INDUSTRIAL ENVIRONMENT MANAGEMENT THROUGH ECO-INDUSTRIAL NETWORK FORMATION: CASE STUDY IN FISHERIES INDUSTRY IN AN GIANG PROVINCE, VIETNAM

by

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Abstract

Vietnam is undergoing rapid industrialization and there is a concern in environmental problems as well as developing the economy. An Giang province where is the first enter of Mekong river into Vietnam contributes an important roles in the development of Vietnam economy. With the favourable natural condition, the provincial economy structures are mostly in fishery and agriculture. In the recent years, *Pagasius Bocourti* and *Pangasius Hypophthalamus*, popularly known as Tra – Basa fish are the main products of fish industry in the province. This study aims to find a solution in sustainable development for the province by applying the "Industrial Ecology" concept in fishery industry which is the one of the most important industries in the province in order to create a model in both economic – environmental benefited development.

All of available industries in the province were investigated through the quantitative and qualitative examination. The alternative fuel industry that used fish fat as input material also was studied and connected to the Eco-Industrial Network. The results from analysing a simple Cleaner Production in representative fish processing company was used to quantitative the material flow for the proposed Network by applying the fish components percentage: fish fillet (32%), fish skin (4%), fish stomach (8%), fish bladder (14%), redundant fish (17%), fish bone and head (12%). All of wastes and by-products of this process can be recycled or reused in others industries such as fish feed industry; animal feed industry etc inside the Fish based Eco-Industrial Network. Hence, other agro-based industries as well as alternative fuel industries are connected to set up this Network. Moreover, this study also explored and investigated the actual polices, legislations condition in both national/local level in order to find better management solutions.

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List of Abbreviations

ADC	Asian Development Country
AGIFISH	An Giang Joint Stock Fishery Company
ASD	An Giang Statistic Department
DARD	Department of Agriculture and Rural Development
DOC	Department of Construction
DOCI	Department of Culture and Information
DOET	Department of Education and Training
DOLISA	Ministry of Labours, Invalids, and Social Affairs
DOI	Department of Industry
DOH	Department of Health
DONRE	Department of Natural Resources and Environment
DOPI	Department of Planning and Investment
DOST	Department of Science and Technology
DOT	Department of Trade
EIN	Eco-industrial Network
FAO	Food Association Organization
FIEN	Fishery Eco-Industry Network
IE	Industrial Ecology
Industrial Zones	Industrial Zones
MARD	Ministry of Agriculture and Rural Development
MOC	Ministry of Construction
MOCI	Ministry of Culture and Information
MOI	Ministry of Industry
MOET	Ministry of Education and Training
MOFI	Ministry of Fishery
MOH	Ministry of Health
MONRE	Ministry of Natural Resources and Environment
MOPI	Ministry of Planning and Investment
MOST	Ministry of Science and Technology
MOT	Ministry of Trade
MT	Ministry of Transportation
PPC	Provincial People Committee

Chapter 1

Introduction

1.1 Background

Rapid population increase has lead to the exploitation of natural resources in addition to industrialization, urbanizationen and agricultural intensification thus contributing to a great environmental crisis. Worldwide, “sustainable development” has become a comprehensive approach to overcome social, environmental and economic problems and ensure a better world, for both today’s and future generations.

Environment and economy are closely linked and interact extremely. According to the Kuznet’s curve, at the first stage of the developing process, economic growth increases the burden on the environment, when economic development achieves a certain level, this burden begins to decrease. Most of the Asian Developing countries, including Vietnam, are in the economic development side of the Kuznet’s curve. Therefore, in order to keep the impacts of economic development at an acceptable level, an urgent requirement to incorporate environmental concerns into economic development is essential. The current situation indicates the pressing socio-economic need to uncover a tool, method or system that benefits both economy and environment.

Industrial Ecology, an emerging model in environmental management assists in addressing environmental issues associated with economic development through industrial development. Applying the principles of natural ecosystems on industrial ecosystems, it focuses on optimizing energy flow, resources conservation and avoiding waste. Industrial Ecology aims at creating closed material and energy systems and helps to attain an ecologically sustainable development.

An Giang province, the southern province of Vietnam, where the Mekong River first enter Vietnam, has a natural geography favored condition for the development of economic especially in Agricultural– Fishery Industries. In the past, fish cultivation only supplied to the local market. But since 1990, Vietnam government had begun to trading with other countries, the export turnover of fishery products especially *Pagasius Bocourti* and *Pangasius Hypophthalamus*, popularly known as Catfish or Basa are the main products. Both are processed and exported to the European Union, the United States of America and Japan. Fishery industry become one of the key industries in this province and is found to be one of the foremost sources of income for the area. Moreover, agriculture is also an important industry of the province where have the highest export rice in Vietnam. Hence, the diversity and young economy create the great potential for creating the linkages between industries in the province in order to create the balancing between economic-environment.

Figure 1.1 An Giang province

However, nowadays sustainable development has become the strategy for the economic, social and ecological development of An Giang Province. Several policy and legal measures such as the enactment of the Fisheries Law have been steadily contributing to the performance of the industry. Bilateral trade agreements between Vietnam and other countries have favoured the financial performance of the industry. The industry in the province has mostly been developing instinctively therefore the An Giang Government is looking for an effective solution to manage this, not only for economic development but also for the protection of environment in this region.

The concept “Industrial Ecology” qualifies and solves the above problem of the province and can orient the planning and development of the province to “sustainable development”. This thesis aims to study the development of Eco-Industrial network, an application of the principles of Industrial Ecology, within the framework of industries operating in the value chain of fish processing and to develop an eco-industrial network with a closed material cycle.

1.2 Objectives of study

The objectives of this study are:

- To investigate the present economic and environment condition in An Giang province with special reference to fish processing network.

- To examine the relevant policies, authorities and government management system of fishery industry in An Giang Province

- To study conduct the in depth study in terms of material flow, production process, resources usages and process technology within this network

- To link this network to other industries in the region in order to optimize the resources and energy to achieve the economic and environmental development.

1.3 Scope of study

The study consists of three parts: theoretical research, data collection and data analysis. The data collection work was carried out in An Giang Province, Vietnam. The main research focused on:

- Collecting data by doing the survey in the industry and community which purpose to get information on the economic-social aspects, current situation and environment performance.

- Studying on the policy framework which relevant to the fishery industry, suggesting appropriate management tools and system in order to achieve the economic – development.

Chapter 2

Literature Review

2.1 Industrial Ecology

Together with the development in population, the demands of humans have been increased day by day which causes the expansion of resources-consumption. The vigorous waves of industrialization to satisfy human demands is contributing to the environmental crisis which relating to natural resources exhaustion that cause many environmental disasters. “Sustainable development” becomes the global approach for the social, economic, environmental development. The concerns of “economy – environment balance” give an impulse to find the new “development model” for the sustainable destination. Industrial ecology is the approach for industry – environment interaction. There are many definitions of Industrial Ecology (IE) but the main principles are waste minimization and the conversion of by-products into usable material (Roberts B. H., 2004).

According to Lowe (1997), an industrial ecosystem is defined as a community or network of companies and other organizations in a region which choose to interact by exchanging and making use of by-products and/or energy in a way that provides one or more of the following benefits over traditional, non-linked operations (Figure 2.1):

- Reduction in the use of virgin materials and resource inputs
- Increased energy efficiency leading to reduced systemic energy use
- Reduction in the volume of waste products requiring disposal (with the added benefit of preventing disposal-related pollution)
- Increase in the amount and types of process outputs that have market value;

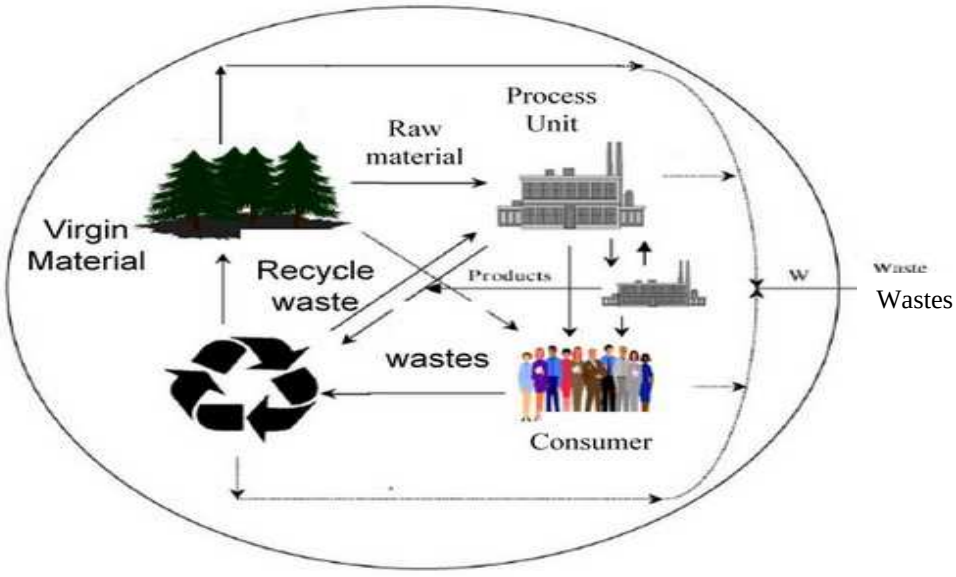

Figure 2.1 Definition of Industrial Ecology
(Source: Roberts, 2004)

This definition makes a valuable distinction between two main approaches of industrial ecosystem for moving towards a close loop or cyclical industrial system. The first approach focuses on products themselves through product policy and environmental designs. The second one seeks to optimize material and energy flows within the region or within the industrial system.

Industrial ecology works best where there is strong agglomeration of firms/organizations that have the capacity to utilize waste as a resource in production. The more intense the agglomeration, the greater are the prospects for innovation and synergies. Industrial ecology is linked to the concept of agglomeration. The synergy of firms/organizations focuses on the linkages and interdependencies of each sector in the network by material connection.

Industrial ecology optimizes the resources, wastes, and energy in the process and promotes its performances. Its development is integrated with national or regional development and link to other industries to create an eco-industrial network aims to benefits the environment, society and economy (Figure 2.2).

The agglomeration of Industrial Ecology is flexible in different scales: estate, park, cluster, network… which integrate the same definition but in different scale and level. There are many terms that used to define the synergy of eco-industrial system such as Eco-Industrial Network, Eco-Industrial Park, Networked eco-industrial park, integrated eco-industrial park, industrial ecosystem, industrial symbiosis (Chiu and Yong, 2004). Industrial ecology offers unique opportunities to add value to manufacturing firms located in a system. Firms with similar waste and by-product streams create opportunities to concentrate and minimize the collection costs of waste and have a potential to reduce individual firms' raw material, by product by industrial ecology application.

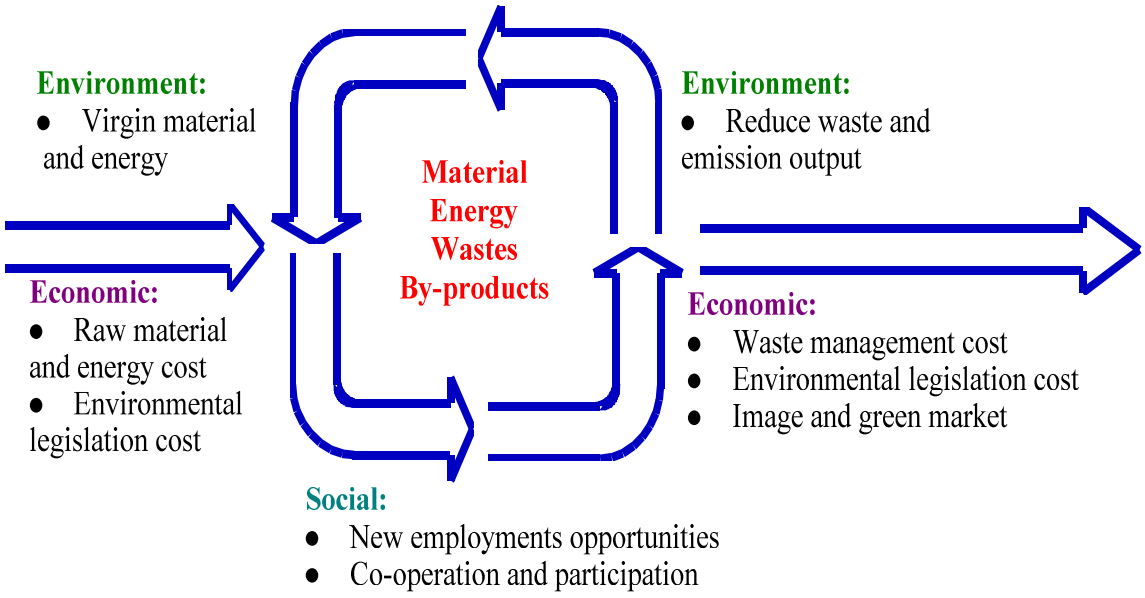

Figure 2.2 Benefits of Industrial Ecology

2.2 The industrial ecology potential in Asian developing countries

The economy of the Asian Developing countries (ADCs) is the largest in the developing world. In the last two decades, Asian economy has experienced the most rapid increase of its history. The ADCs move quickly to encourage local industrialization and to attract foreign investment in the absence of a comprehensive sustainable development scheme. With those conditions, ADCs are the potential place testing the concept of eco-industry. There are many challenges for industrial ecology in ADCs when considering the size of the economy, the rapid growth and the conditions of resource allocation.

2.2.1 Current situation of Industrial Ecology in ADCs

a Academia and research institutions

Academic and research institutions in ADCs usually present industrial ecology in instructional materials and projects in the Asian settings, instead of presenting in deeper research studies. Many local institutions such as university research centers and research teams have played a leading role in the regional industrial ecology project.

In Southwest Asia, industrial ecology has been taught within the context of the general disciplines of ecology, engineering and sciences. Important components of industrial ecology, such as Life Cycle Assessment, are taught in chemical engineering programs. Today, many engineering and science curriculums are yet to integrate these tools into the mainstream curriculum.

b Government

Governments in developing countries are paying attention on environmental protection and supporting the application and development of environmental management strategies. In the industrial ecology vision, the successful implementation of closed-loop systems can enable the national economies to process recycled resources within the region as they substitute non-renewable material with the recycled one and develop technological excellence contributing to overall national development.

c Industry

While the government and civil society may initiate actions on several sustainability issues in ADCs, business and industry continue to be a critically important driver in all sustainability programs. Three themes have been observed as important factors for the development of the business and industrial strategies of sustainable development in ADCs; (i) laws and regulations, (ii) legitimacy and social acceptability and (iii) competitiveness. These three strategies are addressed in the following paragraphs.

d Laws and regulations

Industry needs to comply with the regulatory measures of government. “Polluter pays” is the good economic instrument that reduces the pollutions. Some governments provide allowances and benefits to the industries that adopt and use cleaner production and environmental management system. Regulations require stringent procedures such as obtaining an environmental compliance clearance which requires assessments and other environmental impact studies.

e Legitimacy and social acceptability

There are two main categories in ADC's industries: Small and Medium Enterprises (SMEs) and Large Industries. In recent years, SMEs have been the significant actors among Asia Pacific industrial forces; but they lack resources to follow the required environmental management systems. Large corporations have plentiful resources and have clearly recognized the value of improving the environment performance in responding to the pressure of the society with which they are interacting. They satisfy their stakeholders by global reporting initiatives, eco-labeling, green procurement and corporate social responsibility that have been acknowledged

f Competitiveness

Industries are driven not only by the government and civil society but also by corporate forces and drivers such as efficiency, suppliers, buyers and competitors. The triple bottom line concept with its environmental, economic and social objectives can develop the competitive capability in the firms and is not merely for optimizing operations resources (e.g. costs).

2.2.2 Strengths, Weaknesses, Opportunities and Threats of Industrial Ecology in ADCs

Chiu and Yong (2004) analyzed the Strengths, Weaknesses, Opportunities and Threats (SWOT) to classify the preconditions of industrial ecology in ADCs in order to approach the economic, social and ecological development of these countries more effectively and more efficiently toward sustainable development. Figure 2.3 summarized the SWOT analyzing for the application of IE in ADCs.

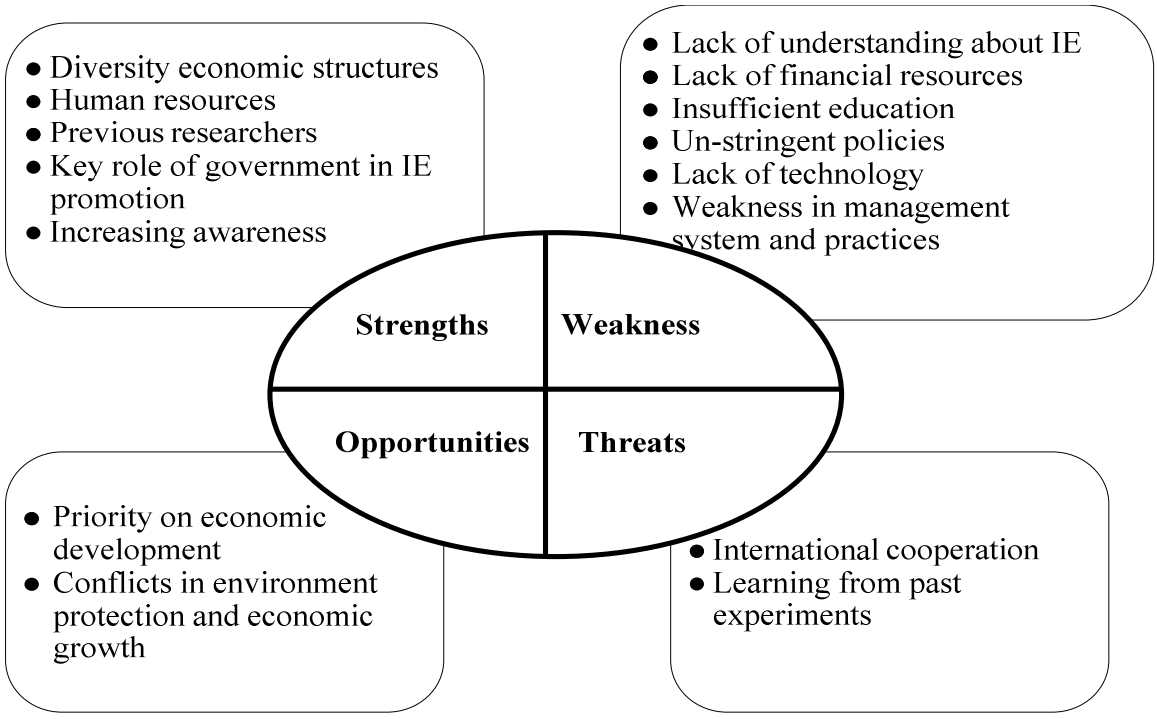

Figure 2.3 Strengths, Weakness, Opportunities and Threats of IE in ADCs

(Source: Adopted from Chiu and Yong, 2004)

2.3 Roles of Economic, Technology and Policies in the applications of Industrial Ecology concept

2.3.1 Economy

According to Ayres (1997), within the eco-industry system, it is difficult to optimize the material flow without long term central planning and coordination of authorities at the same level. In its absence, the decentralized "pure" market system, such that each activity (firm) interacts with the others only by competitive buying and selling, is unlikely to achieve the desired degree of integration. In short, the inability of a group of decentralized manufacturing firms to optimize the use of by-products and secondary resources, and thus to minimize overall waste and pollution, constitutes a kind of market failure. Market approaches are being used to address a variety of environmental issues and they link economic rationality to environmental outcomes. This is the most efficient and effective way of meeting environmental goals. (Hahn et al., 2003) Unlike regulatory approaches which work by penalizing environmentally harmful activity, market approaches rely on profits to increased environmental protection (McCarthy and Prudham, 2004).

Moreover, economic performance is inherent in the concept of sustainable development, and development generally, and the institutions that exist to foster development rely heavily on economic analysis and criteria. In the future, both economics and industrial ecology will be significantly changed by insights derived from the other: indeed, economic insights are critical to successful implementation of industrial ecology.

Chiu at el. (2004) emphasized that applying industrial ecology as a strategic planning alternative can also gain the economy. Furthermore, there are gaps between the regional cluster-based economic development and eco-industrial cluster development and hence requires integrating these two disciplines. In the present situation, industrial cluster-based economic developments are incorporating the environmental mindset into their existing models. Moreover, Industrial ecology not only is a “technical fix” solution but also can be considered as an initial strategic plan for the central economic plans. If industrial ecology is adopted as one of the basic strategic principles from the beginning of a national economy’s strategic planning process for economic development and integrated into policies, a possibility to leapfrog the economy-environment development can be achieved.

2.3.2 Technology

In the eco-industry networks, material and energy flows are optimized to reduce the waste and raw material and energy use. So the process technology in the network is graded to satisfy these requirements: maximum the reuse and recycling of materials, maximize the use of renewable resources, increase the efficiency of process, and decrease the pollutants emission.etc.

To identify the process efficiency, the material balances and using energy analyzing should be carrying out. The waste and energy audit should be implement to identify where the opportunities for upgrading as well as collecting data for management aspects. The audit is implemented at each stage of material extraction, processing and manufacturing.

Technical aspect play an importance role in industrial ecology because it support innovation in the process but must be consider carefully because the innovation will change the wastes and by products and affect to other units in the eco-network.

2.3.3 Policies

Policies play an importance role in the development of industry. Government use law and policy as a management tool to control industry. The concept of sustainable development has enormously complicated the legal structure within which environmental issues are managed. Aware of the important roles of Eco-industry network, government managements nowadays concentrate more on the development of eco-industries. Governments are now supportive of the growth of eco-industrial parks as a mean of supporting business success and environmental protection. At all levels of policymaking, procurement, tax code changes, and infrastructure investments can benefit from industrial ecology insights. So it is important for industrial ecologists to have a working knowledge of applicable aspects of governments, laws, and economics.

Current environmental policies are based around a regulatory foundation, but future initiatives are intended to be more cost-effective and innovative. Innovation-friendly environmental policies will improve upon past policy experiments, increase research efforts, support decentralized decision making, rely on market-based solutions, remove barriers to individual initiative, provide incentives to environmental entrepreneurs, and provide public information to gauge the environmental performance of economic actors. In short, such policies will encourage more rapid evolution in the industrial ecosystem.

2.4 Industrial ecology: Policy potential and research needs

In industrial ecology field, there are the knowledge gaps which need the potential for both science and policy experiments to fill it. Significant advances in industrial ecology will require more researches, new theoretical developments, quantitative models, and field scale experiments. Moreover, further developments and researches need to test and refine the assumptions in industrial ecology and to strengthen basic applied tools aiming to improve the environmental policy making.

There is an innovation in environmental policy: comprehensive management of all the aspects of the industry and its products over their life cycle. This innovation emphasizes on specific products and materials flow. The changing faces many challenges to the policy makers such as the policy must be synchronous with the traditional approach and the development takes place in the global range in order to avoid the counter-affection. There is a need for a program, tool evaluation and examination of the effectiveness of the new policy instruments in comparison with traditional regulation and market based incentives in order to encourage industry becoming environmental proactive development.

