs might take to further the process of Asia's industrial restructuring. Figure 5.5 presents a framework for the transformation to eco-industrial clusters in Asia.

Preliminary analysis suggests that Asian clusters in URF areas fall broadly into three groups. The first group makes its contribution by building a productive environment that in some respects at least, prepares the ground for eco-industrialization. The second group of clusters already has much clear signs of emerging collective efficiency. The third group of clusters includes large as well as medium size firms. They aim for wider markets, national and/or foreign and are generally able produce competitively.

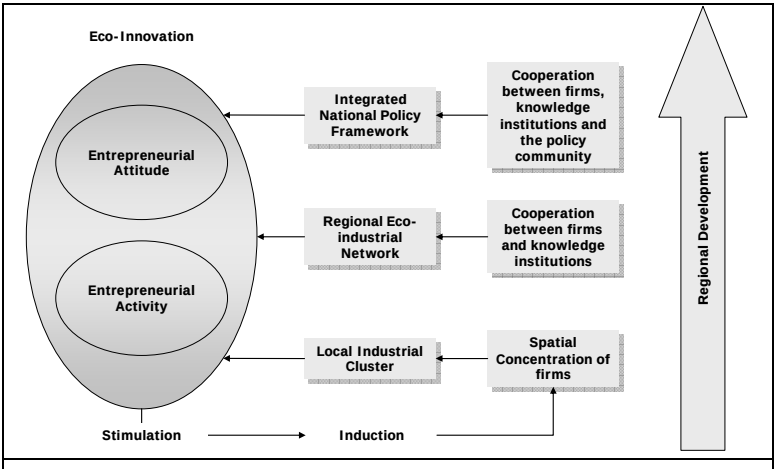


Figure 5.6 Framework for Eco-Industrial Transformation

Within each group, we examine each clusters economic context and its international operations. The contextual variables are three: the nature and size of the product market, the actual and potential economies of scale and scope and the institution governing challenge. Within the cluster, the analysis considers both external economies and joint action.

Existing clusters are at different stages of development. Origins, growth and paths of clusters vary greatly. By no means do all begin at the first level, nor do they proceed through a uniform set of stages. The levels described above are rough guide to the relative development of these clusters. They are useful because they help to explain clusters differing needs, and perhaps more

importantly, they demonstrate multiple forms of the links between EICs and the sustainable development process.

5.6 Stages in Eco-Industrial Cluster Development

Continuous improvement and constant innovation are key to establishing and sustaining competitiveness in all the three pillars of sustainable development. The initiative of turning clusters in eco-industrial clusters is no exception to the rule. Industrial clusters are believed to be a geographical concentration of industries dependent upon local resources, skills, work force and raw materials. An eco-industrial cluster essentially consists of the clusters that operated with a higher degree of eco-efficiency making use of better management practices, technologies and skills. The next step in this hierarchy of growth and development is the shift from eco-industrial clusters to eco friendly economic zones. The transition becomes possible only by way of integrating environmental, economic, engineering and social concerns in industrial planning and development policymaking as shown in Figure 5.7.

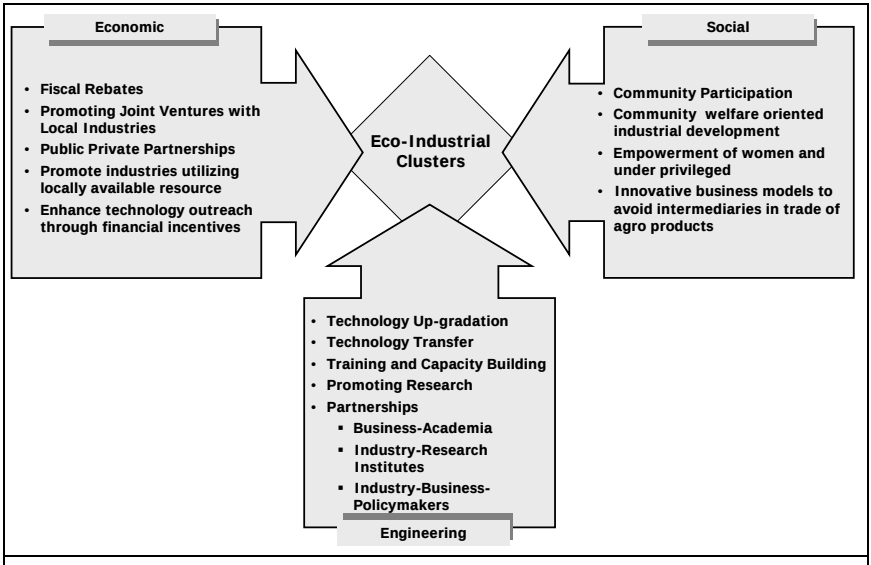


Figure 5.7 Considerations For Continuous Improvement in Clusters

6 Eco-Industrial Clusters: Implications for Policy Making

6.0 Making Sense of Eco-Industrial Clusters

This study began with the question: Can eco-industrial clusters located in urban-rural fringe areas unleash the synergy between the environment and economic development. Analysis of internal working and external environment of clusters in Asia suggest that the answer must be yes, but that is not the end. Eco-industrial clusters in urban fringe areas are at different levels of development, and their ability to contribute to sustainable development varies accordingly.

Eco-industrial clusters can and do contribute for preserving the environment and local development, but in different ways. Those in the first group make their contribution mainly by building a productive environment that in some aspects at least prepares the ground for the emergence of collective eco-efficiency. Clustering clearly facilitates market access and allows some firms to produce their eco-products in quantity. The fact that the firms are clustered also encourages associational environmental activity to begin. It is no coincidence that associations in such clusters focus on improving or gaining policy support or access to needed services. In Asia, infrastructure is the most basic needs of cluster formation. Without them, they are unlikely to move ahead.

The second group of clusters has much clear signs of emerging collective efficiency. These clusters have already started enjoying economic benefits, but remain constrained by the weak technology for further inter-firm network to evolve and the frequent sidetracking of associational activity. Greater specialization and differentiation of firms leads to bilateral production technologies and ultimately higher eco-efficiency. Higher-level technologies in at least some of the firms set the stage for positive technological spillovers. In cases, where basic infrastructural and input needs have been met, associations can begin to deal with issues of market and technology. Table 6.1 presents a comparative overview of the features of the clusters studied.

Table 6.1 Comparative Evaluation of Research Clusters

Key Factors	Countries and Industrial Clusters			
	India	Japan	Thailand	Vietnam
	Sericulture	Wood	Rice & Livestock	Fishery
Nature of Market	Supply–led, mainly secondary towns	Demand–led, domestic	Demand–led, regional, passive exports	Demand–led, mainly export, limited domestic
Key Players	Producers & Development Assistance Policy	Lead firms & Environmental Policy	Large Firms & Social Development Policy	Foreign Buyers & Industrial Policy
Evidence of Inter-firm Networks	Weak bilateral linkages	Extensive multilateral cooperation focussed on supply chain	Effective horizontal linkages	Extensive subcontracting
Key Benefits	Product/market diversification, Employment	Zero-emission, Eco-product development	Waste management, Income generation	Improved water quality, Employment generation
Role of Community & Support Institutions	Limited. Disabling labour market pooling	Significant. Positive intermediate input effects	Important. Potential for significant technology spill over	No local but some central institutions; Improved market access
Major Constraint	Social Capital	Policy mismatch	Enabling Technology	Policy Conflicts

6.1 Cross-cluster Multi-country Analysis

The Vietnam fish cluster and Maniwa wood industry cluster include large as well as small and medium sized firms. They aim for wider markets, both national and international and are generally able to produce competitively. However, the resemblance between them ends. The Maniwa cluster is situated squarely within eco-industrialization process. Market access, labor market pooling, intermediate effects and technological spillovers are all present and positive. The Vietnam cluster is not characterized by extensive and varied

linkages – bilateral and multilateral, vertical and horizontal – that result in joint action in production and on key issues affecting the cluster. The greatest need in this and other alike is for continuing market analysis, focused particularly on the export market and for upgrading the small firm segment of the cluster to encourage equal sharing of benefits. The existing associations can probably handle the first task, but the small firms need assistance of government or NGOs in their efforts to strengthen their position.

The Maniwa cluster, on the other hand is fragile from the eco-products developed. It has to weather frequent shocks, if the weak mechanism for joint action by the METI, MAFE, MOE raise questions about its ability to step-up output and quality. The unequal power relationship between the forest associations and furniture makers on the one hand, and the large wood traders and log processors on the other hand, mean that even when the clusters flourishes, the benefits are not well shared. Furthermore, the challenge of dwindling domestic wood supplies has not been adequately dealt with. All of these problems suggest that those concerned need to work together. This will require new forms of public-private partnership.

The analysis raises other issues that cut across the three grouping of clusters. The first of these has to with the interplay of market access and firm growth. Across the clusters analyzed, there is evidence that clustering reduces growth constraints frequently identified on literatures on small enterprises. The most notable example is access to market. All clusters have been able to attract customers, from traders to final consumers, a result of the concentration of producers. The problems are that the size of the eco-markets they are connected to in most cases remain small. This may partly explain why specialization and skill development have failed to develop very far in most of the small enterprise clusters as well as why the middle sized firms, generally found in clusters everywhere, are missing.

6.2 Institutional Issues

Another issue that cuts across the clusters grouping concerns the relationship of institutions to cluster development. Institutional issues take place in at least two different forms. The first is the failure in many instances of institutionalized cooperation, especially associational activity, to improve cluster operations. One would expect that associations and cooperatives, as vehicles for bringing

together persons with similar interests would be string forces for positive strong joint action. Figure 6.1 presents the results of aspirations of stakeholders expressed during the consultation meetings held in India, Thailand and Vietnam. The role of various agencies as viewed by the stakeholders of eco-industrial cluster formation indicates that frequently policy environment drives the cluster initiative. Some like the Maniwa community initiatives in Japan are adjudged as social capital creation. Other seems to get sidetracked or bogged down in a single difficult problem. The reasons advanced to explain particular cases often do not apply more generally. For example, both the Sericulture Institute and Thailand Environmental Institute were creations of government rather than of the community membership. Yet one appears to be at least attempting to address the clusters strategic needs, while the other is languishing as a government 'errand boy'. Research focused on these institutions and their multiple linkages is probably needed to assess their potential role as engines of cluster development.

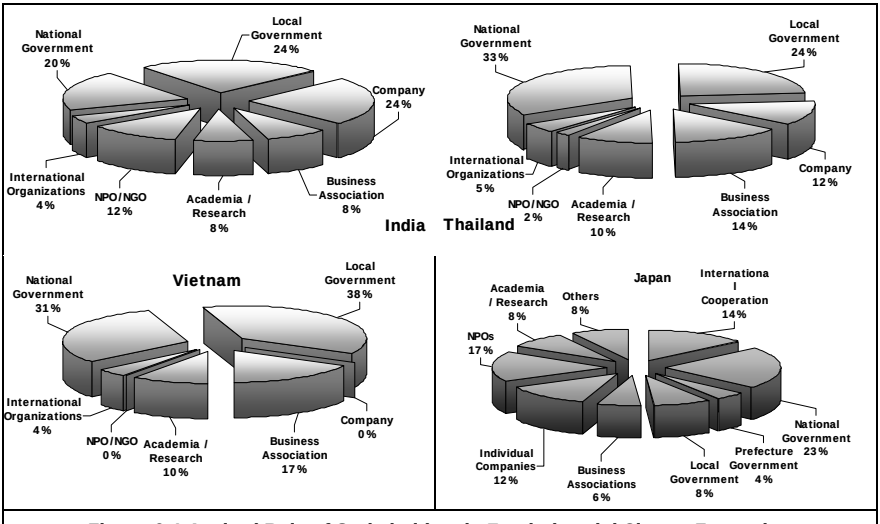


Figure 6.1 Aspired Role of Stakeholders in Eco-industrial Cluster Formation

The second institutional issue concerns the effect of weak institutions on exchange relations and, ultimately, on the clusters performance and growth. In several clusters, for example, it was observed that producer's lack of ability to enforce commercial contracts narrows the market and (or) limits operations to cash transaction. Such a situation constraints business activity and makes a firm

vulnerable to shocks, sometimes on large scale. Much more research, especially comparative research, on the development of economic institutions within the cluster has to be undertaken. Such research should consider social and political as well as economic factors affecting the genesis and growth of institutions.

Micro-finance programs and activities figure prominently in clusters of India; some companies engage in both financial services and manufacturing. The relationship is an important one, not only because it offers some firms the opportunity to realize economies of scope, but also because industrial history in many countries and sectors shows manufacturing growing out of financing. This is beginning to happen in some of the clusters studied. Whether significant small-scale manufacturing can develop from these activities will depend, among other things, on the size of the markets these companies can access and their ability to compete in terms of quality and price with newly available imports from outside.

Many of the small enterprise clusters derive in one way or another from the implementation of government spatial policies barring certain activities from residential areas and central business districts. The relocation of business had created new clusters. India's sericulture cluster is the result of forced agglomeration. It is interesting to note, however that the new cluster then consisted of one or more groups of enterprises from other locations that were joined by others who moved in individually or started their business in the new cluster. In such circumstances, forming a group identity can be a slow and painful process, as producers may tend to hold on to old allegiance. In the Maniwa cluster, for example, the Maniwa juku is a carry over from the former local movement. Although it is welfare, rather than a business association, many of its members apparently felt that this association was necessary to think of future development. And did not bother to join the site association until very recently. This may partly explain the effective joint action in that cluster.

6.3 International Technology Transfer

It is not sufficient for individual companies to form inter-firm networks in order to become environment friendly; EICs also require a range of technologies available within their reach to do so. Environmental technologies for conversion of waste to energy, wastewater treatment and use of renewable materials have to spread easily among the companies to benefit the cluster as a whole. This is an

area where Thailand and Indian EICs need intervention to strengthen the existing inter-firm networks thus enabling them to share relevant technologies among the various firms of the cluster.

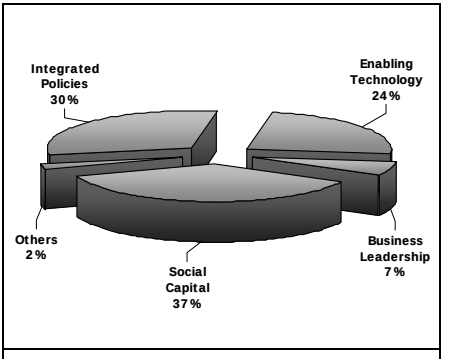


Figure 6.2 Pre-requisites for Eco-industrial Cluster Formation

Academia such as universities or research institutes, for example, Universities of Tokyo and Okayama in Japan's case and the Hosur Sericulture Training Institute in India's case, that focus some of their research within the EIC are found to be helpful in diffusion of appropriate technologies among the firms and induce eco-innovations within the clusters.

Similarly, in the case of Vietnam, affordable and cost-effective technologies are essential to strengthen the inter-firm networks. Small scale and decentralized technologies, for example such as for processing bio-diesel from fish fat would help in improving the eco-efficiency of the eco-industrial cluster. As indicated in Figure 6.2, the eco-industrial clusters of developing Asia require small scale, replicable technologies for biomass power and biogas generation.

The wood eco-industrial cluster of Japan appears to have relatively advanced technologies compared to those in the other three countries. Diffusion of these technologies in appropriate context and time to other countries such as the ones studied in the research is essential to reap the full benefits of the technology, cutting across national and regional boundaries.

6.4 Need for Policy Interventions

The analysis suggests that there is plenty of scope for positive intervention at both policy and program levels in EICs, as appears to be the case. Clusters further eco-industrialization process, then countries with industrialization on their development agenda would do well to enact policies favorable to cluster formation. Figure 6.3 presents the view of stakeholder on the importance of policies as driving forces in eco-industrial cluster formation. Such policies might include incentives for producing firms of varying sizes to locate within clusters.

Such policies might include incentives for producing firms of varying sizes to locate within clusters, priorities to clusters infrastructure decisions, and encouragement of associational activities. At the level of programs, both government and non-governmental associations can assist the development of collective efficiency, providing business ideas and training to encourage the emergence of specialist producers, traders and service enterprises, or strengthening cooperation between enterprises. The measures to be considered include subsidizing visits to trade fairs, support for standardization, and support for arbitration services, or fostering cooperation between enterprises through external assistance. Figure 6.4 presents stakeholder expectations on the role of policy in establishing eco-industrial clusters aimed at regional development.

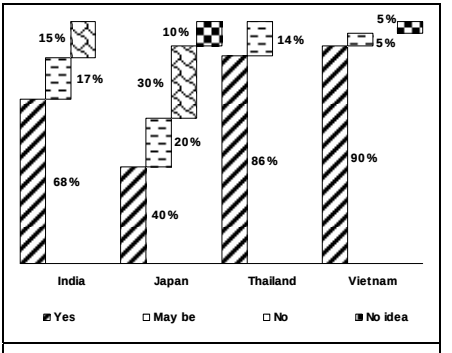


Figure 6.3 Importance of Policies as Driving Forces in Cluster formation

6.5 Integrating Cluster Initiatives in a Wider Policy Arena

The study on eco-industrial clusters was carried out aiming at technological, management and policy aspects. In this endeavor of attempting the transformation of clusters to eco-industrial clusters, governmental policy plays an important role. On the other hand, as the case studies indicate, eco-industrial cluster initiatives are defined by their purpose not by the policy tools. This openness towards many different objectives and activities structurally differentiates eco-industrial cluster initiatives from other institutions defined by their responsibility for a particular set of policy instruments. And it creates unique challenges the eco-industrial clusters have to master. A review of the policies related to the bio-based rural industries and eco-industrial clustering was performed. The key observation from the review is summarized as Fig 6.4. The review also indicates that general lack awareness on environmental issues prevails in developing Asian countries. Predominantly, the policies attempt to address issues related to pollution. Instances where policies insist on efficient use of resources is very minimal or almost nil.

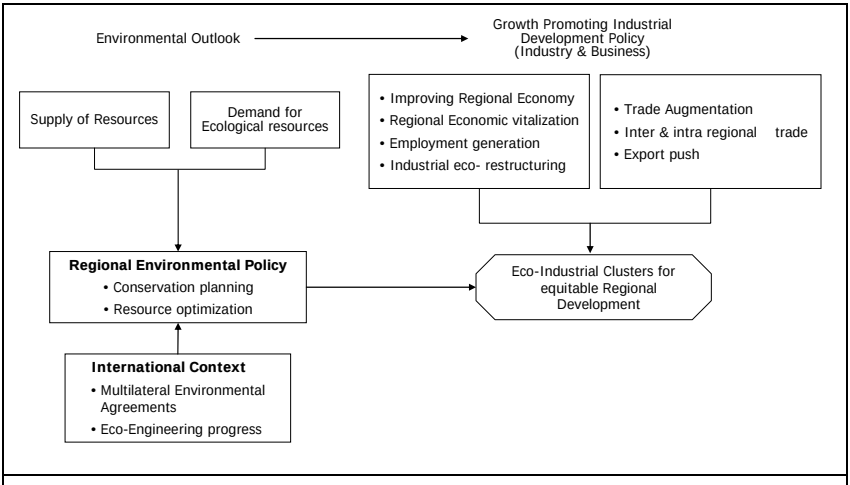


Figure 6.4 Eco-Industrial Clusters in a Wider Policy Arena

More specifically, in India the National Environmental Policy takes an umbrella approach and attempts to cover all issues considered related to the environmental. Other policies mention, rather than discuss, at a broader level the importance of resource conservation and pollution prevention.

In Thailand, policies aim at resource conservation and increasing eco-efficiency by encouraging alternative use of materials and wastes. However, specific polices emphasizing the shift from industrial clusters to eco-industrial clusters with a closed material cycle are absent.