Environmental problem can be reduced by the substitution of materials, or services for products. Expensive, scarce or environmentally harmful resources can be substituted by cheap, abundant and environmentally benign ones. The efficiency of materials and energy can increase by emphasizing the service of products instead of physical products. The “loop closing” the recycling and reuse of products, materials and wastes have significant environmental potential. Eco-industry satisfies its requirements through the concept “Reduce raw material input, and volume of waste output; Increase the energy efficiency and marketable by-product” (Lowe 1997).

Thomas et al. (2003) indicated that industrial ecology emphasizes the opportunities for new technologies and new processes but according to Lowe (1997), changing process can make the whole process faces the risk of losing a critical supply. In the large eco-industry system, this problem can be overcome easily by extending the relationship with alternative

supplier. But in the small scale industry system, it is difficult to find the equivalent supplier and can break the whole web. But the innovation carries out not only on one individual process but also on the whole industrial system, not only on the technical aspect but also in the environmental management. The requirement for new environmental policy which is emphasizing on innovation in both technology and management is appropriate with the goal of eco-industrial strategy.

There are many environmental metrics such as eco-indicator, human toxicity potential and "triple bottom line", etc... Some are being considered in the EU and other countries for use in environmental legislation. The pros and cons of each metrics need to be clarified and need deeper understanding on the impacts of uncertainty and variability on the limitations and benefits of their application.

The researches on testing the assumption of industrial ecology, substitution of resources and services products, technological innovation need to test and refine the assumptions of industrial ecology and to strengthen basis applied tools in order to improve the policy performance and adaptation on environmental ecology. There is a need for peer review of methods and software, standardized tests for methods and software and development of a comprehensive life cycle inventory database and better understanding is needed for the validity and limitations of metrics used to compare different environmental effects. With further development and refinement of the premises and methods of industrial ecology, this emerging field holds significant promise for improved environmental policymaking.

2.5 General information in Fishery

2.5.1 Global

The International Food Policy Research Institute has developed a 2020 Vision of a World where every person has economic and physical access to sufficient food to sustain a healthy and productive life, where malnutrition is absent, and where food originates from efficient, effective, and low-cost food and agricultural systems that are compatible with sustainable use and management of natural resources.

Fishing contributes more than any other animal production activity to the protein intake in the developing regions. In 1999, global fish production from all sources was 137 million tons, including 43 million tons from aquaculture and 94 million tons from capture fisheries. Aquaculture production was more than double between 1990 and 1999 while capture fisheries production increased only marginally from 86.8 million tons in 1990 to 94.1 million tons in 1999 (FAO, 2004). The percentage of global fishery presents in Figure 2.4.

According to the statistic of FAO on World fishery trade, global production of fish currently stands at about 122 million tonnes. International trade of fish and fishery products reached US$52 billions in 1994-1996, over three-times of that in 1990-1982. For comparison, the value of agricultural trade (excluding fishery) only doubled in the corresponding period. Fishery trade is particularly valuable for the developing countries. Their exports of fish and fishery products have been increasing impressively by four-fold from 1980-1982 to reach US$25 billions in 1994-1996. As a result, the share of the developing countries in world trade of fish and fishery products increased from 40 percent in 1980-1982 to 50 percent in 1994-1996. By contrast, their share in total value of world agricultural trade, excluding fishery products, did actually decline in this period (Figure 2.5)

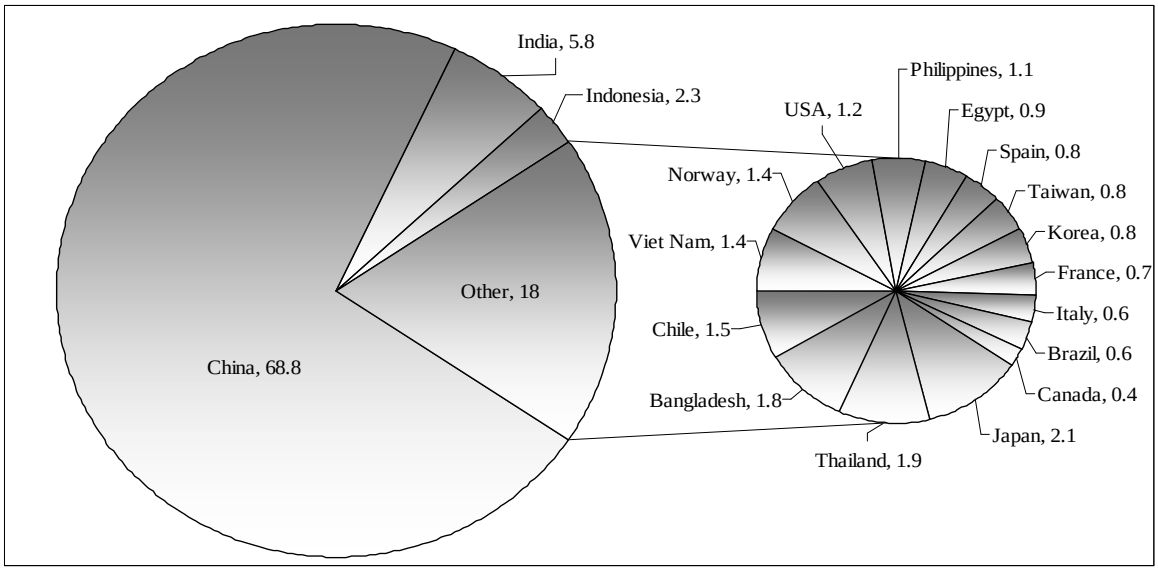

Figure 2.4 Percentage of global fishery production
(Source: FAO, 2004)

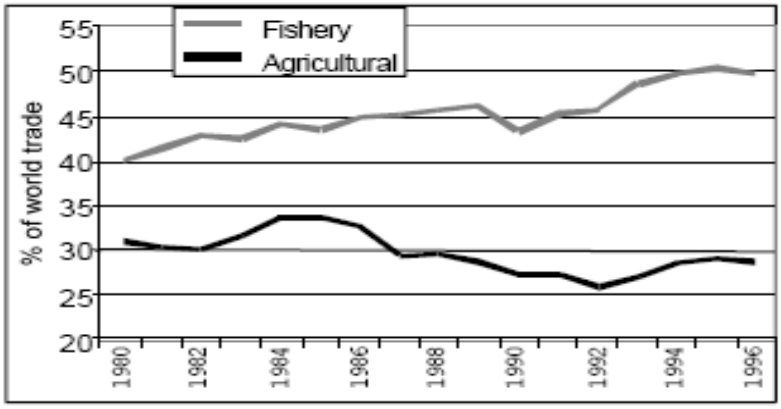

Figure 2.5 Developing country shares in world fishery and agriculture
(Source: FAO, 1999)

Fresh water aquaculture is the key component not only in aquaculture but also in all the Asian fishery sectors. Aquaculture has become the world's fastest growing food-production which is contributed 91% by Asia region. As far as annual growth rate of freshwater aquaculture fish production is concerned, Viet Nam achieved the highest annual growth rate (15.97%) followed by China (13.86%), Bangladesh (11.70%), Thailand (10.85%), and Indonesia (4.70%) while Philippines achieved a very negligible annual growth rate (1.18%) during the period 1989-1999. (FAO, 2004). In Asia, China have the higher percentage on production of fresh water (72.99 %), following are India (99.9%) and Bangladesh (2.6%). Figure 2.6 is the fresh water fish production from aquaculture of Asian.

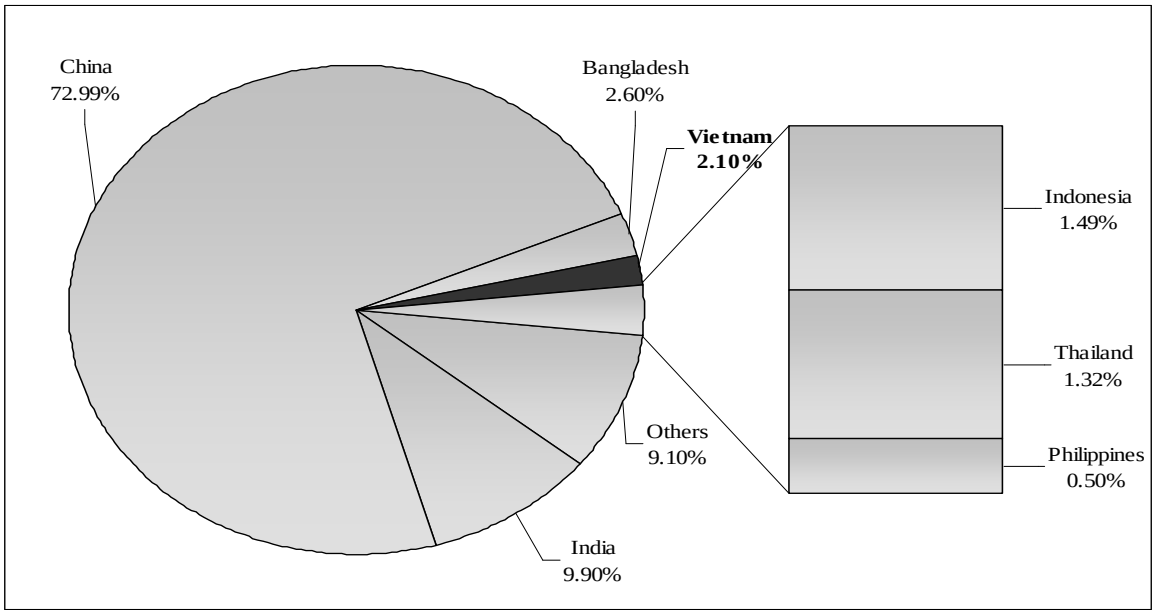

Figure 2.6 Asian productions of fresh water fish from aquaculture
(Source: FAO, 1999)

In developing country, most small-scale fishery finds it increasingly difficult to survive in an overexploited environment so aquaculture becomes the prospective industry. Small-scale farming plays an important role in the fishery industry and has been increased rapidly because of greater market integration and globalization. It operates in the wide range from a self-employing single operator to an informal micro-enterprise and even to a formal business.

Contrary to the meaningful contribution of small scale fishery, its role has been underestimated. There are needs to increase the awareness about this problem and to find a potential development plan for small-scale fishery in developing country in order to integrate the economic-oriented strategy and the environmental sustainable.

2.5.2 Vietnam

Vietnam with unique geography conditions is laid in the lower basin of Mekong Delta and has 2,860 small and big rivers. Vietnam also has many natural lakes with stable water level and closed autotrophic cycle. The area of natural lakes in Vietnam is estimated to be about 20,000 ha. The country also has a number of medium and small sized reservoirs. The area of reservoirs in Vietnam is over 180,000 ha. However, due to the need of irrigation, hydroelectric power and flood control more reservoirs are being built.

With the above advantages in geography, fishery in Vietnam has developed rapidly. Fish farming or aquaculture is an increasingly important rural activity and is the main source of food and income for people who are living in the rural area of Vietnam. In addition, small-scale fishery farms make an individual but important role in distribution to aquaculture production.

The fisheries sector has higher growth rate than some other economic sectors. The share of fisheries sector in the country's GDP has grown consistently from 2.9% in 1995 to 3.4% in 2000 and reached 3.93% in 2003. The growth rate of aquatic exports, which is as high as the industrial, construction and services sector, implies that the fisheries sector is shifting from agriculture based to industrialization based production (Table 2.1).

Table 2.1 Growth rate of Vietnam aquatic exports

Year	Export value (million USD)			
	Total of the country	Industry construction service	Agro-Forestry-Fishery	
			Total	Fisheries
1997	9,185.0	5,952.0	3,233.0	776.5
1998	9,360.3	6,036.0	3,324.3	858.6
1999	11,540.0	8,627.8	2,912.2	976.1
2000	14,308.0	10,186.8	4,121.2	1,478.5
2001	15,100.0	10,090.4	5,009.6	1,816.4
Average growth rate	**13.0**	**14.9**	**9.5**	**14.6**

Source: MoFi[1], 2002

Since 1980, the fisheries sector has become a leader in enhancing the country's trade relations with various markets and regions in the world. As of 1996, the fisheries sector of Viet Nam had relations with only 30 countries and territories; however, this relationship has been extended to cover 60 and 75 countries and territories by 2001 and 2003 respectively.

The country's fisheries sector has gained much prestige in the countries and territories it has trade relations with. Industrial countries, e.g. U.S, Japan and EU member countries have become its major and regular trading partners. In 2003, the aquatic exports of Viet

[1] Ministry of Fishery

Nam into the four principal markets including U.S, Japan, EU and China made up 75% of the total volume; the remainder was allocated to nearly 60 countries and territories.

It could be observed that the fisheries sector's efforts in promoting international trade relations have brought about a number of lessons and opened new prospects for the country's economy in its international and regional integration process. This trend leads to the production restructure - more priorities are given to prominent and effective activities especially in the management aspect. The weakness in fishery and trade policy system of Vietnam government got the "painful" lesson which was taught by American in the course name "catfish war".

2.5.3 An Giang Province, Vietnam

Figure 2.7 Map of An Giang Province

An Giang Province which is located in the South-West of Mekong Delta has border with Cambodia (Figure 2.7). The province area is 3,434 km^2 and has population of 2,049,039 people. The provincial longest length from North to South is 86 km and 87.2 km from East to West. The province is bounded by Cambodia in the North- Northwest, Kien Giang Province in the Southwest, Can Tho in the South and Dong Thap in the East. The province is well-endowed with minerals, rivers and irrigation, and has a handy land and river transport network. It also has international ports Vinh Xuong in Tan Chau District and Tinh Bien in Tinh Bien District, and national ports. Politically, An Giang is divided into nine districts: An Phu, Chau Phu, Chau Thanh, Cho Moi, Phu Tan, Tan Chau, Thoai Son, Tinh Bien, and Tri Ton. The cities of Long Xuyen (the provincial capital) and Chau Doc, both of which are located on the Hau Giang branch of the Mekong River, exist as independent municipalities. In An Giang, beside the delta there also is the mountainous condition. The mountainous region starts from Phu Huu commune, Phu Xuyen district to Vinh Te commune, Chau Doc Town.

With a population of over 2.1 million, a surface area of 3,424 km^2, situated at the source of the Mekong River, the province has an advantage in fishery industry which contributes about 85% of national fishery export and fishery industry becomes the key industry in the province. In first sixth months of the year 2006, fishery industry of An Giang Province exported 37,300 tons of basa and tra fish, increased 77% comparing to the export rate in

2005. The export turnover of fishery products have increase every year (Figure 28). According to the "Social-economic development strategy from 2005 to 2010", fishery becomes one of the most important industries in the province and needs more attention by the government. Fishery industries take the large contributes in the Total Export turnover of the province (Figure 2.9). The "catfish" war with America made the fishery industry facing many difficulties by now the industry has recovered and developed rapidly.

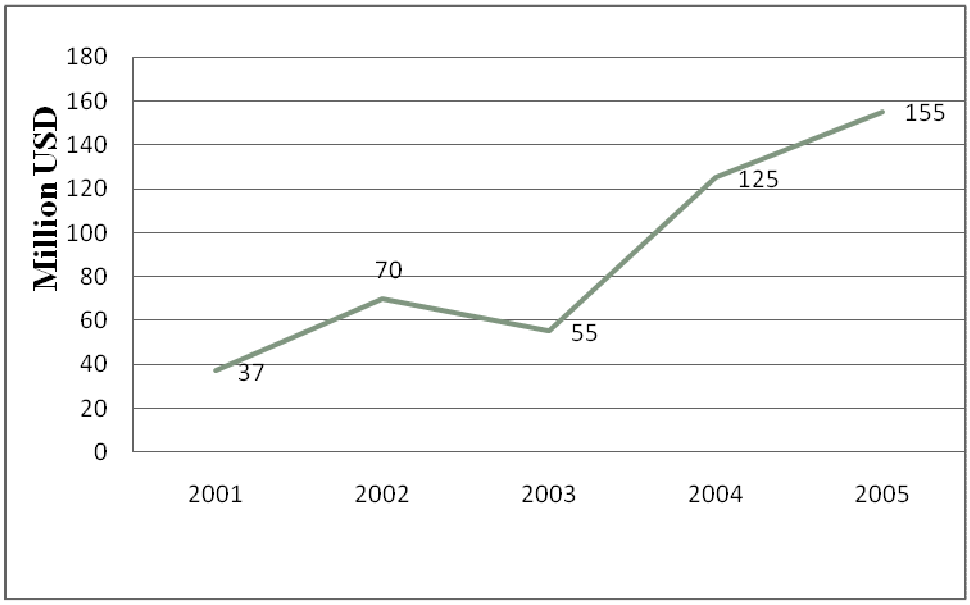

Figure 2.8 Fish Products export turnover in An Giang province
(Source: ASD, 2005)

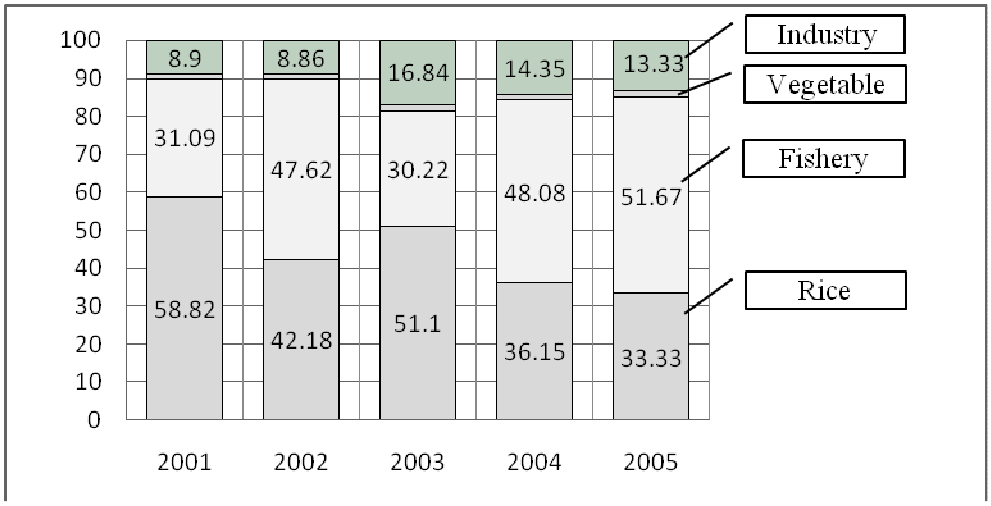

Figure 2.9 Export turnover contribution percentage of An Giang Province
(Source: Adopted from ASD, 2005)

There is an environment concern regarding the cultivating of fish such as: over feeding the fish, using chemical for fish disease curing, pre-treating the fish pond… These problems can be solved by applying high cultivating technique. There is a need for developing new model of cultivation that can benefit both environment and production rate.

A clean fish farming model meeting international organic standards, certified by Naturland of Germany and the Swiss Import Promotion Programme (SIPPO), is expanding throughout the Mekong Delta province of An Giang to meet growing demand. The An Giang Fisheries Association (AFA) coordinated with the Binca Seafood Company (BSC) of Germany to carry out a pilot project in 2004 to raise organic tra catfish in net enclosures (fish pens) and floating rafts (fish cage) in Long Xuyen town An Giang Province. This model of cultivation not only satisfies the production requirement but also is the environmental friendly model.

The organic waste is the most environmental concern in fishery processing. Most of fishery processing in An Giang province only use fish fillet for export and other fish parts become by-products or waste and can be reused in the local market (fish head) or use it for fish feeding.

2.5.4 Policies in fishery industry

Government has recognised aquaculture within the context of rural development and poverty alleviation policies. For example: In Vietnam has established a policy regarding aquaculture for poverty alleviation. This is part of national Hunger Eradication and Poverty Reduction programme. Policy environment outside fisheries sector has a major influence on the development of aquacultures and fishery for example policy on land use.

Fishery legislation has been revised or is being undergone revision to reflect changing circumstances. In Vietnam, a fishery law was issued since November 2003 by The Congress in which concentrate on sustainability in capture and cultivation fishery and Action plan for fishery development from 2001 to 2010 were issued in which exported fishery processing is one of the target development sectors for Vietnam.

Local People committee and Department of Fishery have responsibility for management of fishery activities in the region and report for Ministry of Fishery for report The Congress. Fishery activities include cultivation, capture, processing, trading, etc… which are managed and planned by People Committee in the region.

“Article 32: Concentrated aquaculture areas

1. The State shall support to invest in the establishment of infrastructure for concentrated aquaculture areas in accordance with development master-plan and plans of fisheries sector; shall invest in the setting up of monitoring stations for fisheries environment and fish disease control stations.

2. Organizations and individuals conducting aquaculture in concentrated aquaculture areas shall comply with regulations of concentrated aquaculture areas, professional technical requirements on aquaculture construction, aquaculture techniques and farming environmental protection.

3. Ministry of Fisheries shall make regulations relating to water quality standards on aquaculture, specialized technical standards on aquaculture construction; shall issue rules on organization and operation of concentrated aquaculture areas as well as closed-harvest time to ensure food hygiene and safety.

4. Provincial People's Committee shall have responsibility to manage concentrated aquaculture areas" (Fishery Law issued by Vietnam National Assembly on 21st November 2003).

This law is the advantages for the formation of fishery cluster in An Giang province and needs further analysing.

2.6 A case study in industrial eco-system project

This project was implemented in the western region of Rotterdam harbor area under the leadership of the industry association "Europoort/Boltek Interests" (AEBI). There are 69 member companies in the planned eco-industrial system. This project aims to perform the physical flows of substances, stipulate the cleaner production in each company and increase linkages between company and involved universities, organizations for better implementation of the system in the region. This project goals are not only to achieved the environmental protection but also economic issues which are the companies' benefits in this case. The boundary of the expected eco-system was the material networks within Eropoort/Botlek areas. This project was divided into three phase which the first three phases are designed and pre-feasibility, the last phased are implemented phased.

2.6.1 First phase

At this first phase of the project, the concept "cleaner production" and "Industrial Ecology" was introduced to all companies through workshops. The first workshop presents the previous experiments in industrial ecology which referred to the partnership between companies in the network. The partnership plays importance roles in the economic-environmental performance of this network. The second workshop introduced the design of INES projects as well as the feed backs by questionnaires in environmental problems, cleaner production, integral chain management, industrial ecosystem and sustainable development of each company (Table 2.9). After having a clear image on the project goals and expectations from the companies, the data collection about companies' major products, resources, and waste streams were implemented.

Table 2.9 Categories and potential INES projects

Category	Project
Prevention	Cargo waste in transit and storage Small size package Off-spec products
Chain management	Reuse of sulphur Desulphuring Silicium- and alluminium oxide Crude oil sludge
Energy/utilities sharing	Demand/supply steam Air capacity Low pressure steam Off-spec natural gas High-caloric waste incineration for generation of electricity

Joint treatment	Bio sludge Waste water Ballast water

2.6.2 Second phase

The pre-feasibility study was performed from this phase. The 'bio-sludge', 'compressed air' and wastewater have high priorities and were quantitative analyzed both in environment – economy aspects. An overview of the project selection model Is given in Table 2.9. After this section, the industries were investigated and be able to cluster together.