In the case of Vietnam, the country though having a strong policy regime, fails to strongly emphasize the need for resource efficiency. Most of the policies, in the command and control regime, are aimed at pollution reduction. The long-term developmental plans of the country aim at utilizing the indigenous potential, however without insisting their conservation.

In general, the review of the policies in the study countries, India, Japan, Thailand and Vietnam reveals that governments approach national economic and industrial development with utmost priority. Specific policies such as those emphasizing the transition to eco-industrial clusters taking into consideration the natural resource constraints and pollution hazards are essential to ensure sustainable development.

6.6 Implications for Policy Making

Eco-industrial cluster initiatives can become a promising tool to boost environmental competitiveness and economic development at regional level and have the potential to become critical elements in the tool box for sustainable development. But they also depend on the wider policy domain of which they are part. The policy lessons emerging from the multi-country study in India, Japan, Thailand and Vietnam suggests the following public policy agenda could reinforce the advantages of EICs located in urban-rural fringe areas.

- Eco-industrial cluster initiatives shall be looked as a new market based integrated environmental and economic approach for sustainable regional development that spell out new roles for governments, business, and community based organization and knowledge institutions. In this context, clusters possesses significant potential for sustainable development than just being another well intentioned but often isolated environmental approach with little socio-economic impact.

- Joint efforts that cut across sectoral policies and transcend the boundaries of established departments in different tiers of governments are needed to unleash the sustainability potentials of eco-industrial clusters. Cluster formation and transformation as a sustainable development model can rise or fall based on the same weakness as others. Treating them with narrow revisions of traditional sectoral policies runs the risk of concentrating on peripheral issues, not addressing fundamental problems of unsustainability.

- Existing industrial clusters in urban-rural fringe areas have to be identified to strengthen inter-firm networks within them, however nascent they may be. Looking beyond urban centered manufacturing sectors such as metal processing, textile, chemicals etc, is essential. Private sector involvement in cluster initiatives, during its initial stages, will tend concentrate in urban where adequate infrastructure is available. The permeation of private sector initiative to rural regions and among weaker and more vulnerable sections, can tend to be slow unless the process is accelerated through promotional and institutional support. In most developing Asia, unless comprehensive promotional and institutional support is provided, EIC development in urban-rural fringe areas can take considerable time.

- The socio-economic potentials of cluster development is based on the factors such as locational advantages, cultural specificities, infrastructure needs, entrepreneurship skills, intended social benefits etc. New regulatory

instruments, incentive mechanisms and loosened bureaucratic procedures need to be targeted to foster an entrepreneurial culture within the fringe areas which is open to new ideas, encourage backward and forward linkages and raise prospects for cooperative actions in value chain.

- Facilitation of technology flow into the eco-industrial clusters through agreements at different level will improve urban-rural linkages, particularly when there is less business equity participation and market orientation. For this purpose, an effective system of information on alternative technologies at cluster level is essential

- Working with business associations towards a macro-economic framework is very important as it would provide incentive structure for small business to operate in the cluster on fair terms. Generalist financial support programmes to individual companies within a cluster tend to have limited impact when coming to adoption of new technologies. Environmental policy interventions shall aim at group of small and medium firms around joint action projects. Giving priority access to privileged but scarce fiscal resources to innovative clusters shall be based on performance bench marking.

Basically any eco-industrial cluster initiative can draw upon existing policies, and their main contribution is to select, adapt and combine policy measures to maximize the synergy. None of these challenges are trivial, but solving them offers a huge reward in terms of the capacity to improve environmental and economic performance of small and medium enterprises through cluster growth and competitiveness.

This source book is an initial attempt to rationalize the debate on industrial clusters in urban-rural fringe areas by providing not only a conceptual framework, but also some systematic evidence that goes beyond these four case studies. More such information is necessary, and when there are number of comparative datasets and good practices, we can thoroughly examine the macro-policy environment and micro-business foundations. Studies that compare clustered with isolated firms in the same industry might shed new light on the net benefits of eco-clustering. Further exploration of aspects not well covered in the current studies, such as cluster management framework, financial and political variables will help to deepen our understanding of fully functional EIC. This consideration notwithstanding, it appears that EIC can be one way towards eco-restructuring for developing Asia. This is an important finding for business, governments, donors, and other stakeholders who make clusters their home.

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Fact File IN - Industrial clusters in India

Cluster	Location	Cluster basis	Production Category
Andhra Pradesh			
Oil mills	Adoni	R	C
Polished slabs	Banganapalli	R	C
Polished slabs	Berthamcheria	R	C
Rice milling	East Godavari	R	C
Ceiling fan	Hyderabad	M	C
Electronics	Hyderabad	M	B
Polished slabs	Kolimigundalla	R	C
Artificial diamonds	Kurnool	M	B
Cashew processing	Palasa	R	C
Handloom durries	Warangal	R	C
Leather products training	Warangal	M	C
Power looms	Warangal	M	B
Tice milling	West Godavari	R	C
Pharma	Hyderabad	R	B
Assam			
Timber Bamboo Cane	Dhubri-Goalpura	R	C
Timber Bamboo Cane	Dibrigarh-Tinsukia	R	C
Brass and bell metal	Hajo	R	C
Bihar			
Engineering and fabrication	Adityapur	M	C
Engineering and fabrication	Barauni	M	B
Sericulture	Bhagalpur	R	C
Engineering and fabrication	Bokaro	M	C
Coal mining	Dhanbad	R	B
Auto components	Jamshedpur	M	A
Food products	Muzaffarpur	R	C
Engineering and fabrication	Ranchi	M	C
Delhi			
Auto components	Delhi	M	A

M – Market based, R – Resource based, I – Infrastructure based
A – Above Rs. 10,000 million production; B – Rs. 1000 to 10,000 million production;
C – Rs. 100 to 1000 million production; D – Less than Rs. 100 million production

Hosiery	Delhi	M	B
Ready made garments	Delhi	M	A
Sanitary fittings	Delhi	M	B
Stone crushing	Rajoukri	R	C
Gujarat			
Detergent powder and cake	Ahmedabad	M	B
Drugs and pharmaceuticals	Ahmedabad	M	A
Dyes and intermediates	Ahmedabad	M	A
Molded plastic products	Ahmedabad	R	B
Ready made garments	Ahmedabad	R	B
Textile machinery parts	Ahmedabad	M	A
Ship breaking	Alang	I	A
Oil mills machinery	Amreli, Juna, Garh, Rajkot	M	C
Spectacle frames / glasses	Baroda	R	C
Re-rolling mills	Bhavnagar	M	B
Salt	Bhavnagar	R	C
Oil mills	Dhoraji	R	C
Plastic industry	Dhoraji	R	C
Electronic hardware	Gandhinagar	I	B
Oil mills	Gondal	R	C
Rice flakes	Gondal	R	C
Brass parts	Jamnagar	R	B
Plastic buttons	Jamnagar	R	C
Agricultural implements	Jasdan	M	B
Textile processing	Jetpur	M	B
Engineering industry	Makarpura	M	C
Flooring tiles	Morbi	M	B
Wall clocks	Morbi	M	B
Chemicals	Nandesari	I	C
Sarees	Pattola Patan	M	C
Diesel engines	Rajkot	M	B
Electric motors	Rajkot	M	B
Castings	Rajkot	M	B
Foundry	Rajkot	M	B

M – Market based, R – Resource based, I – Infrastructure based
A – Above Rs. 10,000 million production; B – Rs. 1000 to 10,000 million production;
C – Rs. 100 to 1000 million production; D – Rs. Less than 100 million production

Jewelers gold and silver	Rajkot	R	B
Machine tools	Rajkot	M	B
Oil mills	Rajkot	R	C
Wrist watch and components	Rajkot	M	C
Weights and measures	Savarkundla	M	C
Diamonds	Surat	M	A
Textiles	Surat	M	A
Pottery and ceramics	Surendra nagar	R	C
Ceramics	Thanged	R	B
Isabgol	Urijh	M	D
Petrochemicals	Vadodra	I	B
Oil paints	Vallab Vidya nagar	M	C
Chemicals	Vapi/Ankleshwar	I	B
Dal	Vasad	R	C
Ceramics	Vankenar	R	C
Power looms	Vankenar	M	B
Haryana			
Mixies and grinders	Ambala	M	D
Scientific instruments	Ambala	M	C
Synthetic yarn and products	Bhiwani	M	B
Auto components	Faridabad	M	A
Stone crushing	Faridabad	R	C
Auto components	Gurgaon	M	A
PVC pipes	Hissar	M	B
Stone crushing	Hissar	R	C
Domestic utensils	Jagadhri	R	-
Agricultural implements	Karnal	M	-
Rice milling	Karnal	R	-
Rice milling	Kurukshetra	R	-
Cane products	Mohindergarh	R	D
Stone crushing	Panchkula	R	D
Handlooms	Panipat	M	A
Shoddy yarn	Panipat	M	B
Engineering industry	Pinjore	I	B

M – Market based, R – Resource based, I – Infrastructure based
A – Above Rs. 10,000 million production; B – Rs. 1000 to 10,000 million production;
C – Rs. 100 to 1000 million production; D – Less than Rs. 100 million production

Leather footwear	Riwari	M	D
Nuts/bolts	Rohtak	M	C
Foundry	Samalka	M	D
Auto components	Yamunanagar	M	C
Himachal Pradesh			
Textiles	Baddi Barotiwala	M	D
Tourism	Dalhousie	R	D
Stone crushing	Dantal	R	D
Woolen carpets	Dharamshala, Manali	R	D
Tourism	Dharamshala	R	D
Cement	Sirmaur	R	C
Woolen shawls	Kullu	M	D
Food products	Kullu and Sirmaur	R	D
Tourism	Manali	R	D
Engineering industry	Parwanoo	M	C
Tourism	Shimla	R	C
Paper	Solan	R	C
Induction furnace	Solan and Sirmaur	R	C
Jammu & Kashmir			
Cricket bat industry	Anantnag	R	D
Steel re-rolling mills	Jammu	M	C
Edible oil mills	Jammu/Kathua	M	C
Rice milling	Jammu/Kathua	R	D
Furniture	Jammu/Kathua	R	C
Tourism	Srinagar/Anantnag	R	C
Stone crushing	Srinagar/Udham	R	D
Tourism	Udhampur/Jamnagar	R	D
Karnataka			
Leather	Athni	R	C
Machine tools	Bangalore	M	B
Silk	Bangalore	R	B
Leather	Raichur	R	D
Coir	Arasikara	R	C
Electronics	Bangalore	M	A