2.6.3 Third phase

In this phase, the selected three sections were elaborated as design for implementation as follow:

- Compress air utility sharing

Compress air is considered as a resource for the production process and need 10-15% of total electricity used of a company. From investigated data, air supply network establishment assumedly can lower the price with approximately 30% and energy saving of 20% (Baas, 1998).

- Wastewater

The exact data on the quality and quantity of wastewater of each company within network were made clear. The water use were optimal and cascade circulation both within the companies as well as in the network. The assumed resulted is reduction 10% water use.

- Bio-sludge

There are two difference options for actual and future sludge treatment: better management and facility upgrading and the expected reduction is 10-20 %.

After the three planning phased, the company have a clear image on its environmental economic benefits. Most companies were willingness to give specific information on requests. The expanding number of stakeholder and commitment development as well as the cleaner production approach showed the successfulness in applying "industrial ecology and sustainable development" of this project.

Chapter 3

Methodology

3.1 Introduction

The study focused on environmental management in fishery eco-industrial network and its linkages to other industries. This study was carried out in An Giang Province – Vietnam. The fishery industry in the province has become a national key industry and plays an important role in the economic development of Vietnam. Thus, most of fish processing companies are supplied with fish from cultivation farms where the source of natural water is contaminated. Currently, the industry is unprompted development and there is a need for a comprehensive planning. Therefore, the methodology of this study aims to develop an eco-industry network which can benefit both environmental and economic development.

3.2 Study area

This research was carried out in An Giang province - the secondary level province in Vietnam and concentrated on the aquaculture industries, agro-based industries and other alternative fuel industries. Most of fishery activities such as cultivation and processing are located along the rivers (Figure 3.1) because of the convenience come from waterway systems.

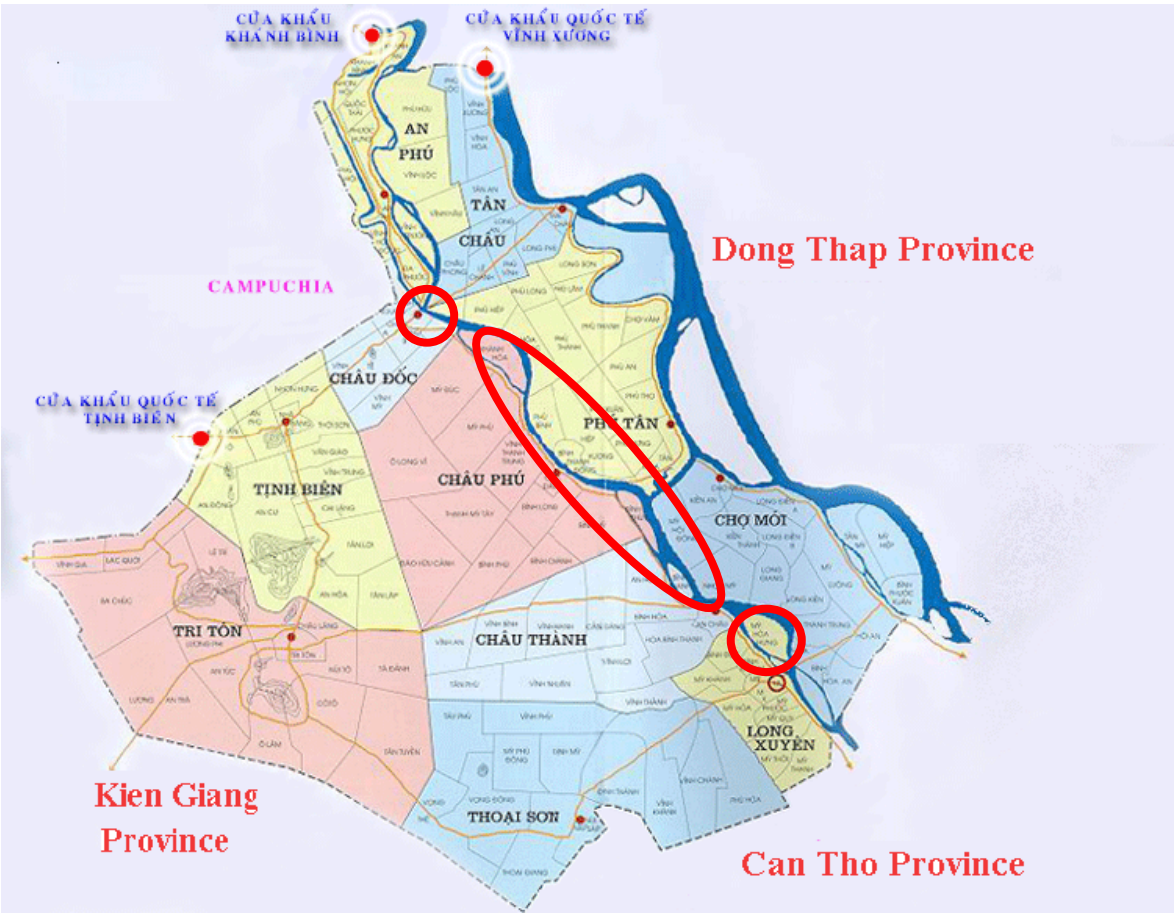

Figure 3.1 Fishery cultivation areas in An Giang Province

3.3 Research Methodology

The nature of the research necessitated direct interactions with the entrepreneurs for obtaining first hand information on the industry, understanding the production processes, technologies and waste generation and treatment methods. In addition, information on the driving forces, such as policy support market forces, trade and legal requirements for the formation of the clusters are also essential for a better understanding. In view of the above requirements of the research, the following methodology was implementing (Figure 3.2).

3.3.1 Secondary Data Collection

The study began with the collection of required data from secondary sources such as AIT Library, journals, vernacular magazines, publications from relevant government departments, NGOs, regional academic / research institutes and business associations. Typical information that was collected from these sources as following:

1) Demography of the study area

2) Socio-economic profile

3) Environmental and Natural Resources in the region

4) List of fish farms, fish processing industries, other industries directly or indirectly connected to fish farms/processing and falling into its supply chain

5) Text of the relevant policies of all industries under the study such as,

- Environmental Protection
- Industrial Promotion
- Rural Growth and Development
- Agriculture and Livestock
- Aquaculture
- Small Medium Enterprises
- Industries

3.3.2 Environmental Baseline

In addition to the above, information on the following environmental aspects, particularly in the study area, was collected so as to develop an environmental baseline

- Water resources, rainfall
- Water quality, pollution loads and sources
- Water consumption; both industrial and domestic
- Wastewater generation and treatment; both industrial and domestic
- Air quality and sources of air pollution, if any
- Land use, forest cover, sources of land degradation
- Solid waste generation; both industrial and municipal
- Solid waste management practices; both industrial and municipal
- Sanitation and public health

3.3.3 Field Study

The field study was focused on obtaining technical, industry and locality specific information. Interviews and interactions with the entrepreneurs and communities aimed at local development was absolutely essential for getting reliable information. In addition, municipalities and local offices of government departments provided valuable information on the region.

a. Collecting data on fishery industry and related industries from the local administration

The information was collected by interviews and interaction with the officials of local government departments and representatives of industry associations etc. The related Government departments and the type of information that was obtained from these departments in presented in Table 3.1.

The Government of Vietnam is divided into three levels: Ministry, Provincial/City, and District/Commune. In this study, information at the Provincial level are collected for local environmental and social issues, demography, business and trade etc:

- Information on socio-economic profile of the region
- Contribution of industries to local development
- Share of the industries in the national market
- Data on export/import trade activities
- Results and experiences of similar studies performed earlier

Whereas, in the case of policy documents, those that are implemented and awaiting implementation was collected irrespective of their origin, Ministry, Provincial/City and District/Commune. Thus, the following policies are collected for analysis:

- Industrial Policy
- Policy on fish trade, agriculture, aquaculture, livestock etc
- Export/Import, Business and Trade Promotions portfolios,
- Marketing facilities, Infrastructure Development and Conflict Resolution
- Energy Policy
- Environmental Protection, Social Development Policies
- Technology Transfer

Table 3.1 Interview checklist with government organizations in An Giang province.

Organizations	Contents	Information need
An Giang Province People Committee	- General Information about An Giang Province, social – economic condition. - Social – economic Development Plan at Province Level, Nation Level. - Present condition and Development Quality Report of An Giang Province - Present Planning for industry, Industrial Zone, Industrial Cluster in An Giang Province. - Role of Fishery Industry in the Province Development. - Provincial Legislations, economic, land supporting for the development of Fishery Industry.	• Social – Economic information: development rate, provincial economic priority, national/provincial economic development plan, Import, export, GDP, industrial production value, key industry, role of industries, market information, land use planning, agriculture information. . • Information about other industries: location, quantity, role of each industries in the national/provincial development (import, export, related legislation)
An Giang Agriculture and Rural Development Department	- Present condition and development of fishery cultivation of Province (specially in Chau Doc Town, Phu Tan and Chau Phu district) - Other activities that support fish cultivation: technical and economic	- Cultivation technique: fish cages, ponds, tanks, pens: productivities, stock density, food, chemical use (pretreatment the pond, curing fish disease) - Present condition for fishery cultivation in the Province: area, quantities, scope, economic effect, cultivation technique, statistic information ..

	supporting. - Training document about the cleaning fish cultivation model. - Present condition and development strategies for agriculture and fish feeding food production. - Economic supporting for fish farms and fishery manufactures. - Related information about fish cultivation. - Information about other agriculture industry. - Legislation, rules, tax, market information that directly affect the development of fishery industry, agriculture products.	- Market information: national/international price, economic performance of each industries, development condition, applicable condition - Government supporting: subsidy, technique, tax … - Legislation that affecting fish cultivation: land use, environment, national/ provincial economic development plan, and government management on fish cultivation. - Clean fish cultivations model
An Giang Science and Technology Department	- Development trend of industries and New industries in the province - Developing potential for cleaner production and using alternative resources and recycling, reuse fishery industry wastes	- Producing process of industries in the Province - Condition and procedure for technology transfer - Cleaner production in the province - Bio-diesel, biogas - Coordinating with institutes in the province about: energy,

		reuse fishery industry waste.
An Giang Natural Resources and Environment Department of	- EIA of industries in the province - EIA report of representative Fishery, Agriculture, fish food production industry - Environmental Law that applicable in the province relate to Fishery Industry. - Environmental Protection Strategies in the Province that relate to water resource, recycle, energy, and fishery industry. - Management in Industrial Zone, Export Processing Zone, Industrial Village. - Legislation that relating to environment, environmental standard in the Province	- EIA of each industries - Environmental information in the provincial boundary: water, surface water quality… - Subsidy for industrial that support for upgrading producing process, waste treatment system, cleaner production
An Giang Industrial Department	- Present condition and development of Industries - Associations of Fishery, Industrial Zone, Industrial Village	- Legislation about industries in the province - Economic, Subsidy, Tax, policy that supporting for each industries in the province - Key industries -Capacity, economic distribution in the government budget

b. Interview with the entrepreneurs

The fundamental of interviews with entrepreneurs was to obtain industry specific information. The objective of this was to establish a material balance to ascertain the environmental performance of the industry with respect to resource use/conservation, practices and techniques, skill level of employees etc. In essence, the following data was being collected to evaluate the environmental performance:

- Production Process, wastes treatment process

- Present condition of manufacture: environment, capacity, economic condition, export

- Material, chemical used (quantities, loses)

- Government supporting: legislation, tax

- Legislation, law that affect to manufacture activities

- Input, output materials (quantitative, qualitative)

- The application of cleaner production.

Those information was used to develop a basic mass balance (material, water, electricity), as in the case of a fish processing industry, shown in example below (Figure 3.1) in order to evaluate the environmental performance.

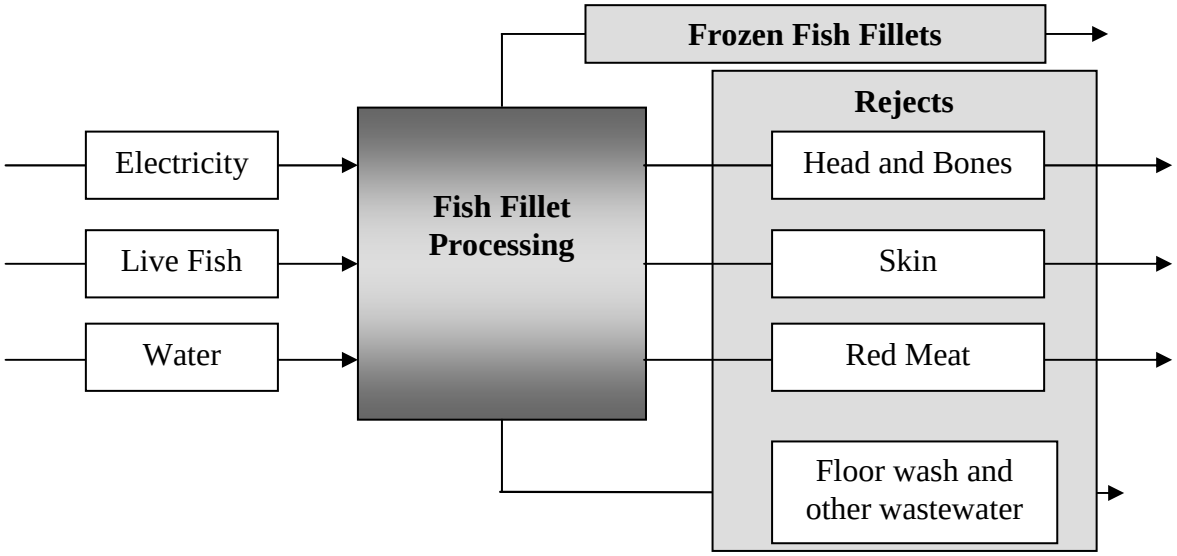

Figure 3.1 Example of material mass balance in fish fillet industries

In this case, Agifish Company – was chosen as a representative fish Fillet Company to examine and evaluate the environmental performance. The quantification of all raw materials, products, by-products and rejects was used and calculated to evaluate the environmental performance of the industry. The efficiency of the process was concluded when the material balance was complete. The waste stream and by-products were also

identified in this stage. The by-products and wastes were analyzed and make it marketable with alternative treatments. The energy process was also to be considered and evaluated in order to rate the performance of the process.

c. Evaluation of financial performance of the industry

In the scope of the study, the financial status of the industries also was evaluated. This was done to understand the financial performance of the industry in terms of raw materials, energy costs, waste treatment and disposal costs, value of products and by products. This process aids in comparing the financial baseline of the industry with that after applying by-product and waste exchanges.

d. Material Flow Analysis

The Material Flow Analysis was a key component of the study as it helped to draw strategic inferences about potential material, product, by product and waste exchanges focused at closing the material cycle. A sustainable supply chain with a closed material loop, results in improved environmental and economic performance in addition to augmenting the product quality. Hence, based on the field data collection, a material flow among all industries in the region was developed. The material flow analysis was done considering all possible linkages in the existing industrial setup.

Though the central theme of the study is the fishery sector, an analysis of all industries falling in its supply chain was implemented. A material flow is presented in Figure 3.5

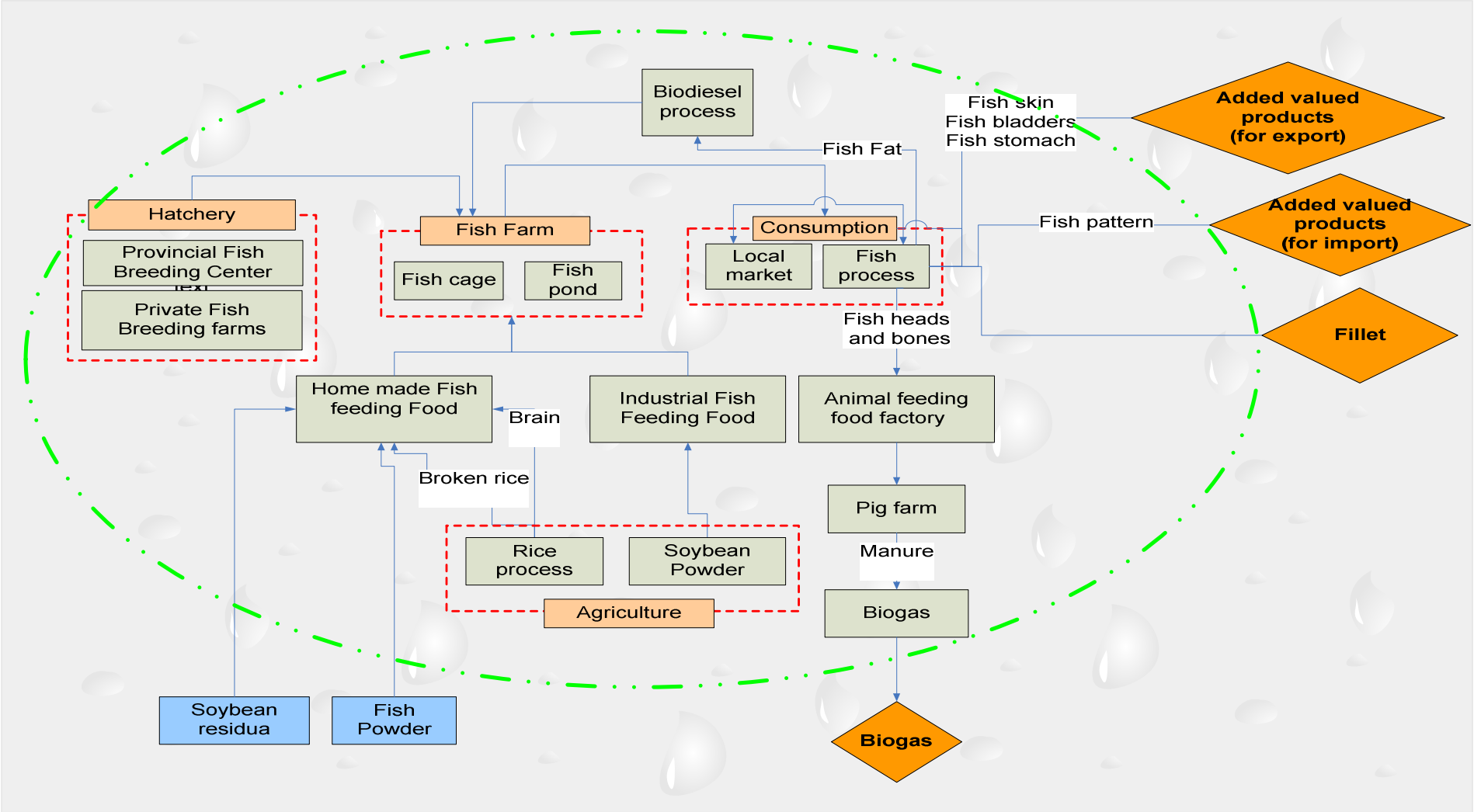

Figure 3.5 Material Flows in An Giang Province

Fishery processing only takes fish fillet for exporting; other parts of fish become waste which can be sold in the local market such as fish head or can be recycled for fish feed or cattle feed industry. In the province, the government has supported the development of bio-diesel production which uses fish fat as a raw material. Initial products received good feedback from the consumers and there is an opportunity to develop this kind of manufacture because there are available market, resource and supporting from the government.

3.3.4 Desk review

In addition to the field study on data collection a comprehensive desk review of collected information was implemented. Field Study and Material Flow Analysis, though described as different components, were carried out simultaneously, based on the experiences obtained in each industry. Thus all required information to develop a sustainable supply chain was available. The desk review was performed considering policy, economic, technological and environmental aspects.

a. Policy Analysis

This task was implemented after all of data are collected which need to be analyzed. Following the objective of the thesis the policies was analyzed and base on the current condition of the province to suggest an effective management system. So the present related policies was investigated all of its envisaged aspects and its effect on the industry in order to find out the fruitful condition for applying those policies on fishery industry not only on the manager role (the government) but also on the industry roles. The study analyzed the policies which are related with the eco-industry network formation. This task was completed step by step as follow:

- Identify and group all policies applicable to the industrial sectors under the supply chain
- Understand the objectives of the policy
- List the industrial sectors to which the policy is applicable
- Tabulate the factors of the policy which favour/ hamper the growth of the target sectors
- Mapping the favoring/hampering aspects of the policies cutting across sectoral boundaries of all industries in the supply chain

Policies for each the industry based on its properties were analyzed. For example: there always have some differences on policy between government company and self employed company; big scale companies have more advantages comparing for the small and medium size of company. The economic loans policies for each type of industry also are different. For example: In recent years, Government of Vietnam has supported the developing of Small and Medium Enterprise. So its development is encouraging by supporting on finance, credits or investment on industries and laws.

The priorities of local and national policies on development of fishery industry also examined and analyzed. In An Giang Province, fishery industry is one of the target development industries in the province along with the promotion of the Government in the

Provincial Fishery Development Plan until 2010 become an advantaged condition in developing the industry and forming the industrial network.

b. Commonalities and conflicting condition between and within policies

The commonalities and the conflicts of policies between the government levels or offices were identified and analyzed. Thus the gaps in policies and missing aspects also identified. From this analyzed result, the study suggested some solutions to overcome these problems and filling the missing aspects of the related policies aiming to the thesis objective: better management and sustainable development.

The result of this task was to suggest some policy measures that aims using policy tool to develop an eco-industry network in the province and effective management system which is suitable with the long term and short term economic – environment development of both national and regional strategies.

An assimilation of various policy aspects, commonalities and conflicts and missing aspects was aid in the reformation. Thus appropriate policy measures with a broader picture of the entire system, aiming at a sustainable supply chain integrated with environmental and economic concerns were suggested.

c. Technology and Environmental aspects

From the Field Study and Material Flow Analysis a broader picture of the material cycle in the region was obtained. In addition to this, where material exchanges take place the strength of the linkage was evaluated in terms of quantity and quality of material exchanges. Options of strengthening these links were explored in addition to establishing new links.

Technology plays a major role to strengthen the existing link or establish new links. The prevailing technology in the industries would be compared with the recent ones and options of introducing new technologies will be suggested. In addition to suggesting new technologies, application of simple Cleaner Production concepts would also be suggested to improve productivity, product quality and profitability.

Chapter 4

Results and Discussions

4.1 Environmental Condition in An Giang province

4.1.1 Climate

An Giang province has two distinct seasons: rainy season and dry season. The rainy season start from May to November and dry season start from December to April. Each season has the specific natural conditions that create the complicated environmental condition.

a. Temperature

The average temperature in An Giang province is 26 - 27^{o}C. The highest temperature is about 40-41^{o}C, the lowest is 15-16^{o}C in the delta area and 13-14^{o}C in the mountainous area. Figure 4.1 shows the monthly average temperature in An Giang province in 2005.

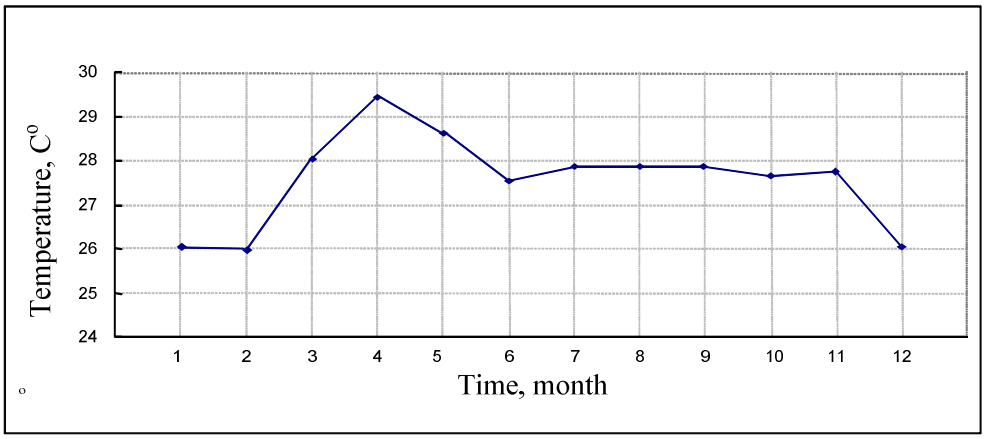

Figure 4.1 Average temperature in the year 2005
(Source: ASD, 2005)

b. Wind-Storm regime

The storm in An Giang province is affected by two distinguished seasons. From May to October, the South West monsoon brings a lot of humidity from Thailand bay to the area with the average wind speed of 3 m/s. From November to April of the next year, the area is affected by Northeast monsoon which is dry and cold.

c. Rainfall regime

Annual highest rainfall is 2,100 mm and lowest rainfall is 900 mm. The highest rainfall is in September to November. Figure 4.2 presents the average rainfall in Long Xuyen Town, An Giang province in 2005.

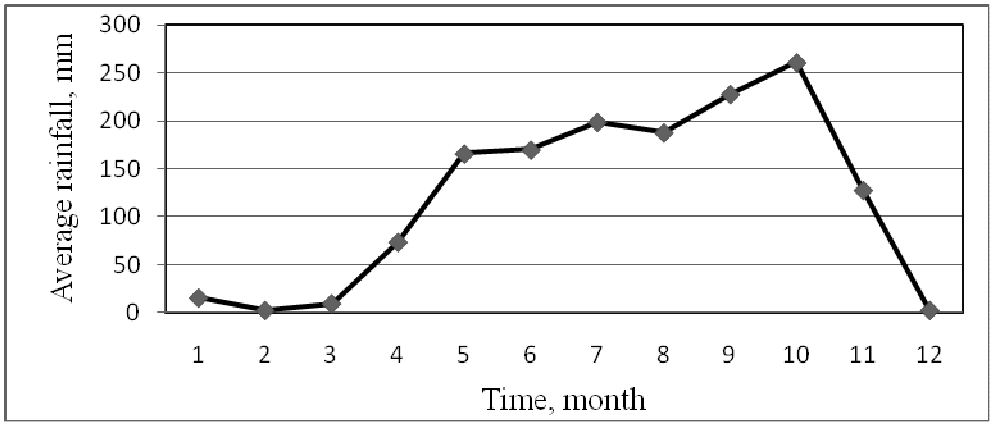

Figure 4.2 Average rainfall in Long Xuyen Town.
(Source: ASD, 2005)

d. Humidity

Humidity changes with the seasons. In dry season, the highest humidity is 76.4%; the average humidity is 71-75 % but never lower than 35%. During rainy season, the average humidity is 80.2 %.

4.1.2 Hydrology

The hydrological condition in An Giang province is daily tide of the East Sea and half daily tide of West Sea. Beside the flow system, the rivers are affected by the water from the upper reaches of Mekong River. During the rainy season, the flow velocity obviously increases resulting in the high alluvial. The typical characteristic of hydrological in An Giang Province is the river system with high density of rivers, streams and irrigation systems. There are two main rivers in the province, Tien River and Hau River. Moreover, there are 85 small rivers, streams with the total lengths of 608 km, and 375 canals and secondary canals with the total lengths of 1,617 km. Table 4.1 presents the water level in Tien and Hau rivers in the year 2004. Highest water level period (flooding season) is from August to October (Table 4.1). This period will be analysed more details in the next issues on flooding regime.

Table 4.1 Water level in An Giang Province

Time (month)	Water level (cm)								
	Chau Doc			Long Xuyen			Tan Chau		
	Highest	Lowest	Average	Highest	Lowest	Average	Highest	Lowest	Average
1	148	14	82	146	-37	62	149	32	90
2	126	-19	62	124	-65	45	127	-6	66
3	115	-47	48	117	-85	34	114	-34	50
4	100	-50	35	102	-86	22	99	-38	38
5	112	-48	36	114	-88	20	118	-30	42
6	133	-3	81	130	-46	47	155	17	103
7	201	50	111	153	-24	65	269	80	144
8	317	177	243	193	56	124	373	254	308
9	401	311	357	241	130	179	441	366	404
10	399	244	336	238	129	192	437	270	364
11	251	123	188	173	40	122	277	147	211
12	176	46	117	167	-16	84	186	71	136

Source: ASD, 2004

a. Flooding regime – The advantages and disadvantages

Flooding water level in An Giang province is not stable and varies from 17 cm/day to 36 cm/day. When the flood runs into the field, the flood water level is stable and then decrease with the speed of 2-4 cm/day. The highest flooding slope is 5cm/km for Tien River and 4cm/km in Hau River. The slow water level changing make fishery activities in An Giang stable. Every year, there is 2.5-5 months of flooding season in An Giang province from August to October (Figure 4.3). In this season, 70% of the province area is covered by water under 1-2.5 m depth.

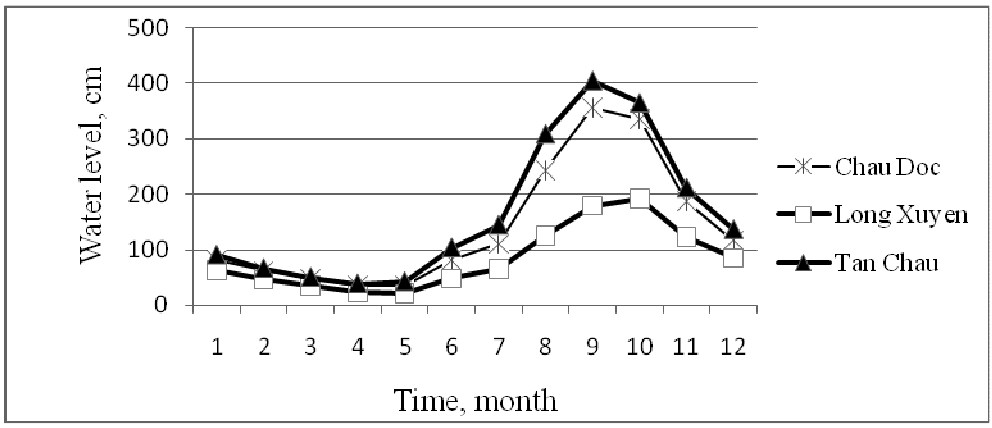

Figure 4.3 Annual Water Level in Tan Chau, Chau Doc and Long Xuyen (Source: ASD, 2005)

Nhi (2003) states that the historical annual flooding has played an important role in helping maintaining soil fertility, though the precise mechanism is uncertain (Table 4.2). There is some evidence of less fertiliser being required after high flood years compared with average or low flood years.

Table 4.2 Disadvantages and advantages of annual flood in An Giang province

Advantages	Disadvantages
• Improve the water quality: alluvium, ecological condition; • Regulating temperature; • Supporting the ground water source; • Supporting the fishery resource in the province, creating a diversified aquatic biology in the province; • Fertilized the soil especially the agriculture field; • Regulation the water flow in the region.	• Material and human losses; • Interrupting the economic and social activities, damage houses, road and public infrastructures; • Affect the environment; cause the difficulties in environment protection.

4.1.3 Water – Wastewater

a. Surface Water

Mekong River enters An Giang province - Vietnam and divides into two main rivers: Hau River and Tien River (Figure 4.3). Every year, Centre of Resources, Environment and Technology (CRET) – Department of Natural Resources and Environment (DONRE)

implements an Environmental Monitor for water quality in An Giang province. Table 4.3 shows the surface water quality in Tien River, Hau River and internal field canal – arroyos.

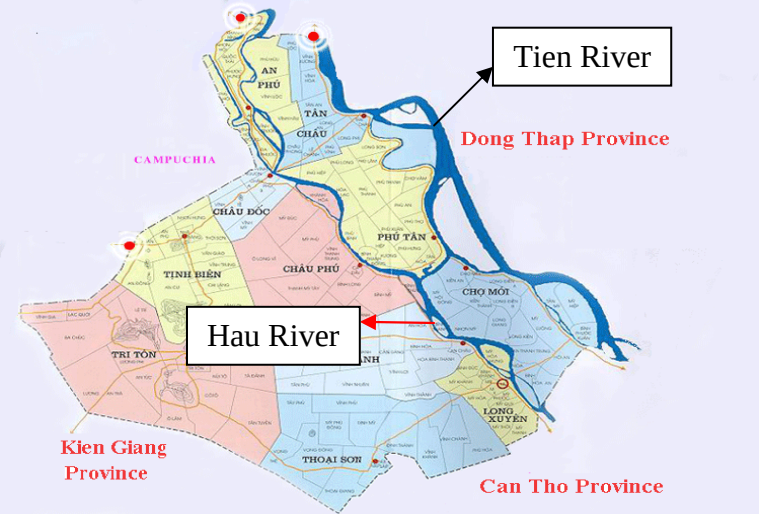

Figure 4.4 Rivers in An Giang province

Table 4.3 Surface Water Qualities in An Giang Province

Parameters	Area	Dry season			Rain season		
		Average	Lowest	Highest	Average	Lowest	Highest
Temperature (^oC)	Tien River	30.64	30.10	31.10	30.03	29.80	30.40
	Hau River	29.76	29.40	30.20	29.30	28.80	30.10
	Canal- arroyos	29.46	28.60	31.00	29.05	28.20	30.10
pH	Tien River	6.59	6.30	6.80	6.40	6.30	6.50
	Hau River	6.01	5.74	6.30	6.46	6.30	6.60
	Canal- arroyos	6.46	5.73	7.98	6.18	5.46	6.60
	TCVN 5942:1995 6 – 8.5						
SS (mg/L)	Tien River	22	9	38	209	170	230
	Hau River	33	13	61	69	24	112
	Canal- arroyos	34	10	84	44	24	102
	TCVN 5942:1995 20 mg/L						
DO (mg/L)	Tien River	3.97	2.10	5.60	4.60	3.50	6.0
	Hau River	3.87	3.00	4.93	3.59	3.10	4.1
	Canal- arroyos	3.48	2.46	4.62	3.83	2.22	6.0
	TCVN 5942:1995 6 mg/L						
NH_3 (mg/L)	Tien River	0.15	0.07	0.34	0.86	0.64	1.12
	Hau River	1.69	0.09	5.20	0.29	0.14	0.72
	Canal- arroyos	0.79	0.09	2.22	0.32	0.11	0.65
	TCVN 5942:1995 0.05 mg/L						
BOD_5 (mg/L)	Tien River	4.86	4.00	6.00	6.33	5.00	9.00
	Hau River	7.40	6.00	11.00	4.71	2.00	9.00
	Canal- arroyos	5.04	3.00	7.00	6.17	2.00	10.00
	TCVN 5942:1995 < 4 mg/L						
Coliform total (MPN.10^3/100 ml)	Tien River	930.0	93.0	2,800	3,810	64.00	110,000
	Hau River	1,411.0	70.0	4,600	2,427	75.00	11,000
	Canal- arroyos	491.5	0.7	4,600	29,554	0.75	210,000
	TCVN 5942:1995 5 (MPN/100 ml)						

Source: ASD, 2005

Based on the data presented in Table 4.3, in regard to provincial water quality, the following conclusions can be summarized:

- Conductivity/salinity is low all year, but higher in the dry season. In the dry season salinity differentials exist throughout the island, indicating circulation/exchange with the lower salinity main rivers. The patterns of limited exchange as shown from the detailed measurements correspond to those indicated in the hydraulic modelling.
- Very high suspended solids/high turbidity levels are present in the rain season. Boat movements and shallow water aggravate the high levels. In the wet and flooding season, suspended solid levels are high close to entrances to the high turbidity main rivers, decreasing slightly along canals and decreasing substantially during flow across the flooded agricultural areas.
- The pH of water in the canals is almost always between 6.5 and 8.0, within an acceptable range.
- Water temperatures are typically between 28–32ºC. In the dry season with low water depths and high solar radiation, water temperatures can increase to over 34ºC.
- Organic levels (as indicated by BOD/ COD ratio) are moderate to high year round.
- Whereas the high organic and nutrient levels might be expected to result in algal blooms, especially during the hot dry season the very high turbidity and movement of canal water limits development of the blooms. However, when water movements are almost stopped, the solids settled, algal blooms develop rapidly.
- When algal blooms occur, dissolved oxygen levels get very low at the depth below water surface throughout the day and night and at the surface at night. During the day time, dissolved oxygen levels are very high at the surface.
- Normally, dissolved oxygen levels are always over 50% of the saturation level, and typically over 70%. Thus low dissolved oxygen is not normally a critical factor other than during water stagnation and associated algal blooms.
- Bacteriological quality is very poor all year, but especially in the dry season and early rising flood.
- Floating rubbish (mostly come from domestic garbage and leaves/plant waste, but often obnoxious dead animals and human sanitary wastes) is a common situation throughout the area.

At the present time, the water is not suitable for domestic usages and does not meet the Vietnamese Standard TCVN 5942-1995 Column A for water prior to treating for domestic uses (especially in relation to bacteriological quality).

b. Ground water

In An Giang province, there are many wells that concentrate in Vam Cong area, My Thoi Ward with the depth of 280-300 m. Most of wells are used for domestic purpose (Figure 4.5). The potential exploited capacity of wells in the province is 85,000 m^3/day (CRET, 2005).

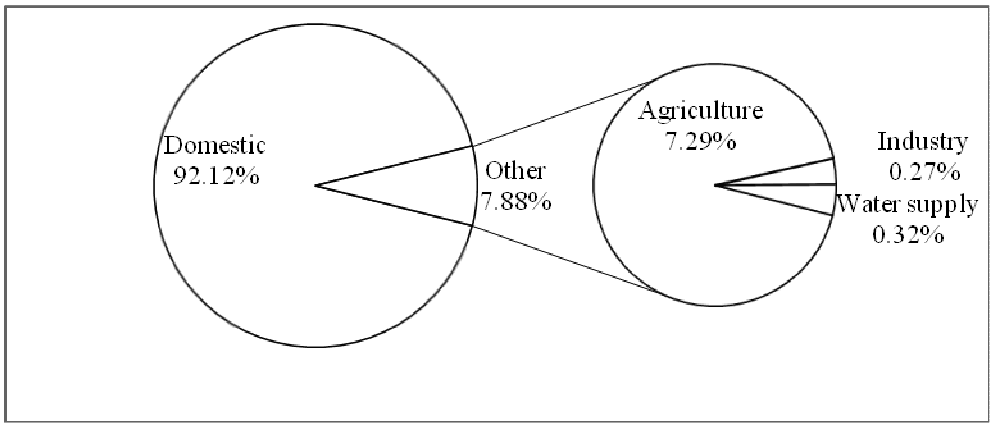

Figure 4.5 Classification of wells in An Giang Province based on the end use (Source: ASD, 2005)

c. Wastewater from industrial activities

Most wastewater from the industrial activities in the province has been discharged directly to the surface water without any treatment. In An Giang province, there is no treatment for the domestic wastewater and it is discharged directly to Hau River. Flood plays a major role in regulating the water quality in the region. In the dry season, the water of Hau River is more contaminated than Tien River because most of fishery activities (cultivation and processing) are implemented in this river. Fishery industry brings the wealth for the province but also pollute the environment. Nam Viet Factory which has the highest production capacity in the province has the wastewater system capacity of 400m^3, the remains wastewater discharge directly to the river (Table 4.4).

Table 4.4 Major fishery factories in An Giang Province

Factory	Output capacity	Wastewater	Wastewater Treatment system	
	tons/day	m^3/day	Yes	No
Frozen Factory 7	50	500	X	
Frozen Factory 8	50	500	X	
AFIEX Factory	30	250	X	
Viet An Fishery Processing	50	500	X	
Cuu Long Fishery Processing	50	500	X	
ANTESCO Fishery Processing	50	500	X	
Nam Viet Fishery Processing	300	3,000	Treatment capacity 400m^3	
Thuan An Fishery Processing	50	500	X	
Tuan An Fishery Processing	50	500	X	
AFA Fishery Processing	50	500		X
Total	730	7,250		

Source: ASD, 2005

Most of industrial wastewater treatment systems in the province do not work well because the production capacity has been increase rapidly. The wastewater systems are overload so the treated wastewaters do not qualify the Vietnamese Standards for discharged industrial wastewater (Table 4.5).

Table 4.5 Treated wastewater quality from fishery factories in An Giang Province

Factory Name	pH	BOD5 mg/L	N-NH_3 mg/L	COD mg/L	SS mg/L	Coliforms total MPN.10^3/100ml
Frozen Factory 7	7.8	0.9	1.000	-	1,030	20
Frozen Factory 8	7.3	28.0	4.130	-	1,190	640
AFIEX Factory	7.8	49.0	5.320	-	558	460
ANTESCO Fishery Processing	7.9	15.0	0.003	-	1,028	46
Nam Việt Fishery Processing	8.1	19.0	1.000	-	1,397	64
Thuận An Fishery Processing	5.5	23.0	-	9	11	24
TCVN 5945-1995 (A)	**6-9**	**20.0**	**0.100**	**50**	**50**	**10**

Source: CRET, 2005

4.1.4 Natural Resources in An Giang Province

a. Forest

The forest areas are 12,810 ha (ASD, 2004) with the cover ratio of 3.76%. Forest trees are eucalyptus, melaleuca cajuput, and trees with short time grow up.

b. Mineral resources

- Construction Stone: The An Giang province supply 30% of the construction stone market in Mekong Delta with the exploitation capacity is 611,062 m^3 in the year 2005.
- Alit stone: exploit 2,900 m^3 in 2005 while the exploitation permission of authorization is 60,000m^3
- Clay: 42,000 m^3/year
- Sand: exploit from the river, exploit 4 million m^3/year
- Peat: The exploitation capacity of peat mines in the province is 16,886,730 tons Arca Shell: Total Arca Shell resource areas are 21.7 ha and mining capacity is 808,691 tons.
- Diatomic: Total exploitation capacity of diatomic resource in An Giang province is 177,728 tons (Son et. al, 1994)

4.1.5 Sociaty

a. Infrastructure

- Transportation system
  - Water way: With the dense rivers, arroyos and canals, waterway system can be the convenient transportation means but because of alluvium, the transports which weight higher than 100 tons cannot enter too far inside the waterway system.
  - Road: there are national, provincial and local roads in the province which are almost asphalted with total length of 4,040 km and density of 2,164 km/km^2.

- Water supply
  - Urban area: In the province, there are 12 urban centres that have the water suppliers with total capacity 42,800 m^3/day that serves 249,000 people.
  - Rural area: there are 13 water supplier and 212 water stations (serving 50 - 100 persons) with total capacity 13,200 m^3/day.

b. Sanitation and Public health

In An Giang province, the health care networks include 16 hospitals, 13 general clinics, 2 maternity hospitals and 139 communal/ward medicine stations. The basic health care networks and health programs in the province have been implementing well especially in national health care programs such as: initial health care program, health care for the people who lives in the rural areas, vaccination programs.

c. Land use

- Total Area 353,500 ha
- Agriculture 281,900 ha
- Forestry 13,800 ha
- Aquaculture 2,300 ha
- Non-agriculture 53,100 ha
- Unoccupied land 2,300 ha

There is a highest land area percentage for agricultural purpose that can convince that agriculture is an important economic element in the province (Figure 4.6).

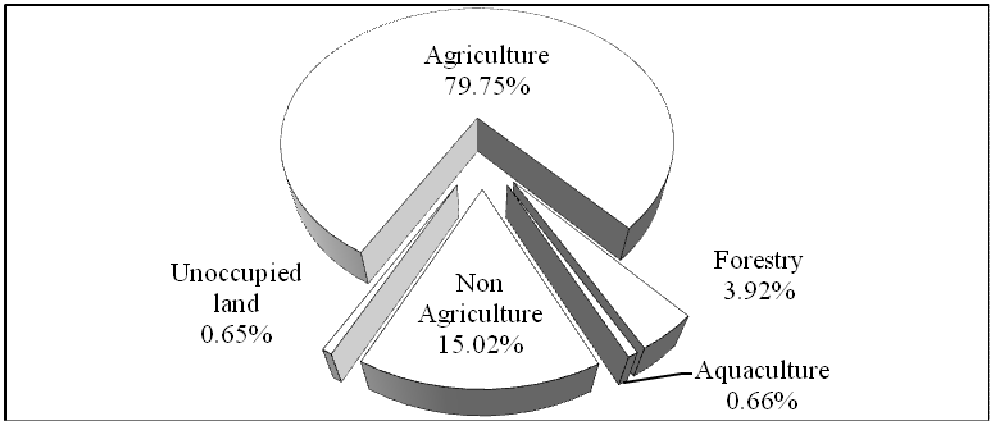

Figure 4.6 Land use percentage in An Giang Province
(Source: ASD, 2005)

d. Population

According to the statistic in 2004, the population of An Giang Province is 2,170,000; population growth rate is 13.9 %. The distribution of population in the province is 560,000 persons in the urban areas and 1,610,000 persons in the rural areas. Long Xuyen City has the highest population density (Figure 4.7) because of the immigration waves from rural areas to city.

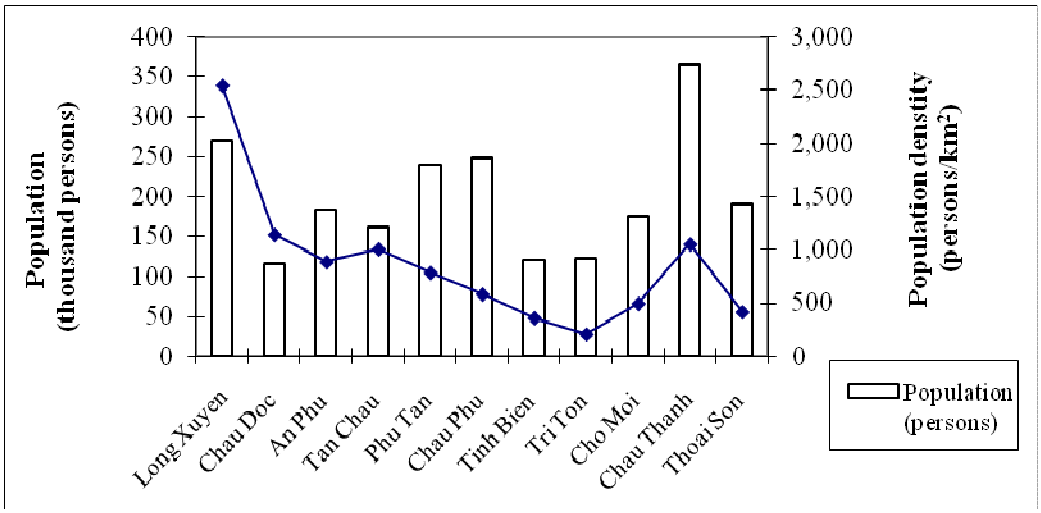

Figure 4.7 An Giang province population and density
(Source: ASD, 2005)

4.1.6 Economic development

In order to implement the economic components structure changing tasks, An Giang government conduct many programs such as: "Eradicate Hunger and alleviate poverty", increasing investment of building infrastructure, developing handicraft traditional village; step by step increasing the industry and service components. In the present time, the largest economic components are agriculture, forestry, and fishery. Total Gross Development Product of An Giang province has been increased every year except of 2001. Because of the catfish war, An Giang province economy in 2001 faced the most difficult period (Figure 4.8). At the present time, An Giang economy was recovery and develops rapidly.