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Readymade garments	Bangalore	M	B
Leather	Bangalore	M	B
Screen printing	Bangalore	M	B
Agarbatti	Bangalore	M	C
Power looms	Belgaum	M	C
Craft ware	Bidar	R	C
Oil mills	Bijapur	R	C
Carpets	Mysore	R	D
Lacquer craft	Channapatna	R	D
Dal mills	Gulbarga	R	C
Cotton handlooms	Ilkal	R	C
Food products	Mysore	R	C
Food products	Mangalore	M	C
Agarbatti	Mysore	M	B
Leather	Mysore	M	C
Rosewood	Mysore	R	C
Silk	Mysore	R	B
Sandalwood	Sagar	R	C
Rice milling	Shimoga	R	B
Foundry	Belgaon	R	C
Kerala			
Sea food	Coastal Kerala	R	C
Rubber	Kottayam	R	B
Rice milling	Palkkad	R	C
Coir	Thiruvananthapuram	R	C
Hosiery	Kanzhikode	M	C
Madhya Pradesh			
Steel re-rolling mills	Bhilai, Durg	R	B
Engineering industry	Bhopal	M	B
Herbal drugs and essential oils	Bilaspur	R	C
Leather	Bilaspur	M	D
Pharmaceutical	Indore	M	C
Readymade garments	Indore	R	C
Electrical items	Devas	M	C

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Maharashtra			
Auto components	Aurangabad	M	C
Power looms	Malegaon	R	A
Brass goods	Bhandara	M	D
Lacquer craft	Bhandara	M	D
Beedi	Bhandarg	R	D
Power Looms	Bhivandi	R	A
Electronics	Mumbai	M	A
Roofing tiles	Chandrapur	R	C
Casting sand	Gadchiroli	R	C
Silver ornaments	Huppari	M	C
Confectionary	Kalyan	M	D
Kumkum	Sholapur	M	D
Slippers	Kolhapur	M	D
Diesel engines	Kolhapur	M	C
Foundry	Kolhapur	M	C
Jaggery	Kolhapur	R	C
Power Looms	Nagpur	M	C
Rice flakes	Nanded	M	D
Textile blue	Nanded	R	D
Tericot	Nanded	M	D
Raisins	Nashik	R	C
Saris	Paithan	M	C
Ganesh statues	Pen Panvel	M	D
Auto components	Pune	M	A
Electronics	Pune	M	B
Food products	Oune	M	B
Readymade garments	Pune	M	B
Chuna batti	Rajura	M	C
Leather	Satura	M	C
Toys	Sawantgadi	M	D
Bed spread	Sholapur	M	C
Cashew	Sindudurg	R	C
Chemicals	Vashi	R	B

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Cashew	Ratnagiri	I	C
Cotton seed oil	Akola	R	C
Dal mills	Akola	R	C
Cotton seed oil	Amravati	M	C
Pharmaceutical	Aurangabad	M	C
Rice milling	Bhandara	R	C
Rice milling	Chandrapur	R	C
Chilly powder	Dhule	R	D
Rice milling	Gadchiroli	R	C
Re-rolling mills	Gondia	M	C
Dal	Jalgaon	R	C
Engineering industry	Jalna	M	C
Flour milling	Kulaba	M	C
Bricks steel gates grills	Latur	M	D
Drugs	Mumbai	M	B
Toys	Mumbai	R	C
Engineering	Nagpur	M	C
Steel	Nagpur	M	C
Garments	Nagpur	M	D
Dal	Nanded	R	D
Drugs	Nasik	M	D
Steel	Pune	M	C
Fibre glass	Pune	M	C
Fish	Ratnagiri	R	C
Rods	Sangli	M	C
Gobar gas	Satara	M	D
Copper wires	Sindhudurg	M	C
Drugs	Tarapur	M	C
Sea food	Thane	R	C
Drugs	Thane	M	C
Solvent oil	Wardha	M	D
Dal	Yavatmal	R	D
Garments	Mumbai	M	A
Orissa			

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Rice milling	Balasore	R	D
Rice milling	Bolangir	R	D
Jewelery	Cuttack	M	C
Rice milling	Cuttack	R	C
Power looms	Gankam	M	C
Rice milling	Ganjam	R	D
Rice milling	Koraput	R	D
Handicrafts	Pipli	M	D
Rice milling	Puri	R	C
Rice milling	Sambalpur	R	C
Silk	Sambalpur	R	C
Punjab			
Rice milling	Amritsar	R	B
Shoddy yarn	Amritsar	M	C
Swords	Amritsar	M	D
Woolen shawls	Amritsar	M	C
Machine tools	Batala	M	B
Rice milling	Gurdsapur	R	D
Craft	Hoshiarpur	M	D
Sports goods	Jalandhar	M	C
Agri implements	Jalandhar	M	B
Hand tools	Jalandhar	M	B
Rubber	Jalandhar	M	C
Rice milling	Kapurthara	R	C
Furniture	Kartapur	M	C
Auto components	Ludhiana	M	B
Bicycle parts	Ludhiana	M	A
Electric fans	Ludhiana	M	B
Knit wear	Ludhiana	R	A
Sewing machine components	Ludhiana	M	B
Rerolling mills	Mandi	M	C
Wheat thresher	Moga	M	C
Rice milling	Pathankot	R	C
Agri implements	Patiala	M	B

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Diesel engines	Phagwara	M	B
Leather	Jalandhar	R	C
Surgical instruments	Jalandhar	M	C
Industrial fasteners	Ludhiana	M	-
Hand tools	Ludhiana	M	-
Machine tools	Ludhiana	M	-
Forging	Ludhiana	M	-
Rajasthan			
Oil mills	Alwar	R	C
Screen printing	Pali	M	D
Textile dyeing and printing	Barmer	M	D
Spinning and processing	Bhilwara	M	A
Papad, Namkeen	Bikaner	R	C
Plaster of Paris	Bikaner	R	C
Gems and Jewelry	Jaipur	R	B
Hand made paper	Jaipur	M	C
Lacquer craft	Jaipur	M	C
Statues	Jaipur	R	C
Woolen carpets	Jaipur	M	B
Textile	Jodhpur	M	C
Marble	Krishnagarh	R	C
Hand tools	Nagaur	M	C
Textile	Sanganer Bagru	M	B
Cement	Sirohi	R	C
Textile	Jaipur	R	B
Tamil Nadu			
Diesel engine	Coimbatore	M	B
Tea	Kotagiri-Ooty	R	B
Matchstick	Kovilpatti	M	C
Auto components	Chennai	M	A
Garments	Madurai	M	A
Gauge cloth	Rajapalayam	M	C
Garments	Salem	M	A
Starch and sago	Salem	R	C

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Rice milling	Tanjavur	R	C
Tin container	Virudunagar	M	B
Agricultural implements	Coimbatore	M	A
Leather	Chennai	R	A
Match/Fire works	Sivakasi	M	A
Rigs	Tiruchengode	M	C
Engineering industry	Tiruchirapalli	M	C
Artificial diamonds	Tiruchirapalli	M	C
Hosiery	Tirupur	M	A
Leather	Ambur	R	B
Leather	Vaniambadi	R	C
Uttar Pradesh			
Foundry	Agra	M	B
Leather	Agra	M	A
Sweets	Agra	R	B
Statues	Aligarh	M	B
Locks	Aligarh	M	B
Carpets	Allahabad	M	B
Carpets	Banaras	M	B
Sheet work	Banaras	M	C
Silk saris	Banaras	M	B
Carpets	Bhadoi	M	C
Potteries	Chunur	R	C
Rice milling	Dehradun	M	C
Durries	Dharmpur	M	C
Handloom	Gorakhpur	M	C
Sheet work	Hathras	M	D
Bells	Jaksar	M	D
Power looms	Jhansi	R	C
Perfumery / Essential oils	Kanauj	M	C
Hosiery	Kanpur	M	B
Leather	Kanpur	R	A
Ceramics	Khurja	M	B
Handlooms	Maunath	M	C

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Blankets	Meerut	M	C
Sports goods	Meerut	M	C
Carpets	Mirzapur	M	B
Brassware	Moradabad	M	A
Rice milling	Muzaffarnagar	R	C
Rice milling	Nainital	R	C
Electronic	Noida	M	B
Rice milling	Pilibit	R	C
Carpets	Pratapgarh	M	C
Survey instruments	Roorkee	M	C
Rice milling	Saharanpur	R	C
Horn and bone products	Sambhal	R	C
Iron	Saharanpur	M	C
Woodwork	Saharanpur	R	C
Carpets	Shahjahanpur	M	C
Glass	Firozabad	M	B
Agricultural implements	Varanasi	M	C
Saddler	Kanpur	R	B
Toys	Noida / Delhi	I	B
Handmade paper	Kalpi	M	C
West Bengal			
Transformers and invertors	Parganas	M	C
Hand tools	Agar Purulila	M	C
Fishing hooks	Bankura	M	C
Wooden handicrafts	Bankura	M	D
Electric fans	Kolkata	M	C
Hosiery	Kolkata	M	A
Garments	Kolkata	M	B
Leather goods	Kolkata	M	A
Transformers and invertors	Kolkata	M	B
Artificial Jewelry	Howrah	M	C
Battery units	Howrah	M	B
Foundry	Howrah	M	B
Leather	Howrah	R	B

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Locks	Howrah	M	C
Steel	Howrah	M	B
Silk	Murshidabad	R	B
Battery	Siliguri	M	B
Metal	Bargachia	M	C

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Fact File JP - Industrial Clusters in Japan

Project	Field	Regional Policy Bureau and Business Promotional Organization
Industrial Cluster Projects *		
Hokkaido Super Cluster Promotion Strategy	Information Technology	Information Policy Division, Hokkaido Bureau of Economy, Trade and Industry Hokkaido IT cluster Forum
Hokkaido Super Cluster Promotion Strategy	Bio-technology	Bio-industry division, Hokkaido Bureau of Economy, Trade and Industry Hokkaido BIO Industrial Forum
Tohoku Industry Promotion for Information Technology	Life science and cutting Edge Manufacturing	Industrial cluster promotion office, Regional Economic Department, Tohoku Bureau of Economy, Trade and Industry Intelligence Cosmos Research Institute
Tohoku Industry Promotion for Recycling oriented society	Recycling	Natural Resources, Energy and Environment Division, Tohoku Bureau of Economy, Trade and Industry Industrial Cluster Committee
Tama Regional Industry Revitalization	Cutting edge manufacturing	Tama Industrial Revitalization organization
Tokyo: Fostering Bio-venture	Bio-genome	Metropolitan Bio-technology Related start-up network
Kanto Developing IT ventures	Information Technology	Information Policy Division, Kanto Bureau of Economy, Trade and Industry IT Venture Forum

* Industrial cluster plan is formulated in 2001 to establish clusters in the local economy owing to changes in international economic situation. It supports establishment of new enterprises and encourages small and medium sized companies to form alliances with other companies or knowledge institutes to innovate locally and compete internationally.

Project	Field	Regional Policy Bureau and Business Promotional Organization
Tokai Manufacturing Industry Promotion	Manufacturing Industry	Enterprise Development Division, Chubu Bureau of Economy, Trade and Industry Tokai Factory Council
Tokai Bio-factory Project	Bio-industry	Bio-industry Division, Chubu Bureau of Economy, Trade and Industry NPO Bio Factory Central Japan
Hokuriku Regional Industry Promotion	Power and gas industry	Hokuriku Branch Office, Chubu Bureau of Economy, Trade and Industry Hokuriku Manufacturing Vitalization Council
Kansai-Tissue Engineering Project	Bio-technology	Bio-technology Industry Promotion Office, Kansai Bureau of Economy, Trade and Industry Kinki Bio-industrial Council
Kansai Active Manufacturing Industry Project	Heavy industry	Manufacturing Industrial Cluster office, Kansai Bureau of Economy, Trade and Industry Manufacturing Cluster Council
Kansai Information Technology Cluster	Information Technology	Information Policy Division, Kansai Bureau of Economy, Trade and Industry
Kansai Energy & Environment Cluster Promotion	Renewable energy technologies	Energy and Environment Division, Kansai Bureau of Economy, Trade and Industry Kansai IT synergistic Society
Chugoku Region Next generation industry project	Cutting edge manufacturing	Economic Policy Division, Chugoku Bureau of Economy, Trade and Industry Chugoku New Business Industrial Cluster Forum
Chugoku Recycling oriented Society Project	Recycling and Environmental Technology	Energy and Environment Division, Chugoku Bureau of Economy, Trade and Industry
Shikoku Techno Bridge Plan	Advanced environmental technology	Shikoku Bureau of Economy, Trade and Industry Shikoku Techno Bridge Forum

Project	Field	Regional Policy Bureau and Business Promotional Organization
Kyushu Silicon Project	Semi-conductors	Information Policy Division, Kyushu Bureau of Economy, Trade and Industry. Kyushu semi-conductor Industrial Technology Innovation Association
Okinawa Industry Promotion	Light manufacturing industry	Economy, Trade and Industry Division, Okinawa General Bureau Okinawa Industry Promotion Project
Eco-town Projects		(subsidy from)
Hokkaido	Home electrical appliances	Economy, Trade and Industry[†]
Sapporo City	Pet and waster bottle recycle	Economy, Trade and Industry
Aomori	Incinerated ash and shell	Economy, Trade and Industry
Akita	Home electrical appliances, Non-iron metal, waste plastic to building material, Coal ash and waste plastic	Economy, Trade and Industry
Iwate -Kamaishi	Fish processing waste	Economy, Trade and Industry
Miyagi-Uguisuzawa	Home electrical appliances	Economy, Trade and Industry
Chiba city - Chiba	Eco-cement, Fusion, Methane gasification, Waste wood Shell, plastic, vinyl chloride	Economy, Trade and Industry Environment Ministry

[†] Ministry of Economy, Trade, Industry (METI) with the support of Ministry of Environment (MOE) has been establishing eco-town projects since 1997. There are two types of support to industries in the eco-town. Hardware project subsidies are applied for effective and stable recycle or reuse projects in eco-town. One third of the costs is subsidized. Software projects include town planning, regional information projects and so on. Total subsides are below one half of the projects. Inter-firm networks within eco-town need to evolve. Apart of from Eco-town projects there are around 900 industrial parks widely distributed across the country. The environmental impacts of such concentrated economic activities are not yet documented.

Project	Field	Regional Policy Bureau and Business Promotional Organization
Tokyo	Construction waste	Economy, Trade and Industry
Kawasaki city	Plastic waste, Paper waste, Concrete waste, Pet bottle	Economy, Trade and Industry
Toyama City	Hybrid waste, wood waste, rubber waste	Economy, Trade and Industry
Nagano – Iida City	Pet bottle, Plastic waste, waste tyre	Economy, Trade and Industry
Gifu	Waste tyre, rubber, pet bottle	Economy, Trade and Industry
Aichi	Nickel recycle Bio-mat	Economy, Trade and Industry
Mie – Suzuka	Paint sewage to manure	Economy, Trade and Industry
Hyogo	Waster tyre gasification	Environment Ministry
Okayama	Wood waste	Economy, Trade and Industry
Okayama – Naoshima	Ash fusion, metal waste	Economy, Trade and Industry New Energy Development
Kochi City	Foamed polystyrne	Economy, Trade and Industry
Yamaguchi	Ash to cement	Economy, Trade and Industry
Hiroshima	RDF power, Ash fusion, polyester cloth	Economy, Trade and Industry New Energy Development
Kitakyshu	Petbottle, home appliances, office equipment, automobile, florescent tune, waste wood, plastic, iron steel recycling	Economy, Trade and Industry

Project	Field	Regional Policy Bureau and Business Promotional Organization
Fukoka – Oomuta	RDF power, waste diaper	New Energy Development, Ministry of Environment
Kumamoto-Minamata	Glass bottle, waste plastic	Economy, Trade and Industry
Biomass Town projects‡		(subsidy from and waste use%)
Hokkaidao - Ootaki	Wood to fuel, direct heating	Agriculture, Forestry and Fisheries (40%)
Hokkaidao – Setana	Farm and fish waste to biogas, Organic fertilizer	Agriculture, Forestry and Fisheries (90%)
Hokkaidao – Rumai	Wood biomass into gas and fuel	Agriculture, Forestry and Fisheries (90%)
Hokkaidao – Nakasatsunai	Animal waste to manure	Agriculture, Forestry and Fisheries (90%)
Aomori -Ichiura	Timber waste to gas power	Agriculture, Forestry and Fisheries (40%)
Akita - Kosaka	Food waste to manure, energy crop	Agriculture, Forestry and Fisheries (98.5%)
Yamagata - Fujishima	Waste oil to biofuel, Wood biomass to charcoal	Agriculture, Forestry and Fisheries (40%)
Yamagata – Tachikawa	Thinned wood to pellet, timber waster to energy	Agriculture, Forestry and Fisheries (90%)
Yamagata – Shinjoyu	Energy crop to ethanol	Agriculture, Forestry and Fisheries (90%)
Fukushima — Tomiokka	Bark, fishery waste into manure	Agriculture, Forestry and Fisheries (85%)
Niigata - Nakajyou	Sewage sludge to charcoal	Agriculture, Forestry and Fisheries (50%)

‡ Biomass town projects implemented by the Ministry of Agriculture, Forestry and Fisheries (MAFF) aims at effective utilization of farm and rural household waste by converting them into energy and material form. It provide financial and technical support for projects to be implemented by local governments and organizations to improve physical recycling facilities and to implement 'soft' – institutional/organizational projects that can contribute to the realization of sound material-cycle society.

Project	Field	Regional Policy Bureau and Business Promotional Organization
Niigata -Jyoetsu	Food waste to biogas, Waste cooking oil to bio-diesel fuel	Agriculture, Forestry and Fisheries (90%)
Chiba - Yamatake	Wood biomass to energy	Agriculture, Forestry and Fisheries (80%)
Tokyo- Akiruno	Wood waste to power	Agriculture, Forestry and Fisheries (60%)
Kangawa-Miura	Fish, sewage, agricultural waste to power	Agriculture, Forestry and Fisheries (96%)
Nagano - Sangou	Food & agric waste to power	Agriculture, Forestry and Fisheries (50%)
Nagano - Chikuma	Waste cooking oil to biofuel	Agriculture, Forestry and Fisheries (59%)
Nagano - Hase	Horticultural waste to energy, Food waste to gas	Agriculture, Forestry and Fisheries (85%)
Yamanashi-Hayakawa	Thinned wood , agriculture waste into energy	Agriculture, Forestry and Fisheries (40%)
Fukui - Miyama	Thinned wood to energy	Agriculture, Forestry and Fisheries (40%)
Fukui - Mikata	Horticulture, sludge into charcoal, fishery waste into fish feed	Agriculture, Forestry and Fisheries (40%)
Kyoto -Yakuno	Agriculture sludge to methane	Agriculture, Forestry and Fisheries (59%)
Hyogo -Kasai	Domestic waste to animal feed, agriculture waste to energy	Agriculture, Forestry and Fisheries (40%)
Fukuoka - Ooki	Food waste, domestic waste to biomass power generation	Agriculture, Forestry and Fisheries (40%)