Figure 4.8 Gross Development Product increase of An Giang Province
(Source: ADS, 2005)

a. Agriculture

The dominant crop in the area is paddy during all seasons. Every year, and almost constant between seasons, the provincial government encourage famers to diversify crops for greater economic return and to take advantage of wider market opportunities. Rice crop varieties can be chosen to match with available growing season (to some degree). The most likely crops under consideration include soybeans, vegetable, and sesame.

Rice related industries are very importance industries in An Giang province where have the highest rice export capacity not only in the Mekong Delta but also in Vietnam. But fishery products have the highest export turnover value (Table 4.6) comparing to other export products.

Table 4.6 Export turnover of some products in An Giang province

		Unit	2001	2002	2003	2004	Estimate 2005
A	Export turnover	Million USD	119.00	147.00	182.00	260.00	300
	Rice	Million USD	70.00	62.00	93.00	94.00	100
	Fishery products	Million USD	37.00	70.00	55.00	125.00	155
	Vegetable	Million USD	1.42	1.97	3.35	3.70	5
	Light industrial – handy craft industrial products	Million USD	10.58	13.03	30.65	37.30	40
B	Percentage						
	Rice	%	58.82	42.18	51.10	36.15	33.33
	Fishery products	%	31.09	47.62	30.22	48.08	51.67
	Vegetable	%	1.19	1.34	1.84	1.42	1.67
	Light industrial – handy craft industrial products	%	8.90	8.86	16.84	14.35	13.33

Source: ASD, 2005

b. Export market

Export market for An Giang fishery products can be divided into three main areas: Asia (Hongkong, Singapore), America (United State and Mexico) and Europe (German, Belgium) and other countries such as Australia etc.

- Asia – Pacific is the important market area because of the short distance, having the advantages in geography location, high market requirement, and rapid development rate. The key markets in Asian countries are China (including Hongkong), Japan, Taiwan and Korea.
- Europe: Have high standards for importing products. The market is the hardship for Vietnam fishery to develop to the next level. There are many requirements such as improving brand name, registering international standard (ISO, HACCP) to participate this area.

c. Industry

Most of industrial zones clusters in An Giang province are at the planning and building infrastructures phases. There are three large scale industrial zones which are My Quy, Binh

Long and Binh Hoa in An Giang Province (Figure 4.9). These large scale industrial zones are managed by Provincial Administration. The remains industrial zones and clusters are directly under the management of district/ward administration. At the present time, only My Quy and Binh Long industrial zone are working, Binh Hoa industrial zone is in construction stage. All of three above industrial zones do not have the central wastewater treatment system except some companies have the wastewater treatment systems.

There are some concerns of industry issues in the province, as follow:

- There is no central industrial wastewater treatment system in the province;
- Factories in the province don't have wastewater treatment systems or the wastewater treatment systems are not working well;
- An Giang province has implemented the "Industrial Promotion Program" that support SMEs, investment project at the starting phase.

An Giang authorization has been planned for the trade village where produces roof tile and brick and in order to control and step by step moving the enterprises to this area, the An Giang government temporary stop issue the trading license for this business until 2010.

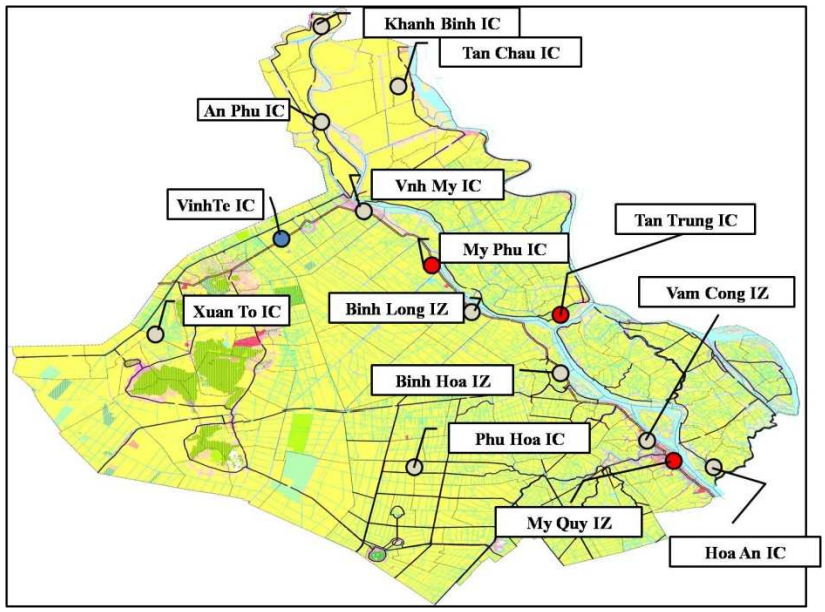

Figure 4.9 Industrial cluster, parks in An Giang province

4.2 Cleaner Production in Fish Process

4.2.1 Fishery Processing

There are ten fish fillet companies in An Giang Province (Figure 4.10) and this section will analyze the representative of Tra – Basa Fish Fillet Processing Factory which is An Giang Fisheries Import & Export Joint Stock Company (AGIFISH). AGIFISH was established in 1985 and since 2001 AGIFISH officially changed from state owned to Joint Stock Company. The company is applying HACCP (Hazard Analysis Critical Control Point) system that is the standardized method for the food industry to minimize food safety risks and reduce the incidence of unsafe food reaching the marketplace. In HACCP system, SQF 1000 code is applied for primary producer (fish farm, fish hatchery) and SQF 2000 code for food industry (fish fillet factory). Beside HACCP, the company also launched other standards such as ISO 9001:2000 for quality management system.

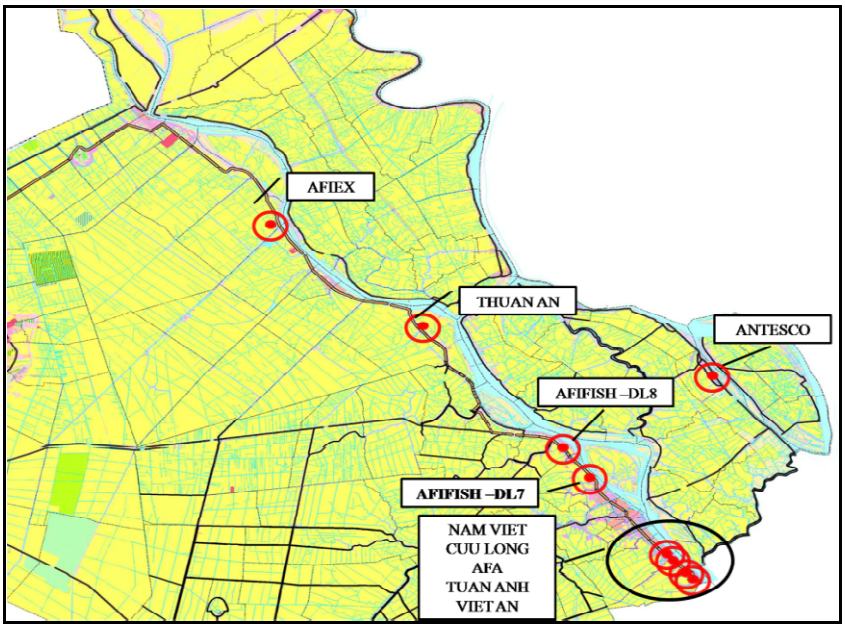

Figure 4.10 Fish Fillet Factories in An Giang province

Raw material (after taking sample, testing, qualifying the antibiotic parameters, unused of banned and limited chemicals following the Decision No 07/2005/QD-BTS, 26/2005/QD-BTS of Fishery Department of An Giang Province) is transported by small boat (Figure 4.11) from harvesting area to factory in order to keep the fish alive. After that the fish is draw out the water by net and transfered to specialized container which is transported to the raw material receiving area by truck. From here, the supervisors check the raw material by eyes (colour, smell, freshness, structure, and size) and necessary documents of raw material quality tests (commitment paper, source of material declaration, testing result of antibiotic parameter, banned and limed using chemicals). Qualified raw material is weight and transferred to the fish fillet process (Figure 4.12).

a. 

Figure 4.11 Fish tranportation means: boat (1) and truck (2)

Fish fillet process can be divided into several stages; each stage has the specific products and wastes (Table 4.7).

Table 4.7 Fish fillet sections and ist characteristic

Section	Objective	Product	Waste
Killing	Cutting fish faucets	Killed fill	Blood Wastewater
Fillet	Fillet the fish meat	Raw fillet with skin	Fish head and bone, fish fat, fish viscera
Skinning	Remove the skin	Raw fillet without skin	Skin Wastewater
Trimming	Remove remain fat, red meat, classify fish fillet	Final fish fillet	Red meat, fish meat residues, fish fat Wastewater
Frozen	Frozen the fillet	Fish frozen fillet	Wastewater
Wrapping, packing	Wrapping the final products	Final products	Plastic bags, carton boxes

On the other hand, fish process has been divided into five stages which are compatible with five areas in process area in the factory (Figure 4.13).

- Raw material pre-treatment: fish killing, fillet and skinning
- Processing: fish trimming
- Pan laying: preparing for freezing, depend on the requirement of the buyer, there are many type of freezing such as IQF, block freezing … with different percentage of ice (5%, 10%, 15%)
- Freezing
- Package
- Storage

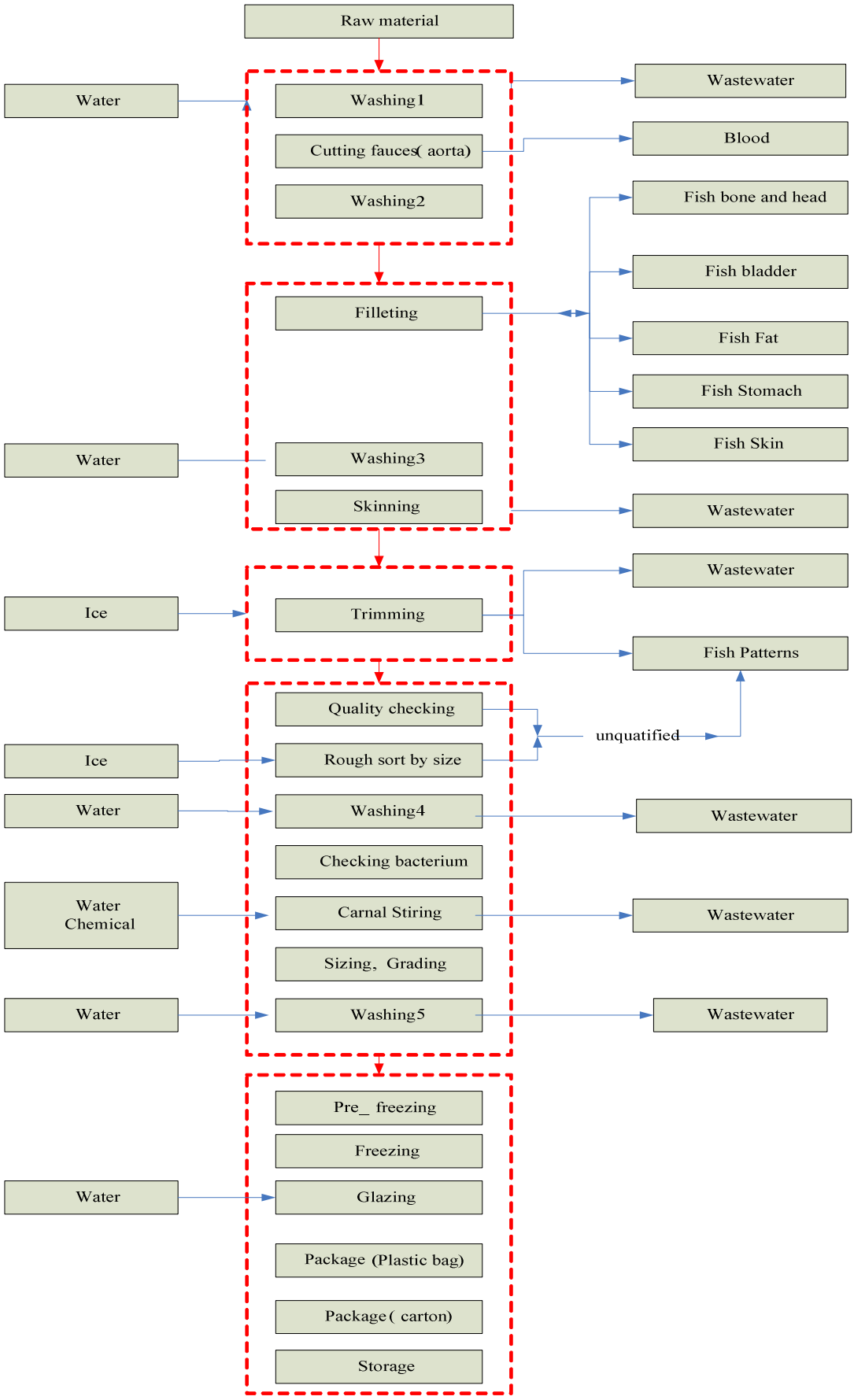

Figure 4.12 Fish fillet process flow diagram

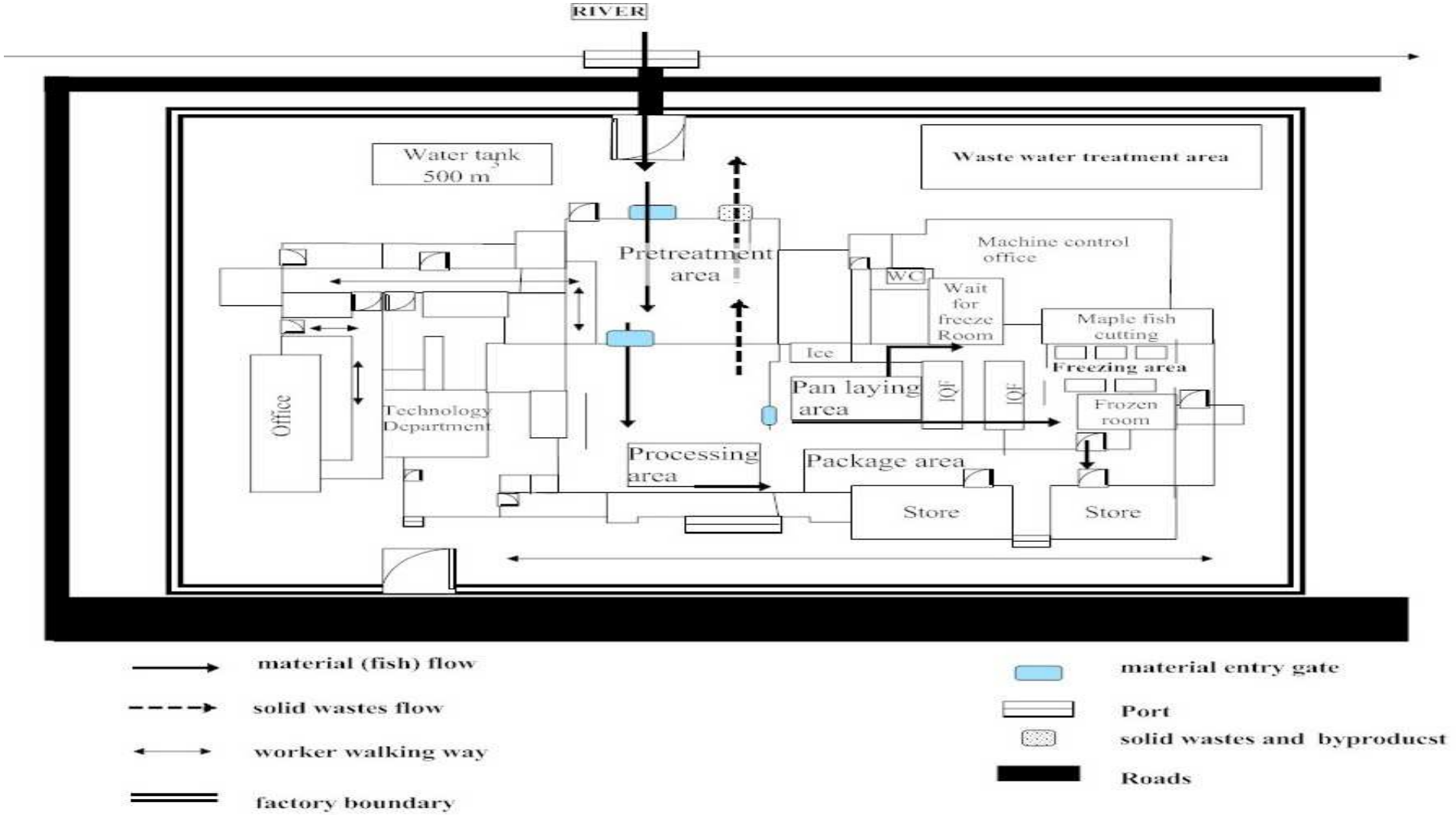

Figure 4.13 AGIFISH DL-7 Factory layout

All of the processes in Figure 4.13 dispose wastewater as cleaning water (chopping board, classing fillet board and fillet containing box), washing fish fillet and the melting water from ice, the evaporated water are negligible in the mass balance in the next section. During the process, organic solid wastes are stored in the blue box (Figure 4.14) and will be disposed to the waste transporting truck whenever the waste container is full.

Figure 4.14 Filleting areas with solid wastes container

4.2.2 Process Mass Balance

The following mass balance was implemented in AGIFISH Company with data in 2005 (Figure 4.15, Figure 4.16). At that time, AGIFISH was the second among fish processing companies in term of production capacity in An Giang province. The wastes and by products were calculated from the ratios which were concluded from the experimental works as mention in section 4.3.

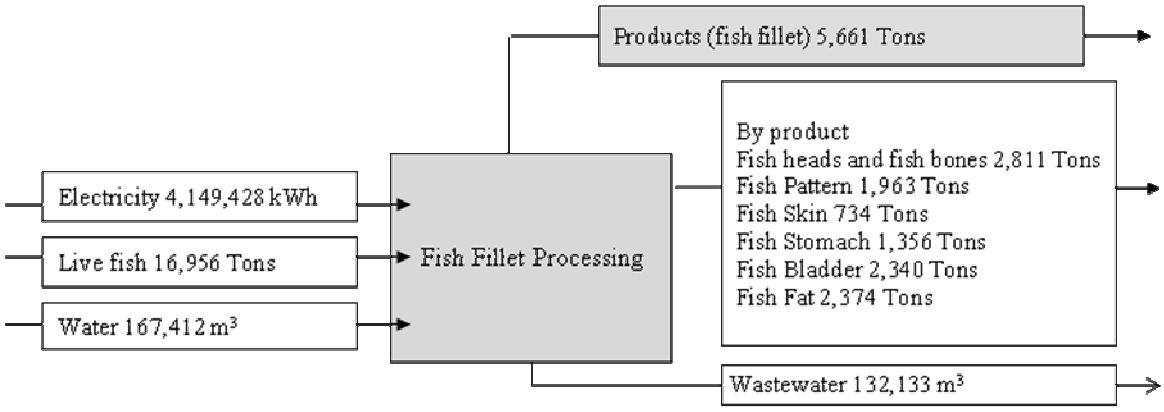

Figure 4.15 Mass balance of fish processing in 2005

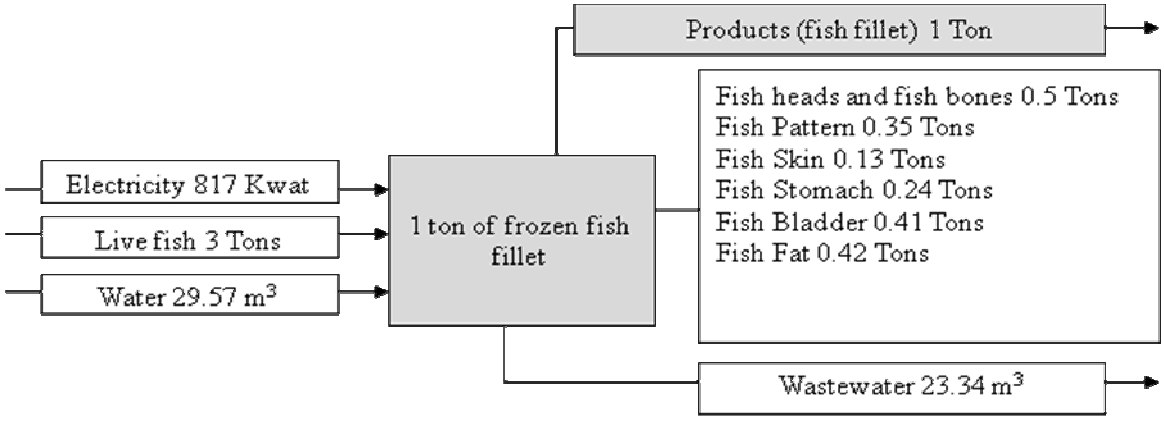

Figure 4.16 Mass balance for fish fillet processing (one ton of products)

There are some key conclusions from those above figures:

- It takes three tons of raw materials to product only 1 tons of products, the remains become by-products and wastes (Figure 4.16). Beside, most of by-products can be use as an input material of another related industries such as animal food processing (fish head and bone), biodiesel (fish fat), or can re-use to produce Added value products (Fish pattern can use to produce Fish sausage; fish skin and bladder can be dry for export product) or sell in the local market (fish stomach).
- Most of organic solid wastes in the process can be reuse or recycling but the efficiency depend almost on transportation system. Moreover, environmental pollutions during by-product transporting need further investigation.
- The difference in the wastewater inlet and wastewater outlet is the ice percentage of frozen fish fillet.

a. Water

In food industry, there is high water consumption in for cleaning, washing for sanitation purpose. In 2005, DL-7 factory consumed 154,000 m^3 of water for both production and other sections (offices, canteen) (Table 4.8). The most consumed water stage is in cleaning stage (20.45%), trimming (19.12%) and fillet process (16.39%) while there still 0.53 % of uncontrolled water (which cannot be identified when minus the main water meter with branch water meters) (Figure 4.17).

Table 4.8 Water consumed percentage

No	Sections	Amount (m^3)	Percentage (%)
	Fish processing	154,437	92.25
1	Raw material washing	4,868	2.91
2	Fillet	27,440	16.39
3	Trimming	32,012	19.12
4	Freezing water	9,237	5.52
5	Pan lying	25,065	14.97
6	Cold water	9,485	5.67
7	Reducing temperature of machine	11,213	6.70
8	Cleaning water	34,241	20.45
9	Uncontrolled water	879	0.53
10	Icing water	6,519.00	3.89
11	Others (Office, canteen)	6,456.00	3.86
	Total	167,412.00	100

This factory has one wastewater collecting system to collect all of wastewater from all stages of the process although the differences in wastewater characteristics in each stage. For example: Wastewater from fish processing areas (high BOD), wastewater from reducing temperature of machine. Separately wastewater collecting system would increase the wastewater treatment efficiency.