Project	Field	Regional Policy Bureau and Business Promotional Organization
Nagasaki - Sakai	Food waste to animal feed, Wood biomass to power generation	Agriculture, Forestry and Fisheries (40%)
Oita - Hita	Livestock waste to gas power, wood biomass to power generation	Agriculture, Forestry and Fisheries (40%)
Kumamoto - Hakusui	Waste cooking to biofuel, Agricultural waste to power generation	Agriculture, Forestry and Fisheries (40%)
Kagoshima - Minamisumi	Waste cooking to bio-fuel	Agriculture, Forestry and Fisheries (90%)
Okinawa -Ie	Sugarcane to ethanol, Bagasse Charcoal	Agriculture, Forestry and Fisheries (90%)

Fact File TH - Industrial Parks in Thailand

Name	Location	Type of industries
Central Region		
Eastern Sea Board Industrial Estate	Chachoengsao, Chonburi, and Rayong	Petro-chemicals, automobile manufacturing, and electronic consumer goods, rubber, plastics, civil, construction, warehousing, packaging, food, beverage, Manufacture of climate control system components including radiator, condenser, compressor, air handling units air conditioning control, air conditioning hose and pipe and associated site activities
Kabinburi Industrial Estate	Prachinburi Province	Auto parts, chemical, construction materials, electrical appliance, foods, packaging, plastic parts, rubber products, textile, toy, transportation service, service apartments, metal parts Manufacture of blow, injection and painting plastic automotive parts and manufacture and fabrication of polyurethane
Ayutthaya	Bangkok.	Automobile and electronics industries
Laem Chabang Industrial Complex	Chonburi	General Industrial Zone, Export Processing Zone, Commercial Zone, Infrastructure and Facilities. Manufacture and sale of compressor
Well Grow Industrial Estate	Chachoengsao Province	Manufacture of fiberglass reinforced plastic (FRP) products such as air pollution control system, storage tank, blower, pump - Manufacture of products made from metal, wood and other material such as fume hood, dust collector, laboratory furniture and Manufacture of precision machining parts, stamping parts, precision jigs and fixtures, Manufacture and sale of steering column, steering joint
Gateway City Industrial Estate	Chonburi Province	Development and manufacture of semi-processed food

Name	Location	Type of industries
Bangkok		
Bangchan Industrial Estate	Minburi, Bangkok	General industries, electronics, electricity, gems and jewelers, computer, IT, pulp, paper, publishing, automotive, mining, minerals, food and beverage, metal, metallurgy, metal working, wood furniture, chemicals, pharmaceuticals, civil, construction, warehousing, packaging, rubber, plastics, Manufacture of cookie product in box for arsenal brand
Gemopolis Industrial Estate	Bangkok	Jewelers
Jongsatit Industrial Park	Bangkok	General
Lardkrabang I.E	Bangkok	General Industrial zone and Export processing zone.
Lat Krabang Industrial Estate		Manufacturing of diesel engines and component parts, Manufacturing of diesel engines and component parts,
Thapaya International Industrial City	Bangkok	General Industrial zone and Export processing zone.
Rayong		
Map Ta Phut Industrial Estate and New Town	Map Ta Put, Rayong Province,	General Industrial Zone, Commercial and Residential Zone, oil, gas, chemicals, pharmaceuticals, textile clothing,
PI Rayong Industrial Park2,4	Rayong Province,	
Phadaeng Industrial Estate	Rayong Province,	
Siam Eastern Industrial Park2,4	Rayong Province	Manufacturing and sales of alternator, starter motor, gear drive vacuum pump, egr valve, solenoid valve and car audio
Siam Eastern Industrial Park2,4	Rayong Province	

Name	Location	Type of industries
Rayong Industrial Park2	Rayong Province,	
Eastern Sea Board Industrial Estate	Chonburi and Rayong Provinces	Manufacture and assembly of driveshaft and components for driveshaft, fabricated copper for air conditioners and refrigerators
Amata City Industrial Estate2,3,5	Rayong Province,	Automotive parts, electronics and related products, chemicals, paper, plastic, steel and metal, food products,
Amata Nakorn Industrial Estate	Chonburi Province	Manufacturing of air conditioner Manufacture of nuts and fasteners (nuts, bolts, pins, rivets and washers and other small parts (collar, spacer, roller, spindle) for automotive industry, timing drive system,
Rojana Industrial Park, Rayong	Rayong Province	Cooper tube, motor brush, ferrite core, fuel cock, fuel filter, activator, engine parts, treatment and industrial waste
SSP Industrial Park2	Rayong Province	
TUS Industrial Park6	Rayong Province	
Eastern Industrial City6	Rayong Province,	
Chonburi		
Bangpakong Industrial Estate, Amata Nakorn (former Bang Pakong) Industrial Estate1,2,3	Chonburi Province	Production of air conditioners and compressors, Design and manufacture of elevators and escalators
Chonburi Industrial Estate	Chonburi Province,	General Industrial Zone, Export Processing Zone, Commercial and Residential Zone, pulp, paper, publishing,
Sriracha Saha-Group Industrial Park2	Chonburi Province	

Name	Location	Type of industries
Laem Chabang Industrial Estate5	Chonburi Province	
Pinthong Industrial Estate1	Chonburi Province	
Eastern Industrial Estate1,2,3	Rayong Province	
Rojana Industrial Par, Ayutthaya	Ayutthaya Province	Gas, Cellular phone, clothes, conductor, refrigerator, welding gas, light bulb, children wear, elec. Plate, plastic coating, mold, electronic, fast food, concrete, ware house, insulator, stain less steel, poly aster, circuit board, food, telephone, , plastic, brakes, transportation, audio, belts, lead plate, foam, cable cord, aluminum wheel, dapped cable, mack wheel, capsules The manufacture of noodle and sauce
Hi-Tech Industrial Estate	Ayutthaya Province	Export processing zone, general industry zone, commercial zone, residential and utility facility Manufacture of precision wire spring, flat spring, stamping parts and sub-assembly
Bangpa-in Industrial Estate1,2,3	Ayutthaya Province	
Saha Rattana Nakorn Industrial Estate1,2,3	Ayutthaya Province	
CTK (Chutikarn) Factory House Inudstrial Estate1	Ayutthaya Province	

Name	Location	Type of industries
Samut Prakarn - Central and Western Region		
Bangplee Industrial Estate	Samut Prakarn Province	General Industrial zone, chemicals, pharmaceuticals, rubber, plastics, machinery, tooling, food, beverage, ware housing, packaging, metal, metallurgy, metal working, electronics, electricity, civil, construction, pulp, paper, publishing, textile and clothing, wood, furniture, transportation,
Bangpoo Industrial Estate	Samut Prakarn Province	General Industrial zone and Export processing zone. Commercial zone and public utilities and facilities. The Manufacture of Press Part Die, Checking Fixture and Press Part Product
Nava Nakorn	Pathumthani Province	Industrial promotion zone and Free zone, Machinery and tooling, leather and footwear, rubber, plastics
Bangkadi Industrial Park	Pathumthani Province	The manufacture of confectionery
Samut Sakhon Industrial Estate	Samut Sakhon Province	General industrial zone Chemical and pharmaceuticals, electronics and electricity, textile, clothing, agriculture, The manufacture of frozen foods, vegetables and fruits
Sinsakorn Industrial Estate (The Printing City)	Samut Sakorn Province	Printing
Northern Region Industrial Estate (Chiangmai-Lamphun)		General industrial zone, Export processing zone, Commercial and residential zone, public utilities and facilities. The design and manufacture of volumetric infusion pumps, motors and vibration devices
304 Industrial Park	Prachin Buri Province	Manufacturing of motorcycle parts, automobile part and general purpose equipment, Surface finish by painting for 4 wheel & 2 wheel vehicles parts and electric appliance parts and plastic injection molding

Fact File VN - Industrial clusters in Vietnam

Name	Location	Area (ha)	Main products
Thua Thien Hue province			
Tu Ha IC	-	-	
Thuy Phuong	-	-	-
Thuy Luong	-	-	-
Huong So	Hue City	-	Handicraft
Binh Thuan province			
Phan Ri Cua	-	-	
Tanh Linh	-	-	Wooden products, mineral water, bricks, ice-making, agro-machinery
Duc Linh	-		Wood, bricks, machinery
Lam Dong province			
Phu Hoi	Duc Trong district	195	Agro and food products, forest products, constructive materials, chemicals, metallurgy,
Tan Phu	Duc Trong district	75	Machinery, handicraft, agricultural and forestry products, garments, food processing
Gia Hiep	Di Linh district	65	Agricultural and forestry products, food, machinery, handicraft, textiles, garment
Tan Chau	Di Linh district	90	Agricultural and forestry products, food, machinery, handicraft, textiles, garment
Dinh Van	Lam Ha district	30	Agricultural products, constructive materials.
Ka Do	Don Duong district	45	Agricultural and forestry products, food, machinery, handicraft, consumer goods
Loc Tien	Bao Loc town	50	Agricultural products
Loc Thang	Bao Lam district	35	Agricultural products
Loc An	Bao Lam distict	27	Agricultural products

Name	Location	Area (ha)	Main products
Ha Lam	Da Huoai	50	Agricultural and forestry products, food, constructive materials, machinery, handicraft
Thon 9 Da The	Da Teh districs	50	Agricultural and forestry products, food, constructive materials, machinery, handicraft, garment
Duc Pho	Cat Tien	50	Agricultural and forestry products, food, constructive materials, machinery, handicraft
Phat Chi	Da Lat city	30	Processing industry
Ho Chi Minh City			
Binh Dang	District 8	23	Garment, shoes, textile, electric equipment, paper, food processing, pharmaceutical products
Phu Loi	District 8	14	Garment, shoes, textile, electric goods assembly
Phu Dinh	District 8	20	Garment, shoes, textile, electric goods assembly
ICs located in Phu Thuan Co.	District 9	6	Furniture
Phuoc Long	District 9	100	Garment, tile sheet
Long Buu	District 9	16	Material
Cau Ong Tan	District 9	16	Constructive material
Vinh Thuan	District 9	10	dyeing, fiber, garment, exported chopsticks
ICs located in Agricultural campus	District 9	10	Furniture
ICs located in Can Gio Import and Export Enterprise	District 9	3	Furniture
ICs located in ASC	District 9	10	Furniture