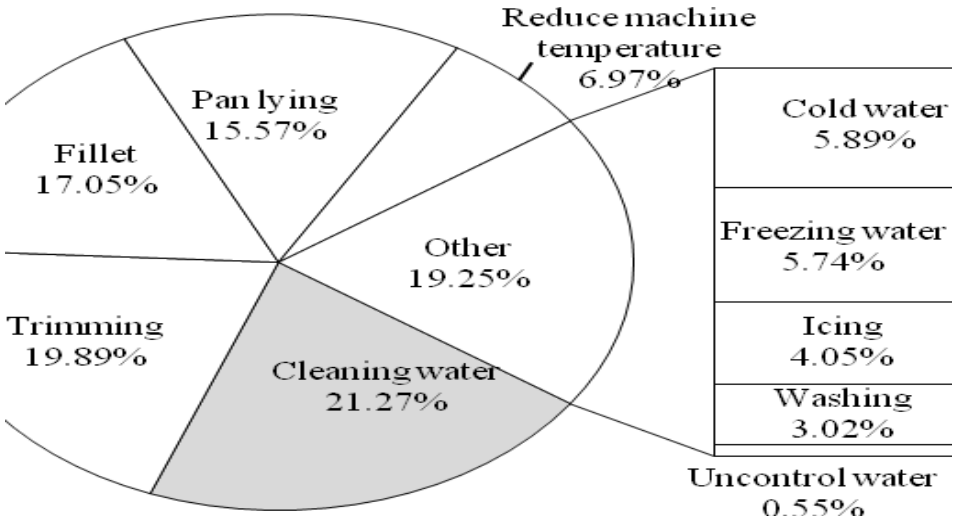

Figure 4.17 Water consumed percentage

b. Electricity

DL-7 factory is using electricity from the national electricity network. The electric generator only operates in the emergency case or when the main electricity network is not working. In 2005, the electronic generator only supplied 1.9 % of total consumed electricity of this factory (Table 4.9). The most consumed electricity is temperature regulating equipment such as Freezer and Icier (61%), air conditioner (5.3%) (Figure 4.18). Hence, freezing and icing systems are not work effectively. For example: the IQF machine only create the frozen filter that have 15% ice, if the customer require the higher ice percent, frozen stage need to be process twice.

Table 4.9 Electricity consumed percentages

No	Sections	Amount (kW)	Percentage (%)
1	Electronic Generate	87,074	1.88
2	Freezer and Icier 2	2,460,546	53.21
3	Freeze store	304,509	6.59
4	Icer 1	424,317	9.18
5	Cold Water	90,456	1.96
6	Air conditioner	244,707	5.29
7	Light system	135,950	2.94
8	Others (Office, canteen …)	343,688	7.43
9	Water and wastewater treatment	267,450	5.78
10	Heating water	44,460	0.96
11	Uncontrolled	307,741	6.66
	Total	4,623,824	100

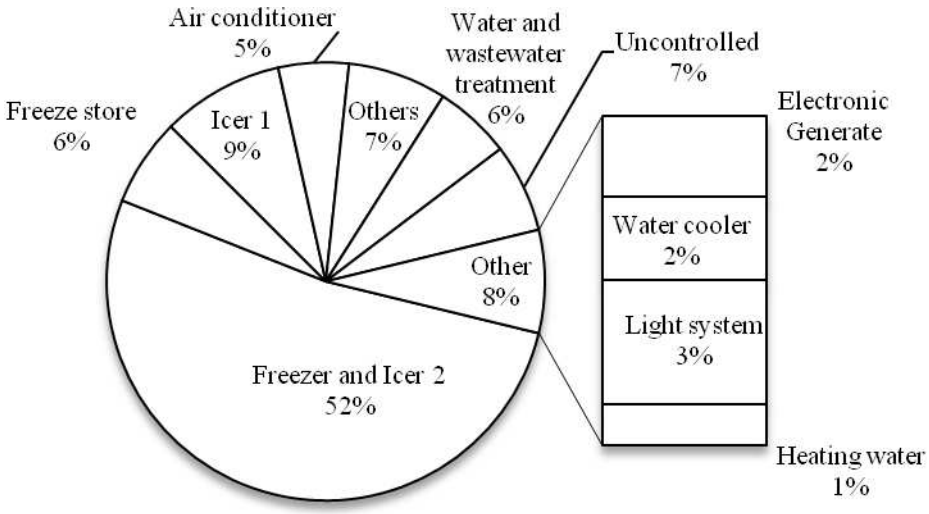

Figure 4.18 Consumed Electricity percentage

4.2.3 Water treatment plan

Water which use for the production and other activities in company come from well at depth 320m. The output capacity of this water treatment system is 500 m^3/day. Figure 4.19 shows the water treatment plan of DL-7 factory. The treated water then will be pumped to the water tower for storage.

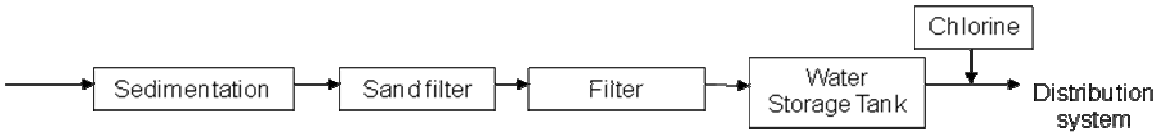

Figure 4.19 Water treatment system

4.2.4 Wastewater treatment system

Wastewater system of DL-7 was designed in 2000 and build in 2001 with treating capacity is 500m^3/day (Figure 4.20). But at the present time this system are overload and the output water is not qualified. Moreover, sludge from this wastewater system is discharge directly to the field without further treatment. From Figure 4.21 and Figure 4.22, the screening is now overloaded and the worker needs to help it by the manual screener.

Consequently, this wastewater treatment is cannot applicable with the present condition of factory. Beside, the most important parameter (oil and fat) was not considered when designed this system (Table 4.10). There a need to upgrading this system and the ignoring of administration can prove that the weakness in management and polices of this areas.

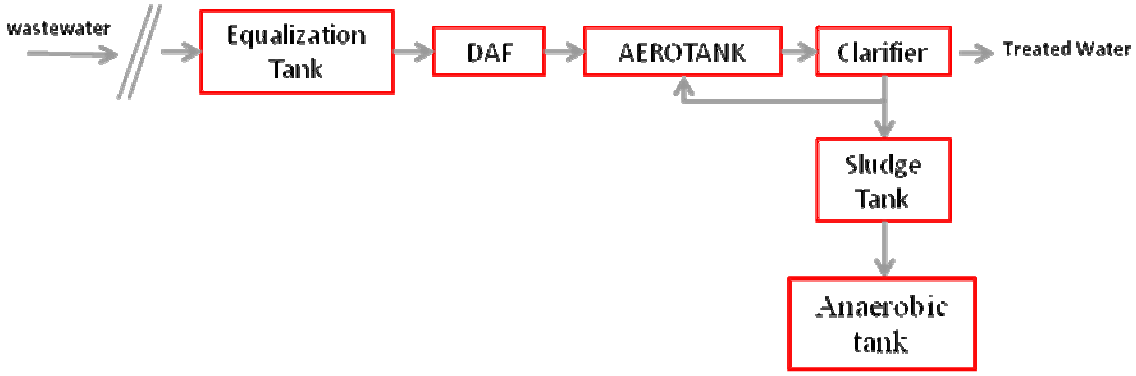

Figure 4.20 Wastewater treatment system

Table 4.10 Wastewater characteristic of DL-7 Factory

Influent	Effluent
Flow: Q = 500 m^3/day Retention time: T = 10 h BOD_5 = 900 mg/L COD = 1000 mg/L SS = 400 mg/L Total N = 40 mg/L Total P = 10 mg/L	 BOD_5 ≤ 20 mg/L COD ≤ 50 mg/L SS ≤ 20 mg/L Total N = 0.1 mg/L Total P = 4 mg/L

Figure 4.21 Sludge tank

Figure 4.22 Screen that are overload

4.3 Fishery eco-industrial network

4.3.1 Tra – Basa fish cultivation

a. <u>History on the development of Tra basa fish cultivation in the province</u>

Since 20th century, fish pond cultivation began to develop in An Giang province and tra fish is the major cultivated type. According to An Giang province Statistic Department, in 1985, over 90% of fish pond areas cultivated tra fish (ASD, 2005). At that time, because of the limitation of fish cultivating technique, there were a few of other types of fish were cultivated in the area but tra fish.

But nowadays, with the development of fish cultivation technique, many type of fishes are cultivated in the province such as anabas, snake-head fish, red tilapia, tra, basa etc. but only tra, basa fish can be exported to the international market and brings huge wealth for the farmers. Since 1990, economy of Vietnam changed vigorously due to the “doi moi”, An Giang province’s economy also began to develop rapidly. Fishery becames the potential industry for the farmers which can help them escape from poverty and change their life.

There are three types of tra basa fish cultivation in An Giang Province: floating cage, fish pond and fish pens. In the recent years, the fish cultivation areas increase quickly while the numbers of fish cages have decreased. Most of fish cage have been changed to rearing other type of fishes. (Table 4.11)

Table 4.11 Productivity and scale of some kinds of fish cultivation in the province

Description	Unit	1997	1998	1999	2000	2001	2002	2003	2004	2005
I Cultivation scale	ha	1,156	1,092	1,219	1,215	1,219	1,788	1,561	1,896	1,835
1.1 Cage	cage	2,102	2,070	2,439	3,086	3,237	4,053	3,178	3,504	3,058
1.2 Area	ha	1,156	1,086	1,214	1,210	984	1,465	1,123	1,217	1,124
- Pond	ha	948	910	1,038	1,080	722	1,415	1,056	1,167	1,017
- Beside the rice field	ha	208	176	176	130	262	50	46	17	53
- Pen	ha							22	33	53
II Productivity										
Total fish cultivation	Ton	41,133	40,728	60,742	80,032	83,335	111,157	136,231	152,507	179,412
- Cage	Ton	19,302	18,997	27,601	41,695	45,443	58,132	95,665	71,708	53,308
- Pond	Ton	21,831	21,731	33,141	38,337	37,892	52,524	40,566	80,799	**126.104**

Source: ASD, 2005

b. Fish cage:

Fish cage looks like the floating house on the river which people lives on the boat and below them is the cultivation cage (Figure 4.23). Fish cage cultivation has been begun in Tonle Sap, Cambodia and An Giang province is the first province that develops this type of cultivation in Vietnam in the 1950s decade. Step by step, with the favourable condition from natural condition in the province, fish cage cultivation play an important role in province's economic development. In the past time, breeding tra – basa fish can only catch in the natural environment but since 1996, basa fish could be born artificially which create a revolution in tra – basa fish cultivation.

Figure 4.23 Fish cage (floating cage) in An Giang Province

c. Fish pond:

Most of fish ponds are connected with the main river: by manmade irrigation system or naturally river (Figure 4.24). In some case, the ponds are totally separate with the main

rivers and pumps play an important role in this case (Figure 4.25). With the modern cultivation technique, the farmers understand role of water environment in cultivating so they try to unanimous about water in stream and water out stream. But the water flows planning only establish at the community level and don't have any legal linkage or commitment.

Figure 4.24 Fish pond

Figure 4.25 Pumps in fish pond

d. Fish pen

Farmers use net to place along the river side to cultivate the fish (Figure 4.26). This type of cultivation creates the best quality fish meat but seriously affect the environment and ecosystem along the river. At the present time, fish pen are banned in the areas because it violates the Water resources Law (Article 9 and 17).

Figure 4.26 Fish pen

e. Environmental issues in fish cultivation

Fish cultivation types' has been changed along with the fish cultivation technique and aquaculture technology. Nowadays, fish pond areas has been developed rapidly while the numbers of fish cages do not increase because of its disadvantaged in economic, cultivation technique and high risks (Table 4.12).

Table 4.12 Compare between fish cage and fish pond cultivation

Specification	Fish cage	Fish pond
Cultivation time	8 – 10 months	4 – 8 months
Breeding fish	Bigger size	Small size
Feeding food	Mostly homemade food	Industrial food
Disease control	Difficult	Easy
Initial investment*	1,400,000 VND/m^3	500,000 VND/m^2
Fish density	30 fishes/m^2	60 fishes/m^3
Environmental affect: Wastewater treatment Solid waste collection	 No Difficult	 Yes Easy

*Source: Thanh, 2003

- Fish pond

According to Tra, basa fish pond cultivation guideline, the farmers are encouraged to discharge wastewater to a wastewater pond at least half month before discharge to the main river (Fishery extension department, 2006). Sludge from the pond can be used as fertilizer after disinfection by lime. But at the actual state, there are rarely farmers follow this instruction because of the economic reason and weakly management at the district level.

- Fish cage

There are no solid wastes collecting system in the fish cage areas which can be conclude that all of solid wastes are disposed to the river. Moreover, the surface water in the fish cages areas do not qualify the Vietnamese standard TCVN 5942-1995 and TCVN 6774:2000 because the fish cages density is high in the Da Phuoc, My Hoa Hung and Chau Phu areas where taking the samples (Table 4.13). Beside, most of fish cages in these areas don't have septic tank and there are a large amount of solid wastes be discharged directly to the rivers. The water is only suitable for fishery cultivation but cannot be used by the community especially in the rural areas that still use river water for daily activities.

Table 4.13 Water quality in the fish cages areas

	Temperature (^oC)	pH	DO (mg/L)	BOD_5 (mg/L)	NH_3 (mg/L)	SS (mg/L)	Fe (mg/L)	Coliform (MPN.10^3/100 ml)
Dry season	30	5.86	3.83	7.78	0.30	20.1	0.23	113.76
Rainy season	29	6.50	3.70	4.10	0.22	66.7		2,357.75

Source: CRET, 2005

4.3.2 Fish Feed

There are two types of fish feed in An Giang province: industrial and homemade. About 97% of fish cage cultivation use homemade fish feed, the remaining use industrial. In fish pond cultivation, 95% using homemade feed while 5% uses industrial food.

a. Home made fish feed

There are many recipes for home made fish feed but almost all of the components are by-product of agriculture activities such as bran, soy bean residue (by-product of soy beans oil factory) and broken rice. Depending on types of cultivated fish, the fish food components are also different. Fish feed for tra basa fish do not use by-products from fish fillet process for feeding the fish because the farmers are afraid of "anti-biology": using fish meat (tra, basa) to feed tra, basa fish. All components are cooked by husk in the special tools (Figure 4.27), and then the food will be dry naturally in the normal temperature (Figure 4.28). Homemade fish feed have advantages in cheap price and salvage the by agricultural by-products but difficult to control the fish ration. There are some problems in using homemade fish feed as follow:

- Because of the difficulties in control the fish ration and high organic contents of homemade food, farmers often overfeed the fish, the excess food causes water pollution;
- The components that depend on agriculture activities are unstable
- Husk is used as combustion material that cause air pollution.

Figure 4.27 Homemade fish food cooker that use husk as combust material

Figure 4.28 Homemade fish feeding food

b. Industrial Food process

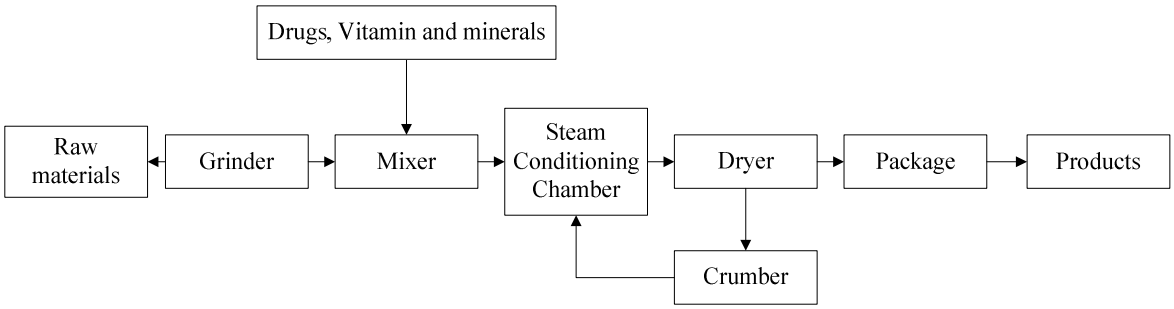

Figure 4.29 Industrial Fish Food Production

Each company has specific fish feed for each type of fish but the main components are bran, broken rice, corn, fish powder, required mineral and vitamins and have similar production process (Figure 4.29). Raw material was ground, mixed together and dried to become the final products. Beside the normal industrial food, there is a special food for organic fish cultivation (Figure 4.30). The environmental problems in this process are noise due to the equipment operation and air pollution (dust). Advantages of using industrial fish feed are ease in storage, controlling the fish ration, and safety for the fish (disease prevention). But for economic reason, the farmer prefers to use homemade fish feed to reduce the cultivation price. Administration and some factories encourage farmers using industrial fish feed by cultivation guidelines and training classes. AGIFISH encourages farmers in their supplied system using industrial food; supplies industrial food for farmers with deferred payment.

Figure 4.30 Organic fish feeding food and ist components

c. Biodiesel process

- Basa Tra fish fat pre-treatment (Figure 4.31)

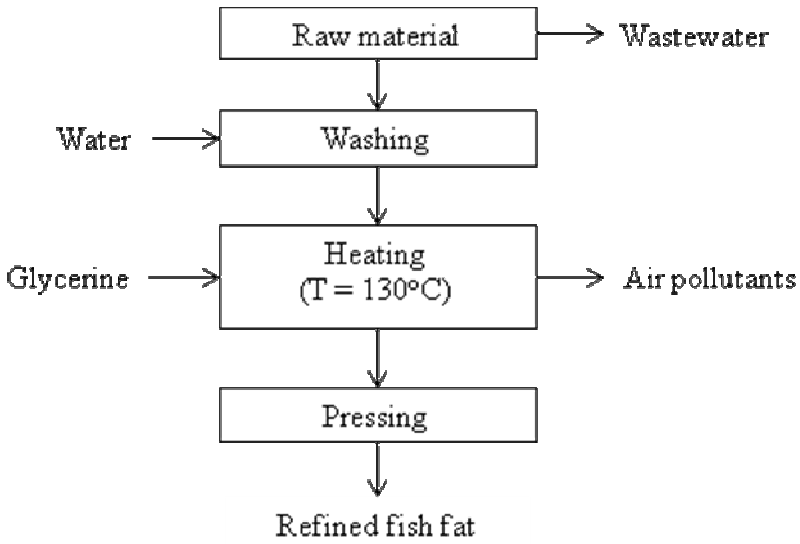

Figure 4.31 Fish fat refined process

In the past, Tra Basa fish fat was treated by the process in this step before selling or exporting. In this pilot model, the process begins with pre-treated fish fat and the manager buy pre-treated fish fat from small company. The factory will expand which including this step for producing biodiesel. Figure 4.31 present the fish fat pre-treatment procedure which uses glycerine (by product of biodiesel production) and fossil fuel as a combusting fuel. Fish fat refining improves the efficiency of biodiesel producing in the next step.

- Biodiesel producing process (Figure 4.32)
  - Fish fat refining
  - Measuring the volume of fish fat for the batch: 300L
  - Heating the fat until achieve 35^{o}C
  - Adding methanol (8% of fat ≈ 24L methanol)
  - Stirring the solution for 2 hours
  - Adding 36L Sodium methodize. The mixture temperature is 60^{o}C and let the mixture settle in 1 hour.
  - Remove the glycerine, checking the concentration of NaOH in the mixture after removal in order to calculating the amount of added acid phosphoric for neutralization)
  - Add 10ml H_3PO_4 10% for each 1 litter of fat (total 3 litters of H_3PO_4 for 300L fish fat). Let the mixture settle in 6 hours then remove the glycerol from the bottom of the container.
  - Cleaning the biodiesel by adding air to removing the impurities such as NaOH, H_3PO_4, CH_3OH
  - Drying biodiesel by vacuum dryer to ensure the water is completely removed from biodiesel.
  - Checking the quality
  - Colour: transparent, amber colour
  - Biodiesel don't have glycerol, glycerine ester and NaOH.

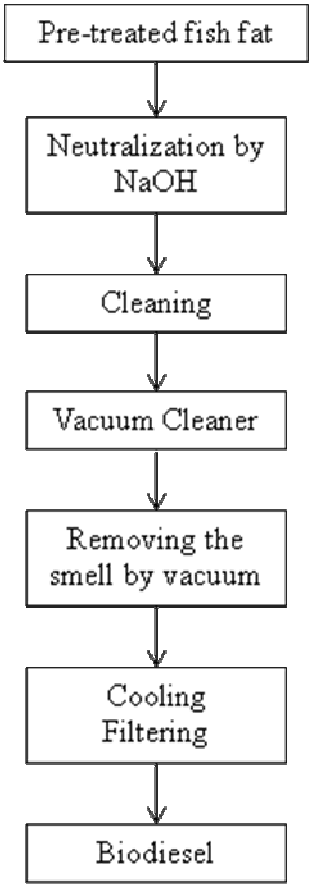

Figure 4.32 Biodiesel production process

- Equipment (Figure 4.33)
  - Raw material container: 1000 litters
  - Process container: 300 litters
  - Cleaning container: 300 litters
  - Methanol container: 164 litters
  - Methoxide container: 100 litters
  - NaOH, acid sulphuric and acid phosphoric
  - Biodiesel container: 300 litters
  - Glycerine and lees: 100 litters
  - Air supply machine
  - Cleaning container
  - Methoxide producing equipment
  - Pumps

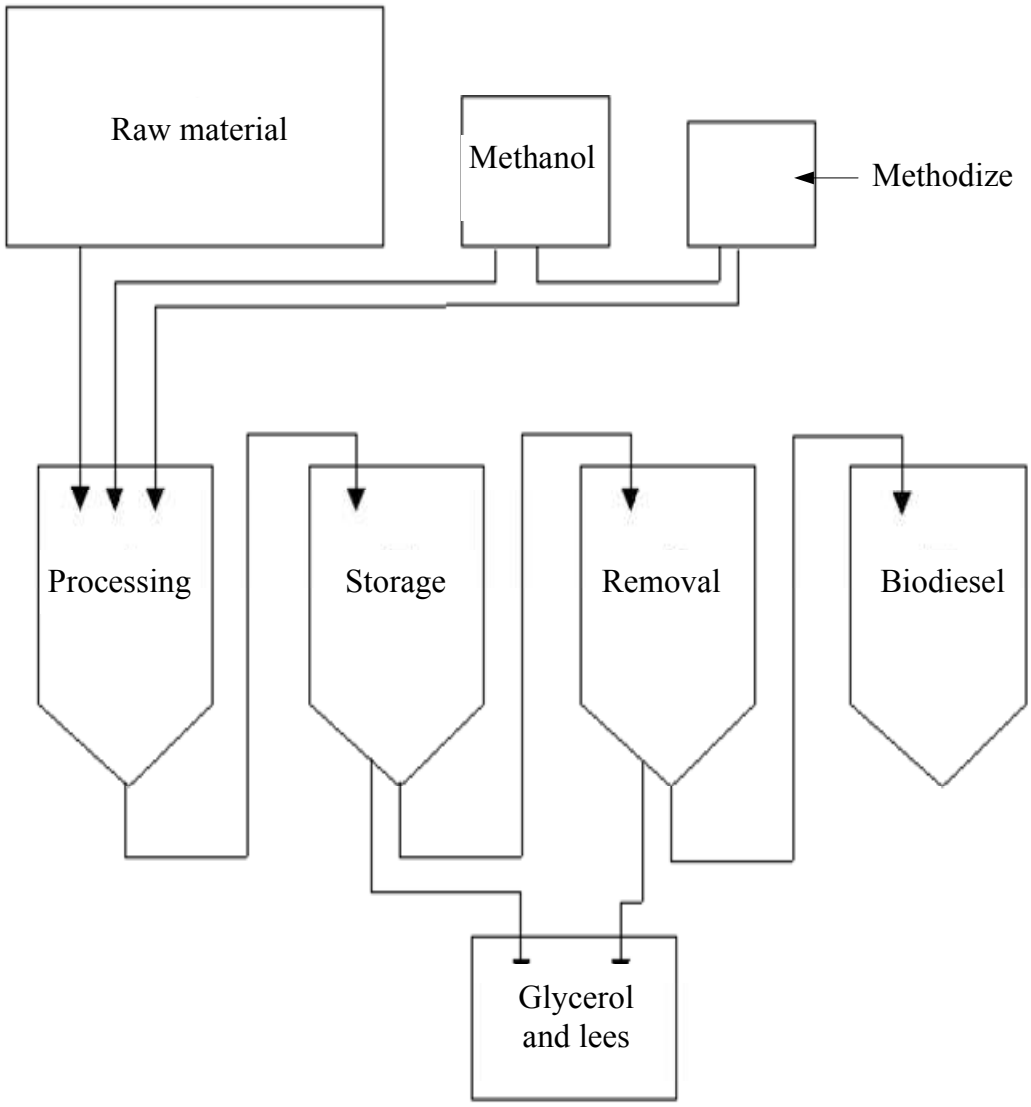

Figure 4.33 Production Flowchart

4.3.3 Fishey Eco-Industrial Network

After collected all needed data as presented in the Methodology, the fishery eco-industrial network was set up as a closed network as showing in the Figure 4.34. In this network, the Fishery Industry has been considered as a core industry while the others become a fishery – by-products-consumed industries. Hence, in the scope of this study, the industries in the network are only connected by the material flow, the physical relocation of the industries is not considered. Data that was used to calculate the quantitative material linkages in the network in 2005 was both statistic and experimental data. In this network, the needed materials were calculated by quantitative production capacity and raw materials in each industry in the province (Table 4.14).

Table 4.14 Needed materials in the network

	Unit	Provincial actual condition	Network use
Soya bean	10^3 Tons	1,709	34
Soybean residues	Tons	11,651	9,100
Broken rice	10^3 Tons	782	34
Husk	10^3 Tons	626	15.3
Bran	10^3 Tons	313	74.7
Breeding fish	Million fishes	200-300	166

Source: ASD, 2005

In the network, alternative fuels that use the wastes or by products of industries in the network was considered carefully. Biodiesel is only at the pilot section but its production potentials were high and environmental friendly as well.

a. Fish feed

The average Food Converting Ratio for Tra and Basa is 2.0 (2 kg food will convert to 1kg of fish meat) (DARD, 2005). So with the fish production of 145.5 kilotons of Tra Basa fishes in 2005 of An Giang province, the needed food amounts are 291 kilotons/year. According to the Statistic Department of An Giang Province, the Production of Industrial Fish Feed was 170 kilotons in 2005, so industrial fish feed was not sufficient with the needs in the province (ASD, 2005). The remains used homemade food which the recipe presents in Table 4.15. Most of the components of homemade fish feed come from agricultural by-products such as bran, broken rice and straw is being used as and combustion material for cooking the food. 100kg hush is used to cook 600kg of food (survey data), so 91.9 thousand tons of homemade fish food need 15.3 thousand tons of hush. (Figure 4.35)

Table 4.16 presents the components of industrial fish feeding food. There are many recipes for industrial and homemade fish food with similar components but different in the percentages. 100kg hush is used to cook 600kg of food (survey data), so 91.9 thousand tons of homemade fish food needs 15.3 thousand tons of hush. (Figure 4.35)

Table 4.15 Components of homemade fish feeding food

	Percentage (%)	Amount (kilotons)
Brian	54 %	49.2
Fish powder	35%	31.9
Soybean residue	10%	09.1
Mineral, vitamins	1%	0.9

Table 4.16 Industrial Fish Feeding Food Components

Component	Percentage (%)	Amount (kilotons)
Corn	12	20.4
Broken rice	20	34.0
Brain	25	25.5
Soybean	20	34.0
Fish Power	10	17.0
Mineral, vitamins and other components	13	22.1

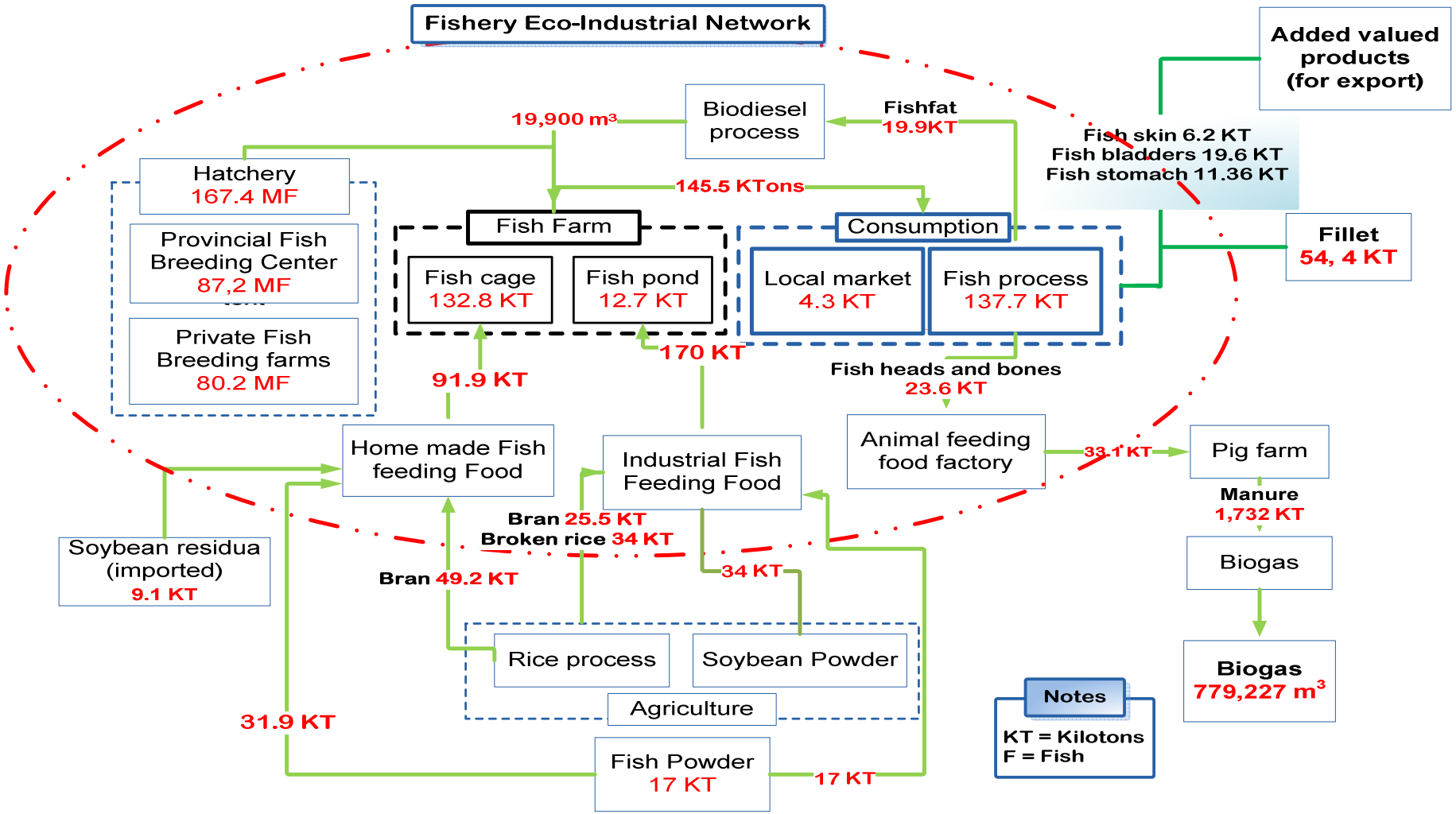

Figure 4.34 Fishery Eco-Industrial Network

b. Animal feed

The solid wastes and by products from fishery processing are being used to produce animal feed in order to create the supply chain in the Fishery Eco Industrial Network. The production capacity of animal feeding food is 33,094 Tons in 2005 while the supplied of fishery by product is 23.6 thousand tons wet weight/year. This by products is dried by the drying system and storage for animal food producing. The feed converting ratio for pig is 3.2 and the amount of pig meat is 23,000 Tons, so the amount of needed food for pig is 74,650 Tons (Chi, 2005). At the present time, animal food production in An Giang province is only 33,100 Tons, so remains is import from other province. Moreover, the small scales pig cultivation (home scale) is using homemade food (from agriculture residue or by product and from fishery processing) for feeding the pig.

Consequently, the provincial developing plans for the period 2005-2010 is increasing the animal food production and increase the components that the province can produce itself in order to support the cattle, poultry cultivation. The orientation for province development is following the national trend: industrialization and modernizations. That will lead to the percentage of home-made feeding food will decrease rapidly and be replaced by industrial food that have many convenience in production, cultivation and management.

c. Pig farm

In An Giang province, most of pig farms are in small scale (5-20 pigs), only four medium pig farm and one large scale farm (4000 pig). So the application of biogas for treating pig manures also can develop at the small scale for family usages (Table 4.17) .

Table 4.17 Pig farm in An Giang province

Cattle	Number	Meat production (tons)	Manure production * (tons)	Biogas production ** (m^3)
Pig	209,197	23,328	1,731,616	779,227

Source: ASD, 2005.

Note:

* Manures production ratio of pig manure is 33.7 Ton/year/454 kg meat

** Biogas production of pig manures is 340 -500 L/kg manure

d. Agriculture products

Soybean: cultivation capacity of soybean in An Giang province is 677,8 tons/hectare with the cultivation areas of 2,521 hectares (ASD, 2005))→ production capacity for soybean in the province is 1,709 thousand Tons in 2005.

Soybean residue: this is the residue from the soybean oil process that is used to increase the lipid percentage of the cattle food. According to the statistic data, in 2005, the province imports 11,651 tons of soybean residues.

Rice: during the rice processing from unhusked rice to final product (rice), there are many by products have been produced such as: bran (10%), broken rice (25%), husk (20%). The percentages of by-products depend completely into the rice husk removing and polishing process, the above is the typical one for export rice. In 2005, there is 3,127,600 tons of unhusked rice in An Giang which produce 312,760 tons of bran, 781,900 tons of broken rice and 625,520 tons of husks.

4.3.4 Fish processing

The fish wastes and by-products percentage ratios which show in Figure 4.35 come from the experimental study in fish processing company. Ten kilogram of Tra fish was killed and classified by hand according to following categories: fillet, skin, stomach, bladder, fat, redundant fish, fish bones and head. Each category was weight and calculated to get the final ratios which were used to quantitative the flow material in this Eco-industrial network.

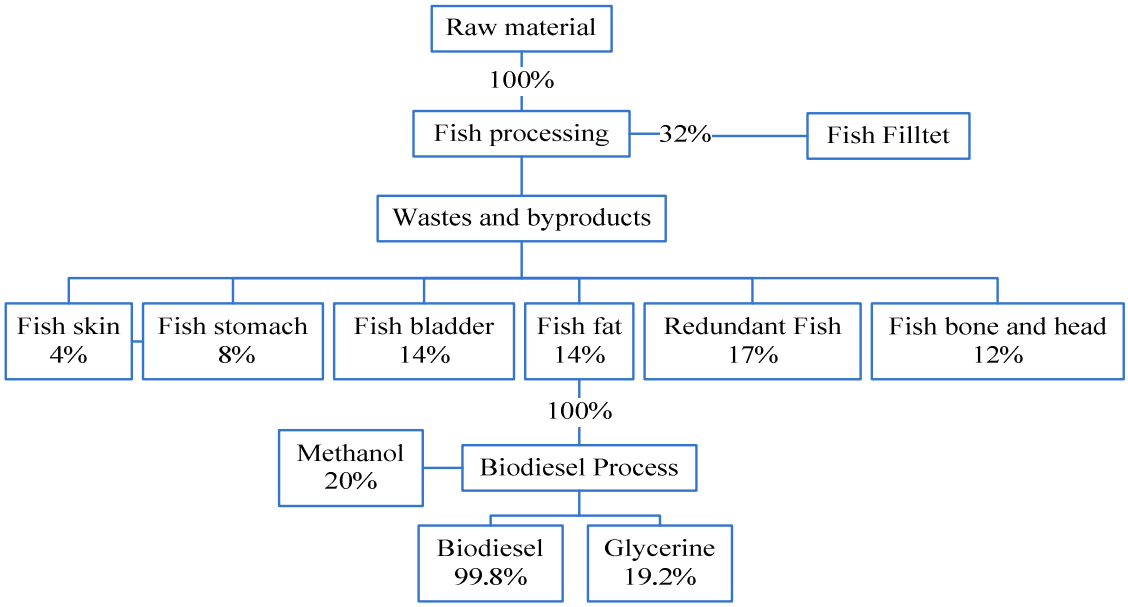

Figure 4.35 Components in fishery process and biodiesel

This network was technically assumed based on the actual condition of the provinces. Beside the quantitative and qualitative material flows to form an Eco-Network, police also play an importance role in establishment and management the network. Section 4.4 will examine the present policies that support the establishment as well as affect the operation of FEIN.

4.4 Policies

4.4.1 General information about legislation and administrative system in Vietnam

a. Legislation

There are several types of laws and regulation in Vietnam which are issued by different level administrators and have different power (Figure 4.36)

1. “Laws” and “Codes” are passed by the National Assembly;

2. “Resolutions”, “Ordinances” and “Acts” are passed by the Standing Committee of the National Assembly;

3. “Government decrees” are passed by the Prime Minister or the Vice Prime Minister;

4. “Regulations”, “Rules”, “Directives” and “Ordinances” are passed by the relevant Minister; and

5. “Regulations” are passed by local/provincial governments

As the common rule, the local/provincial government regulations should consistent with the laws and regulations that were enacted by higher levels. However, in some cases the provincial regulation are difference or even inconsistent with the central government laws. Because the province has been autonomous in regulation, the provincial government will enact and enforce their own regulation in case the central regulation has any unsuitable or inapplicable laws. Then, the disparity in laws will be inform to the higher level (where enacted the laws) for further corrections or guidelines.

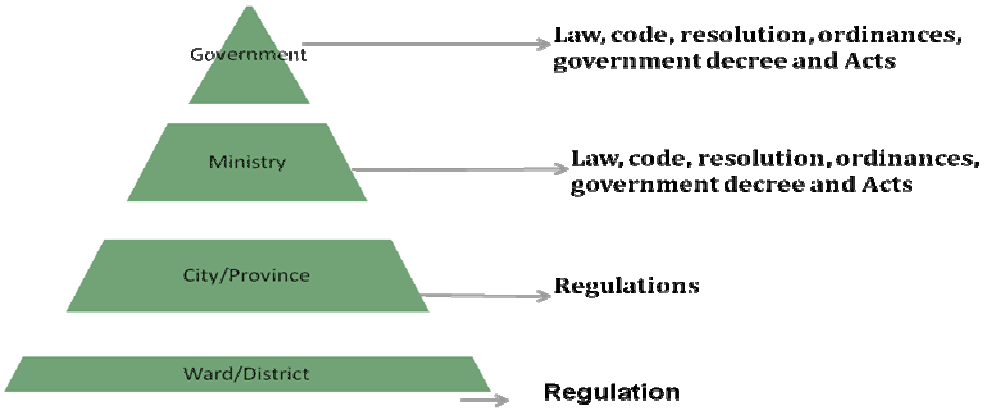

Figure 4.36 Administrative and legislative system in Vietnam

b. Administrative system in Vietnam

Government system in Vietnam has been divided into 3 levels: national, provincial level and district level. These organizations are linking closely together and have the operation frameworks at difference aspects which can be divided into many sections such as administration, social, industry, environment, economic, agriculture etc. In case of Fishery eco-industrial network, there are many policies in several aspects that affect the formation and operation of the network (Figure 4.37). Consequently, this study will focus on the policies in fishery, industry, environment, economic, social that affect the fishery eco-industrial networks.

The administration relationship between governments organizations have been divided into 2 type: “vertical” link and “horizontal link” (Figure 4.38). For example, from the figure 4.38, there are two relationships: ministry departments (horizontal link) and between department at the ministry level and its branch department at the provincial level. As a theory, if there is the ministry of one subject, there will also have the department/ branch office that belong directly to this ministry at the smaller level. The table above presents the function of main ministries in many subjects in Vietnam. At the provincial or commune level, the correlative organizations have the same function but at the smaller power boundary. Table 4.18 presents the function of some key administrative organizations of Vietnam Government.

Figure 4.37 Polices that affects FEIN

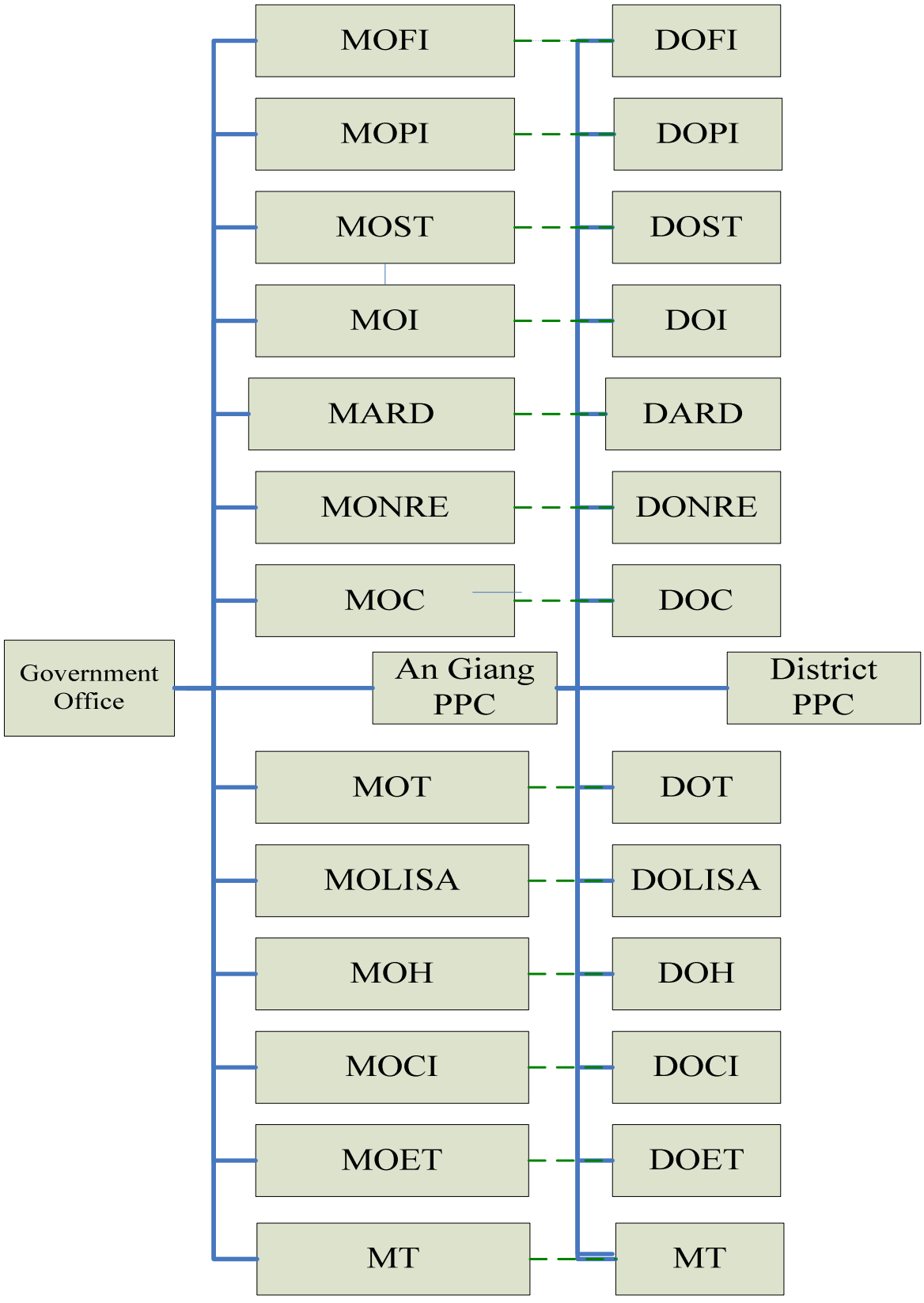

Figure 4.38 Vietnam key administrative organization

4.4.2 Legislation and the formation of FIEN

Legislation is a major and effective tool to plan, form appropriate Eco-industrial Network and support its implement successfully. In FEIN case, there is a need for a comprehensive cooperation of many state organizations in the provinces. But from the function of each organization, there is an overlaps and complicated situation especially in FOFI, MONRE and MARD. For example: the technical support for fish farm and hatchery are conducted by DOFI while DOST/ DONRE have some training courses on "Rural Development" that relate to improving Fishery cultivation technique. There is a need for cooperation between Departments in the region. Moreover, the management tasks between each levels make the administration work ineffective and slowly. For example, the fish pen cultivation has been ban by the government and be deployed in the provinces and communes. But in the rural areas or even in the fringe areas of An Giang province, this type of cultivation still exist and being ignored by the local administrators. The law deploying process from the government to local administrative system is sluggish and even the law have some gap or unclear points that the local government cannot implement or misunderstand, so they send an official letter to higher related department and waiting for the official answer letter or an decree on implementing guideline. It take such a long time since identify the problems to receiving the necessary attention and response from ministry and make the deploy process even slower. The other weakness of local administration is the lack trained manpower to implement the policies and polices requirements such as inspection or monitoring. Hence, like other administration systems, the poor staffs can lead to the deploying of policies to the difference way as the ministry level expected.