Name	Location	Area (ha)	Main products
ICs located in Irrigation Area No.4	District 9	10	Seafood products, ice-making
Hiep Thanh	District 12	22	
Thoi An ward	District 12	25	Beverage, machinery
An Phu Dong Ward	District 12	19	Food, wooden products
Trung My Tay ward	District 12	10	garment, leather shoes, wooden products
Tan Thoi Hiep Ward	District 12	14	Food, garment, elastic
Tan Chanh Hiep Ward	District 12	48	Food, garment
Tan Thoi Nhat Ward	District 12	69	textile garment, machinery
Dong Hung Thuan Ward	District 12	11	textile dyeing, garment, machinery, packing
Thanh Xuan Ward	District 12	3	-
Sai Gon machinery	Go Vap district	19	machiner
Ward12	Go Vap district	40	machinery, chemical, paper, plastic, wooden products, food, leather shoe
Hoang Hoa Tham st. light	Tan Binh District	10	garment, machinery, electronic equipment
Ward 1 and 7	Tan Binh District	50	garment, machinery
Phu Trung Ward	Tan Phu District	60	elastic, plastic, machinery, electric equipment
Hoa Thanh Ward	Tan Phu District		textile, dyeing, machinery
Hiep Tan Ward	Tan Phu District		elastic, plastic, machinery, electric, food
Tan Thoi Hoa Ward	Tan Phu District		elastic, plastic, machinery, electric, food
Northern Thu Duc	Thu Duc District	12	food, machinery, textile garment, electronic equipment, Constructive material, paper, chemical
Linh Trung	Thu Duc District	60	textile, machinery, electronic equipment
Truong Tho	Thu Duc District	90	food, machinery, textile garment, electronic equipment, Constructive material, paper, chemical

Name	Location	Area (ha)	Main products
Hiep Binh Phuoc	Thu Duc District	31	food, candy, machinery, textile garment
Kha Van Can st.	Thu Duc District	16	Machinery, chemical, textile
Dang Van Bi st.	Thu Duc District	10	Machinery, warehouse, Constructive material, paper
IC located in A74Jointndstock Co.	Thu Duc District	14	Machinery, wooden furniture
IC located in Day Indian enterprise	Thu Duc District	5	Machinery, textile, wood
IC located in Binh Trieu elastic enterprise	Thu Duc District	5	food, pharmaceutical
Hai Thanh	Binh Tan District	18	garment, textile, leather shoes, paper, elastic, chemical, machinery, soldering stick, Constructive material
Viet Tai	Binh Tan Distric	10	food, textile garment, leather shoes, paper, plastic, machinery, electric
Hiep Thanh Hung	Binh Tan Distric	1	food, textile, leather shoes, Garment, ra agricultural products, chemical, electric equipment
Thien Tue	Binh Tan Distric	2	Plywood, food , electric equipment, plastic, lighting tube, machinery
Leather shoes Pounchen	Binh Tan Distric	62	garment, leather shoes, accessories
An Ha home craft	Binh Chanh district	80	-
Le Minh Xuan	Binh Chanh district	2	metals, machinery, packing, aromatic spices products.
Hiep Nguyen	Binh Chanh district	3	garment , wax, plastic, elastic, seafood, embroidering, machinery
Bo Ngua	Binh Chanh district	10	Shoes, plastic, agro food and seafoods

Name	Location	Area (ha)	Main products
Tran Dai Nghia	Binh Chanh district	10	shoes , plastic , agro food and seafood
Binh Dien bridge	Binh Chanh district	10	shoes , plastic , Garment, electric wire
Tan Qui	Cu Chi District	64	leather shoes, electronic, food processing, machinery
Hao Vo Powder	Can Gio District	2	Powder
Tay Ninh province			
Ben Keo	Hoa Thanh town	143	Constructive materials, agro-forestry products, food processing, consumer goods, garment,
Binh Minh	Tay Ninh town	106	Light industry (textile, garment, silt, shoes, leather, food processing, beverage, Pharmaceutical product, cosmetic)
Thanh Tan	Tay Ninh town	50	Light industry (textile, garment, silt, shoes, leather, food processing, beverage, Pharmaceutical product, cosmetic)
Tan Binh IC	Tay Ninh town	92	Food processing from local products, packing, beverage, animal food
Cha La IC	Duong Minh Chau	39	Handicraft, agro-food processing
Thanh Dien IC	Chau Thanh district	50	Machinery, consumer goods, food processing
Truong Hoa	Hoa Thanh town	96	Electric, assembly, shoes, garment, local products, warehouse
Tram Vang	Go Dau district	479	Exported and house products
Binh Duong			
Bình Chun	Thunh An district	54	-
An Thunh	Thunh An district	45	-

Name	Location	Area (ha)	Main products
Tân Đông Hip	Dĩ An district	60	-
Thái Hòa	Tân Uyên district	48	-
Tân Đnh An	Bun Cát distric	47	-
Phú Hòa	Thu Mt town	30	-
Dong Nai province			
The IC in Tan Hanh commune	Bien Hoa City	30	Ceramic ware and porcelain products
The IC in Tan Hoa ward	Bien Hoa City	30	woods
The IC in Long Phuoc 1 commune	Long Thanh District	30	-
The IC in Long An commune	Long Thanh District	40	-
The IC in Loc An commune	Long Thanh District	50	-
The IC in An Phuoc commune	Long Thanh District	50	brick
The IC in Phu Thanh commune and Vinh Thanh commune	Nhon Trach District	50	-
The IC in Phu Dong commune and Phuoc Khanh commune	Nhon Trach District	50	-
The IC in Thanh Phu commune	Vinh Cuu District	20	sport shoes products
The IC in Thanh Phu commune (nearly CP Chicken farm)	Vinh Cuu District	40	-
The IC in Tan Binh commune	Vinh Cuu District	50	ceramic ware products and Constructive materials products

Name	Location	Area (ha)	Main products
The IC in Quang Trung commune	Thong Nhat District	10	agricultural products
The IC in Cay Gaond Thanh Binh commune	Trang Bom District	20	agricultural products, handicraft
The IC in Hung Thinh commune	Trang Bom District	20	-
The IC in Ho Nai commune	Trang Bom District	50	brick
IC in the township	Long Khanh Township	30	-
The IC in Song Ray commune	Xuan Loc District	20	agricultural products
The industrial groups in Xuan Hung Village	Xuan Loc District	20	-
The IC in Suoi Cat commune	Xuan Loc District	15	-
The town	Dinh Quan District	7	-
Phu Vinh	Dinh Quan District	30	-

Stakeholder Consultations

STAKEHOLDER MEETING IN INDIA	
Date : 04, August 2006 Time : 09.00 hrs to 19.00hrs	Venue : Tamil Nadu Sericulture Training Institute, Hosur, India
AGENDA	

(A) Opening Session: 09.00 – 09.45

09.00 – 09.15	Welcome Address Prof. K Thanasekaran (Director, CES, Anna University, Chennai) Activities of IGES and the Objectives of Present Study Dr. V. Anbumozhi (Senior Policy Researcher, IGES-KRC, Japan) Phase I study results and Discussion on plans for Phase II Dr. R. Nagendran (Professor, CES, Anna University, Chennai)
09.15 – 09.45	Inauguration and Keynote address: Status and Potential of Sericulture in Tamil Nadu Mr. Harmindar Singh, I.A.S. (Commissioner of Sericulture, Government of Tamil Nadu)

(B) Discussions: 10.00 – 13.35

Moderator	Mr. Aravind Jannu, I.A.S. Commissioner for Sericulture Development and Director of Sericulture, Government of Karnataka
10.00 – 10.30	Perspective I: Efficient Sharing of Resources
10.30 – 11.00	Perspective II: Gains in Environmental Quality
11.00 – 11.30	Perspective III: Economic Benefits
11.30 – 12.00	Perspective IV: Equitable Enhancement of Human Resources for the Business Community
12.00 – 12.30	Perspective V: Community Engagement and Social Agenda
12.30 – 13.00	Perspective VI: Policy Environment
13.00 – 13.30	Panel Discussion on EIC in India
13.30 – 13:35	Vote of Thanks: Dr. Kurian Joseph, CES, Anna University, Chennai
13.35 – 14:30	Lunch
14:30 – 19:00	Stress interviews and questionnaire surveys

Participants of the Stakeholder Meeting in Hosur

Name	Designation	Organization
Mr. T.S. Krishnamoorthy	SRO	Regional Sericulture Research Station, Central Silk Board, Salem
Mr. J. T. Iyyanna Reddy	Additional Director	Department of Sericulture, Government of Karnataka
Dr. H. S. Prakash	Deputy Director	Department of Sericulture, Government of Karnataka
Mr. B. S. Subrahmanya	Deputy Director	Department of Sericulture, Government of Karnataka
Mr. A. Ramaih	Reeler	Silk Farm, Dinnur
Mr. K. Srinivasan	Reeler	Silk Farm, Dinkarikotri
Mr. M. D. Munvar	Reeler	Silk Farm, Gurupatti
Mr. N.M. Choodanath	Reeler	Silk Farm, Avaranetti
Mr. C. Gopal	Reeler	-
Mr. Babulal	Reeler	-
Mr. R. Vijayakumar	SRO	REC, Krishnagiri
Mr. Ahmad Ali	Reeler	Kurubatty
Mr. Crousepeer	Reeler	Kurubatty
Mr. Jayachandran	Reeler	Thally
Mr. A. Fazula	Reeler	Hosur
Mr. K. Jayakumar	Assistant Director	Hosur
Mr. K. Selvaraj	Assistant Director	Kalkondapally
Mr. S. Padmanabhan	Assistant Director	Avalapalli, Hosur
Mr. R. Rengaraj	Deputy Director	Hosur
Mr. S. Harinath	Senior Lecturer	Adhiyaman College of Engineering, Hosur
Mr. H. Karibasappa	Assistant Professor	Adhiyaman College of Engineering, Hosur

Mr. C. Balasubramaniam	Inspector of Sericulture	Department of Sericulture, Hosur
Mr. G. Alagesan	Inspector of Sericulture	Department of Sericulture, Hosur
Ms. R. Chandrakantha	Inspector of Sericulture	Tamil Nadu Sericulture Training Institute, Hosur
Mr. S. Krishna	Additional Inspector of Sericulture	Assistant Director of Sericulture, Hosur
Mr. T. Ravignanam	Additional Inspector of Sericulture	Tamil Nadu Sericulture Training Institute, Hosur
Mr. R. Dhas	Regional Inspector	Tamil Nadu Sericulture Training Institute
Mr. T. Mathivanan	Inspector of Sericulture	Hosur
Mr. A. Mohanasundaram	Trainer	Muthiyoor Illam, Samudram
Mr. A. Elanchezhian	Inspector	Service section, Jalakantapuram
Mr. R. Gnanam	Banker	Central Bank of India, Salem
Mr. Jaishankar	Deputy Director	Regional Sericulture Research Station, Karnataka
Dr. U.D. Bongale	Division Chief	Karnataka State Sericulture Research and Development Institute
Dr. V.G. Hathsal	Division Chief	Karnataka State Sericulture Research and Development Institute
Dr. R. Raghuraman	Division Chief	Karnataka State Sericulture Research and Development Institute
Dr. S.M.H. Qadri	Joint Director	Regional Sericulture Research Station, Tamil Nadu
Dr. B. Nataraja	Deputy Director	Central Sericulture Research Training Institute, Hosur

STAKEHOLDER MEETING IN THAILAND	
Date : 05, July 2006 Time : 08.30 hrs to 19:00 hrs	Venue : Sukothai II Room, 2nd Floor, Century Park Hotel Bangkok, Thailand
AGENDA	

(A) Opening Session: 08.30 – 9.45

08.30 – 09.00	Registration
09.00 – 09.15	Activities of IGES and the objectives of the present study Dr. V. Anbumozhi, (Senior Policy Researcher, IGES – KRC, Japan) Phase I study results and Discussion on plans for Phase II Dr. C. Visvanathan, (Professor, Asian Institute of Technology)
09.15 – 09.45	Industrial Ecology: "*Road to Successful Industrial Development*" Dr. Verapong Chaiperm, (Director, Map Ta Phut Industrial Port Department)

(B) Discussions: 9.45 – 19.00

Moderator	Prof. Samorn Muttamara, President, Thai Resources and Environmental Management Institute, Bangkok
09.45 – 10.15	Perspective I : Efficient Sharing of Resources
10.15 – 10.45	Perspective II: Gains in Environmental Quality
10.45 – 11.00	Coffee Break
11.00 – 11.30	Perspective III: Economic Benefits
11.30 – 12.00	Perspective IV: Equitable Enhancement of Human Resources for the Business Community
12.00 – 12.30	Perspective V: Community Engagement and Social Agenda
12.30 – 13.00	Perspective VI: Policy Environment
13.00 – 13.30	Panel discussion on EIC in Thailand
13.30 – 14:30	Lunch
14:30 – 19:00	Stress interviews and Questionnaire survey

Participants of the Stakeholder Meeting in Bangkok

Name	Designation	Organization
Prof. Samorn Muttamara	President	Thai Resources and Environmental Management Institute, Bangkok
Dr. Verapong Chaiperm	Director	Map Ta Phut Industrial Port Department, Bangkok
Ms. Tipjinda Chairerk	Research Associate	Thailand Environment Institute (TEI), Nonthaburi,
Mr. Prasitthichai Ronraem	Process Engineer Operation	Thai Power Operation Co.Ltd, Prachinburi,
Dr. Shabbir H. Gheewala	Assistant Professor	The Joint Graduate School of Energy and Environment, King Mongkut's University of Technology Thonburi
Mr. Sunun Pultanakit	Engineer	Liquor Distillery Organisation, Excise Department, Bangkok
Mr. Prawat Leetanakul	Project Advisor	Asian Palm Oil Co. Ltd, Krabi
Mr. Paitoon Onsiri	Technical Advisor	Energy Department, ENOP Co. Ltd, Bangkok
Mr. Patarapol Tularak	Engineer	Pollution Control Department, Bangkok
Mr. Thawatchai Kwanchan	Project Manager	STE International Co.Ltd,Krabi
Mr. Pajon Sriboonruang,	Chief Operating Officer	Thai Biogas Energy Company, Bangkok
Dr. Chaiyod Bunyagidj	Vice President	Thailand Environment Institute (TEI), Nonthaburi
Dr. Kessinee Unapumnuk	Environmental Scientist	Pollution Control Department, Bangkok
Mrs. Pimon Jiravithayaboon	Environmental Scientist	Environment Clusters, Ministry of Natural Resources and Environment, Bangkok

Dr. Rattanawan Tam Mungkung	Research Scholar	Department of Environmental Science, King Mongkut's University of Technology Thonburi
Dr. Kraichat Tantrakarnapa	Deputy Director	Public Health and Environmental Services, Mahidol University, Bangkok
Ms. Phunsri Salaya	Senior Lab Supervisor	Asian Institute of Technology, Bangkok
Dr. R. Nagendran	Professor	Centre for Environmental Studies Anna University, India
Dr. Nguyen Phuoc Dan	Deputy Dean	Ho Chi Minh City University of Technology, Vietnam
Mr. A. Prem Ananth	Research Associate	Asian Institute of Technology, Bangkok
Mr. Tenzin Norbu	Research Associate	Asian Institute of Technology, Bangkok

STAKEHOLDER MEETING IN VIETNAM	
Date : 28, July 2006 Time : 08.00 hrs to 19.00 hrs	Venue : Riverside Hotel Ho Chi Minh City, Vietnam
AGENDA	

(A) Opening Session: 08.00 – 10.00

08.00 – 08.30	Registration
08.30 – 08.35	Introduction of Participants Dr. Nguyen Phuoc Dan (Deputy Dean, Faculty of Environment, Ho Chi Minh City University of Technology)
08.35 – 08.55	Eco-Industrial Clusters in Urban –Rural Fringe Areas Dr. V. Anbumozhi (Senior Policy Researcher, IGES – KRC, Japan)
08.55 – 09.15	Development Status of Industrial Clusters in Vietnam Dr. Nguyen Phuoc Dan, Deputy Dean, HCM City University of Technolgy
09.15 – 09.30	Environmental Situation of Fish farms and Fish Processing Industries in An Giang Province Ms. Pham Ngoc Xuan, (Department of Natural Resource and Environment, An Giang Province)

(B) Discussions: 09.45 – 19.00

Moderator	Dr. Nguyen Dinh Tuan Ho Chi Minh City Environmental Protection Agency
09.45 – 10.45	How can aquaculture processing Eco-industrial clusters in An Giang province be established? *Group I* - Sharing of resources - Gains in Environmental Quality - Community Engagement and Social Agenda *Group II* - Economic benefits of eco-industrial clustering - Strategies for sustainable development of aquaculture processing - Environmental policies
10.45 – 11.45	Group Presentation and Discussion
11.45 – 12.00	Wrap-up and Vote of Thanks

12.00 – 14:00	Lunch
14:00 – 19:00	Stress interviews and questionnaire surveys

Participants of the Stakeholder Meeting in Ho Chi Minh City

Name	Designation	Organization
Dr. C. Visvanathan	Professor	Asian Institute of Technology, Thailand
Dr. Nguyen Phuoc Dan	Deputy Dean	Faculty of Environment, HCMC University of Technology
Mr. Bui Xuan Thanh	Lecturer	Faculty of Environment, HCMC University of Technology
Mrs. Huynh Thi Thu Ha	Head	Environmental Board, People Committee of HCMC
Prof. Phung Chi Sy	Vice Director	Institute for Tropical Technology and Environmental Protection
Dr. Nguyen Dinh Tuan	Director	HCM City Environmental Protection Agency
Dr. Le Van Khoa	Deputy Director	HCM City Environmental Protection Agency
Dr. Phan Thu Nga	Head	Science and Technology Management Office, Department of Science and Technology (DOST), HCMC
Dr. Do Van Dung	Dean	Faculty of Public Health, HCMC University of Medical and Health Care
Dr. Phung Thuy Phuong	Lecturer	Division of Environment-Ecology, HCMC University of Natural Science
Dr. Tran Thi My Dieu	Dean	Faculty of Environment Engineering and Management, Van Lang University
Mr. Hoang Nam	Vice Head	Science and Technology Management Office, DOST, HCMC
Mr. Tran Anh Thu	Head	Science and Technology Management Office, DOST, An Giang Province

Ms. Dinh Thi Viet Huynh	Manager	DOST, An Giang Province
Mr. Trinh Son Tong	Director	ANFESCO Aquatic Product Processing Company
Mr. Nguyen Van Tin	Director and Basa fish Farmer	Center for Technology, Resource and Environment – An Giang Province
Ms. Pham Ngoc Xuan	Head	Environmental Management Office, DOST of An Giang Province
Mr. Truong Kien Tho	Deputy Director	Center for Scientific and Technology Application, DOST, An Giang Province
Mr. Bui Ho Ngoc	Director	Asia Aqua Fish Food Processing Company
Mr. Nguyen Dinh Huan	Deputy General Director	An Giang Fisheries Import and Export Joint Stock Company
Mr. Phan Cong Bang	Head	Technology Office, An Giang Fisheries Import and Export Joint Stock Company
Dr. Nguyen The Vinh	Lecturer	Faculty of Environment, HCM city University of Technology
Ms. Dang Vu Bich Hanh	Lecturer	Faculty of Environment, HCM city University of Technology
Mrs. Kim Anh	Lecturer	University of Van Lang
Mr. Nguyen Tran Thien Khanh	Deputy Head	Division of Environmental Technology, Faculty of Environmental Technology, An Giang University