At the provincial level, the highest administrative organization is An Giang People Committee will manage the activities of network and being a "linking station" between the local and higher administration (ministries, government). The operation of each department is the same as the function of relevant ministry but at the provincial level. Roles of important department on FIEC operations:

Department of Industrial:

- Advice PPC on issuing legislation documents, administration procedure, solutions in order to support the industry that relevant with the provincial development.
- Cooperation with other departments to develop industrial plan in accordance with not only the general the national/provincial development plan but also the specific industries developing plan Deploy the industrial related decree from PPC or higher "horizontal linkage" (Ministry of Industry)

Department of agriculture and rural development

- Planning the agriculture, forestry areas, cooperating with other departments to conduct a plan that meet the economic raw material demand not only in the province area but also for other province and export requirement.
- Technical supporting for agriculture and forestry activities, plant protection, veterinary, monitoring the using of chemical in agriculture: herbicide, pesticide, fertilizer, and drug for animal, agriculture infrastructure.
- Prevent, keep quarantine and curing epidemic diseases on agriculture plan, animal in the provincial areas.
- Guiding the branch office in the commune area deploy the agricultural decree, laws

- Organize the training class for farmers, staffs to updates the new cultivation, rearing, processing technique, applying advanced technology in agriculture production
- Developing the irrigation network in the area, cooperating with other Department of Transportation, Department of Fishery to plan a waterway and land use, surface water use plan in order to develop a comprehensive plan for the province
- Implement the flooding protection task, improve and maintenance the dike, canals system to protect the people. Hence, ensure the normal activities; cultivations of the people can be normally conducted in the flooding areas.
- Guiding on developing the home-scale enterprise, farming, cooperative economic enterprise, SMEs.
- Have the responsibilities on agriculture, forestry promotion programs in the province and guiding for the office in the lower level implement these program
- Guiding on the agriculture processing, developing the traditional handicraft, industries in the rural area.
- Have the responsibilities for the clean water in the rural area program in the province.

Department of Planning and Investment

- Develop the procedure, legislation which support and create the convenience environment to invite the investment that suitable with the provincial developing strategy.
- Collection, summarizing the information and planning from other departments in order to develop a comprehensive plan for the province before submit it to higher level
- Cooperation with the State treasury, Department of tax to balance the state fund and managing the provincial state fund, investment fund … in order to report the economic plan to the highest level for fund requirement.

Department of Science and Technology

- Guiding and supporting enterprise on trade mark registration, product trade name, and international management standards: ISO 9000, HACCP, GMP in order to improve the product qualities in the economic market.
- Help enterprise upgrading technology, studying, applying the new technology and technology transfer.

Department of Natural Resources and Environment

- Deploy the environmental legislations, programs from the national level and have the responsibility to report the environment conditions, forecast the environment status in the provinces.
- Manage, monitor and evaluate the environmental related activities, facilities, system.
- Technically evaluate the Environment license, EIA report before submit to PPC for final approval.
- Issue, revoking the certificate of compliance with the environmental standards
- Training, educating, updating the environmental protection, legislation especially in the rural areas
- Technical supporting on environment technology, legislation, and developing international relationship with other organization in environmental fields.

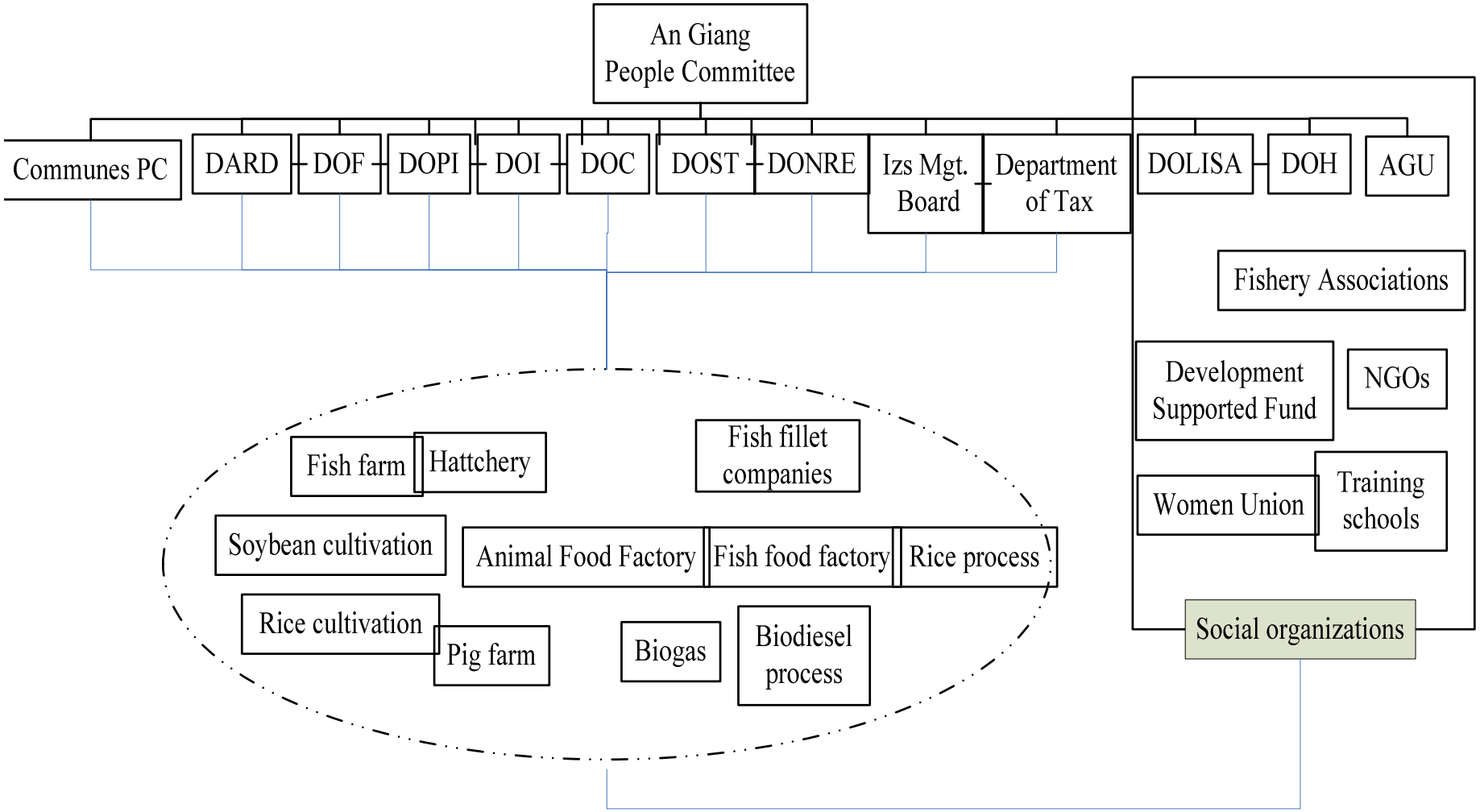

Figure 4.39 Local administrative organizations and FIEN

4.4.3 Related polices that affect the formation, operation of FEIN

a. Policies of Aquaculture

Fishery in An Giang is an important industry and has the supporting from policies and legislation. Moreover, the structure of fishery cultivation and processing has changed from old technology to modern technology and call for advanced and environmental friendly technology. The target for fishery development in An Giang province is "sustainable development", not only developing the economic but also protecting the environment for long-term development (Decree 859/QD-UBND dated 27 April 2006, Fishery development plan 2010 – 2020). To carry out this target, policies on fishery promotion have been issued in order to increase the fishery development rate. Table 4.19 shows the policies in aquacultures that affect the operation of FIEN (Table 4.19)

Table 4.18 List of polices in aquacultre that promote and affect the operation of FIEN

Number	Date	Issued by	Content
56/2005/ND-Cp	26/04/05	Government	**Agriculture and Fishery Promotion** • Technical support • Training programme: seminar, conferences, trade fairs • Providing consultancy services on policies, technical, market, applying advanced production • Support SMEs, fishery and rural crafts • Fishery promotion fund
59/2005/ND-Cp	04/05/05	Government	Production and business conditions of a number of fisheries trades
17/2003/QH11		National Assembly	Fishery law
22/2006/QD-BTC	04/04/06	Ministry of Financial	Fishery management fee
2944/2005/QĐ-UBND	27/10/05	An Giang PPC	An Giang fishery resources protection and development program
35/2003/CT-UB	25/12/03	An Giang PPC	Promotion on cooperation and farm of agriculture, forestry and aquaculture • Support from the administrative organization: technical support, financial management • Investment incentive
1465/QD-UBND	01/08/06	An Giang PPC	Changing agriculture economic structure and fishery development • Planning for a Eco fishery cultivation areas follow international standard (SQF 1000 and Naturland) • Encourage fish fillet company applying SQF 2000 standard • Training
859/QD-	27/04/06	An Giang	Changing the general fishery development

UBND		PPC	2010 – 2020.
10/2006/QD-TTg	11/01/06	Prime Minister	Fishery General development planning until 2010 and orientation to 2020.
118/TB-UBND	10/08/05	An Giang PPC	Surface water environment protection in fishery cultivation and water transportation means
02/2006/TT-BTS	20/03/06	Ministry of Fishery	Fishery Trading, processing conditions :
11/2006/QD-BTS	19/07/06	Ministry of Fishery	Law Violation in Fishery

At the provincial level, administration was trying to control the environmental issues that relate to fishery cultivation activities. Decree 901/2000/QD.UB of An Giang People Committee stipulate that all of fish cages in An Giang province must:

- Submit EIA report, identify the wastes discharged point and solutions
- Have the solid waste container and join the solid wastes collection system in the fish cages areas
- Place the cages at the prescribed areas
- Have the sanitation toilet on the cage
- Choose the high quality fish feeding food in order to reduce the environmental affects.

Fishery Developing Plan 2010 – 2020 of An Giang province have some important issues that support the formation of FIEN and resemble with the study objectives as follow:

- Upgrading technology in fish cultivation and processing.
- Encourage farmers and enterprises apply international standard for Quality management such as SQF, HACCP.
- Strengthen the linkage between enterprise and fish farmers in products consumption thought the network.
- Encourage the capital and technology investing participation of economic components in order to develop the trading of all aspect of fishery industry.
- Beside lend with low interest, encourage the commercial bank invest directly in the fishery industry's infrastructure
- Building and improve the production linkage in fishery industry that can develop a multi-components economic.

- Planning the raw material production areas, organize the production according to the "concentrationlism" trend in order to create the favorable condition for infrastructure development for production, processing and consumption.
- Consolidate the actual Cooperative; step by step developing new fishery cooperative especially in the planed cultivating areas.
- Building the stringent linkage between enterprises and fish farmers through economic contracts.

b. Industrial polices

The figure below presents the relationship between administration offices in industry zone forming, building and management in Vietnam. There are two level of industrial zone: ministerial level and provincial level and each level have the specific administrator systems that link and interact together. There are two organizations that directly administrate Industrial Zones: Government (for Industrial Zones at the ministry level) and People

Committee (for Industrial Zones at the provincial level) where other state organizations advise and submit the related policies documents for final approval.

In case of FIEN, there are the industrial related elements being affected by industrial legislations such as fishery processes, animal and fish food processing and biodiesel production whether its location in the industrial zones or not.

According to the national industrial zone development plan until 2015 (Decree no 1107/QD-TTg), there is a need to synchronize the infrastructure and facilities in the industrial zones especially the wastewater treatment system follow the national strategy "sustainable development". The important points in this plan are as follow

- Building the large scale solid wastes treatment in the important economic development areas.
- The developing of industrial zones must be comprehensive with the social, economic conditions of each provinces, land use planning, national strategy, domestic area plan etc
- Reserving for the Land for develop and link Industrial Zones to the Group of Industrial Zones. For the area have only agriculture land, the investment need to implement in separated period in order to increase the efficiency of the economic structure changing.

Decision 36/CP of Government, dated 24 April 1997 on the Regulations on Industrial Zone, Processing Zone and Advance Technology has defined the role of Government administration on Industrial Zones as follow:

- Developing strategies, plans and policies on Industrial Zones development
- Issue the legislation that relate to Industrial Zones operation
- Stipulating and guiding on the implement, development and management the performance of Industrial Zones
- Issue, change and revoke the related license and implement related administrative procedures.
- Training, educating staff
- Monitoring, examine the operation or Industrial Zones and solving the problems.

The national plan for industry development has been present in decision no 73/2006/QD-TTg by prime minister that shows the industry development viewpoint of Vietnam: developing industry compliance with environment benefits and local conditions. At the present time, the industry development in the Mekong delta must integrate with agriculture-aquaculture-forestry and related industries. The industrial development orientations for Mekong delta are as follow

- To concentrate on the development of export-led farm, forest and aquatic product processing industries
- To develop gas-fuelled industries and mechanical engineering in service of agriculture, especially the industries of post-harvest processing and preservation of farm, forest and aquatic products and shipbuilding engineering.
- To intensify the attraction of investors to fill up the existing industrial parks. To carefully consider the construction of new industrial parks along routes with favourable traffic conditions

- The construction of industrial parks shall be followed by the construction of urban centres to provide dwelling houses and socio-cultural services to labourers.
- The construction of industrial zones and parks must be associated with the construction of waste treatment systems to protect the environment
- To develop industrial zones and spots to promote the development of cottage and handicraft industries and rural industries.

The above polices create the good premise for the forming of Eco-industrial network especially the agro-base network in this thesis.

c. Environmental Policies

New environment protection law was enacted in 12 December 2005 and has the valid time since 2006. This law replaced the old one that had many unsuitable and inadequate with the present situation of the country (Table 4.20).

Table 4.19 List of Environmental policies that relate to the forming/operating of FIEN

Policies no	**Issue date**	**Issue office**	**Content**
01/2003/TTLT-BTNMT-BNV	15/07/03	MONRE	Function, responsibility of specialized organization on Local Environment and natural resources management
01/2004/NQLT-TLD-BTNMT	15/11/04	MONRE	Environment protection and sustainable development
02/2004/CT-BTNMT	02/06/04	MONRE	Ground water management
03/2004/QD-BTNMT	02/04/04	MONRE	Using imported by-products, waste materials as the process' raw material
08/1998/QH10	20/05/98	National Assembly	Water natural resources Law and En
08/2006/TT-BTNMT	08/09/06	MONRE	Guiding on Strategy EIA., EIA Commitment on Environmental Protection.
104/2004/TTLT-BTC-BXD	08/11/04	MOF	Clean water consumption price for urban, industrial zones, and rural domestic area
125/2003/TTLT-BTC-BTNMT	18/12/03	Government	Wastewater fee
15/2005/TTLT-BTC-BTNMT	22/02/05	MONRE	using the economic development fund for environment protection
152/1999/QĐ-TTG	10/07/99	Government	Solid wastes management strategy for urban area and industrial zone
16 /2006/QĐ-UBND	12/04/06	An Giang PPC	Surface water fee
179/1999/NĐ-CP	30/12/99	Government	Implement guiding for "Water natural resource laws"
19/2003/QĐ-BTNMT	30/12/03	MONRE	Procedure on certifying Serious environmental pollution factory
23/2005/CT-TTG	21/06/05	Government	Solid waste management in the urban and industrial area
26/CP	26/04/96	Government	Sanction, against administrative violations in environmental protection

2718/2005/QD-UBND	30/09/05	An Giang PPC	Environment protection fee for domestic water
328/2005/QD-TTg	12/12/05	Government	Environmental pollution control plan until 2010
34/2005/Q§-TTg	22/02/05	Government	Government Action Plan about Environmental Protection in the industrialization, modernization time.
41-NQ/TW	15/11/04	Ministry of Political	Environmental Protection in industrialization, modernization time.
48/CP	12/08/98	Government	Sanction against administrative violations in aquatic resources protection
67/2003/ND-Cp	13/06/03	Government	Wastewater fee
80/2006/NĐ-CP	09/08/06	Government	Guiding on Environmental Protection Law
81/2006/NĐ-CP		Government	Administrative violation in Environment
93/2003/TT-BTC	06/10/03	Ministry of Financial	Environment Protection fund management
1582/1999/QĐ-UB	19/07/99	An Giang PPC	Surface water management in Fish cage cultivation
901/2000/QĐ.UB	27/04/00	An Giang PPC	Approving plan for fish cage location

Decision 623/CV NN&PTNT-TN&MT dated 02/08/2004 of DONRE and DARD about stipulate that fish pond that have large scale (cultivation areas larger than 5ha) must have the wastewater treatment pond before discharge the wastewater to main river and must send Six-monthly wastewater monitoring report to DORNE.

Decision 894/2004/QD-UB (dated 25/05/2004) on "Temporary regulations on fish, poultry, cattle cultivation" stipulate clearly the distance between each type of cultivation farm and urban areas, school, factory, market.

- The cattle, poultry farm must have manures treatment, wastewater treatment and far away from the water source at least 20 meters
- Before construct breeding facilities, there are a need to have the permission from DARD for location and EIA approving.

Decision 02/2005/Ctr.UB dated 19/05/2005 about the action plan for environmental protection of An Giang province in the industrialization-modernization period until 2010 that favor the forming of Eco-industrial Fishery Network as following issues

- Limit the pollution increasing rate
  - 100% new manufactures must apply Cleaner Production or install environmental standard qualified equippments, wastes treatment.
  - Planning and rearrangement the process that link with environmental protection of handicraft industries, trade villages (overcome the evrironmental pollution problems or moving to the industrial zones); handle all of serious environmental polluted manufactures.
  - Control the chemical safetyness especially toxic chemical; minimize the produce/use of plan protected chemical that cause environmental pollution;

- Prevent surface water polllution in Tien and Hau river, intergrated irrigation system in order to make sure the water quality in the river qualify the Water quality standards for Agriculture and Fishery Cultivation.

- Improve the environment quality
  - In Long Xuyen and Chau Doc town, complely operation the drainage system, and central wastewater treatment sytem; 90% of domestic, industrial and serviced solid waste will be collected; investe on the complement of central solidwastes treament system; 50% towns, domestic areas of districts have drainage system;
  - Improve the cultivation technique in agriculture production; reduce the excess of fertilizer, pesticide in the field. Beside, the land quality protection and improvement must be focus to implement the sustainable development.
  - Animal rearing farm must follow these decisions: 894/2004/QD-UB dated 25/05/2004 on Temporary regulations for cattle, poetry, fishery cultivation; Decisions 1582/1999/QD-UB dated 19/07/1999 on Surface water protection in Fish cage cultivation; Decision no 901/2000/QD.UB dated 27/03/2000 on proving fish cage locations in An Giang Province.
- Industrial zone, handicraft areas, trade village
  - Establish Environmental Protection Fund by set up the polices for enterprise lend money for constructing waste treatment system or upgrading technology to reduce the environmental pollution, moving enterprise to industrial zones, industrial centers
  - Have the solutions for enterprises that cause serious environmental pollution: suspending the operation or moving to other places. Essentially overcome the environmental pollution problems in trading village, industrial enterprises, and handicrafts enterprises together with forming industrial cluster in order to ensure the environmental treatment.

Chapter 5

Conclusions and Recommendations

An Giang province has the natural condition favoured for the development of economy. With the high density water system, fishery industry is an important industry in this province. After investigating and examining the present condition of the province, this study explored the possibility of setting up a fishery based Eco-Industrial Network. The conclusions draws from this study are presented below:

5.1 Conclusions

1. Diversity economic structure in An Giang province is the great potential for establish an Eco-Industrial Network. This network solved the actual environmental problems in the province such as solid wastes, combustion fuel by re-arranging and linking related industries together.

2. Linkages between each industry in Fishery Eco-Industrial Network were build base on the actual material flow of the province. New environmental friendly industries are also investigated and added to this network such as biodiesel, biogas. All of materials were quantified, analysed and connecting to other industries based on its production capacity, needed material.

3. The supports from national/local administrations on co-operations between each industry and the concerns of government on environmental issues in the province. This Fishery Eco-Industrial Network can become a model for similar agro-based industrial zones in the regions in order to create a sustainable development model.

4. Some conclusions from Cleaner Production in representative fish fillet process company:

- Most of solid wastes and by products in the factory were organic and can be recycled within the process to produce added value products.

- Wastewater treatment system is overloaded and need to upgrade. To increase the system efficiency, separated wastewaters was suggested.

- The experimental results in this representative company were used to quantify the material flows in the network

5. At the present time, there are no legislations about Industrial Ecology in Vietnam. The concept “Industrial Ecology” still unfamiliar with administrations and policy makers. This study investigated some related polices that supported the formation of the Eco-industrial Networkhe formation

6. The overlapping and inappropriate operations of government organizations make the management tasks especially in environmental monitor task. There are an overlapping and unclear in functions of some administrative organizations in some fishery activities that need well co-ordinating between DARD, DOFI and DONRE for better management task in fishery sector in the province.

5.2 Recommendations for future study

1. Linkages between each industry need to be examined further in order to strengthen the connection in the network. At the present time, these linkages was set up by marked forces and there is a need in well planning for the future development of this network.

2. In this study, the re-locating industries were not concerned when forming this network. In future study, this issue need to be investigated.

3. The roles of market-based linkages and administration organizations in regulating and managing the material linkages within and among industries in the areas need further examine.

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Appendices

Appendix A

Vietnamese Standards

1. Vietnamese Standards for Surface Water Quality: TCVN 5942-1995

a. Scope

1.1 This standard specifies parameter limits and maximum allowable concentrations of pollutants in surface water.

1.2 This standard is applicable to control of quality of a surface water source.

b. Limitation Value

2.1 Parameter limits and maximum allowable concentration of pollutants in surface water are specified in table A1.

2.2 Standard methods of analysis of parameters and pollutant concentrations of surface water are specified in available current TCVNs.

Table A1 Parameter Limits and Maximum Allowable Concentration of Pollutants in Surface Water

Nº	Parameter and Substance	Unit	Value	
			A	B
1	pH value	--	6 - 8,5	5,5 - 9
2	BOD_5 (20ºC)	mg/L	<4	<25
3	COD	mg/L	<10	<35
4	Dissolved oxygen	mg/L	³ 6	³ 2
5	Suspended solids	mg/L	20	80
6	Arsen	mg/L	0,05	0,1
7	Barium	mg/L	1	4
8	Cadimium	mg/L	0,01	0,02
9	Lead	mg/L	0,05	0,1
10	Chromium, Hexavalent	mg/L	0,05	0,05
11	Chromium, Trivalent	mg/L	0,1	1
12	Copper	mg/L	0,1	1
13	Zinc	mg/L	1	2
14	Manganese	mg/L	0,1	0,8
15	Nickel	mg/L	0,1	1
16	Iron	mg/L	1	2
17	Mercury	mg/L	0,001	0,002
18	Tin	mg/L	1	2
19	Ammonia (as N)	mg/L	0,05	1
20	Fluoride	mg/L	1	1,5
21	Nitrate (as N)	mg/L	10	15
22	Nitrite (as N)	mg/L	0,01	0,05
23	Cyanide	mg/L	0,01	0,05
24	Phenol compounds	mg/L	0,001	0,02
25	Oil and grease	mg/L	not detectable	0,3
26	Detergent	mg/L	0,5	0,5
27	Coliform	MPN/100 ml	5000	10000
28	Total pesticides (except DDT)	mg/L	0,15	0,15
29	DDT	mg/L	0,01	0,01
30	Gross alpha activity	Bq/L	0,1	0,1
31	Gross beta activity	Bq/L	1,0	1,0

Note

- Values in the column A are applied to the surface water using for source of domestic water supply with appropriate treatments.
- Values in the column B are applied to the surface water using for the purposes other than domestic water supply. Quality criteria of water for aquatic life are specified in a separate standard.

2. Industrial wastewater discharge standards: TCVN 5945-1995

a. Scope

1.1 This standard specifies limit values of parameters and concentration of substances in industrial waste water.

In this standard industrial waste water means: liquid water or waste water produced by reason of working or production processes taking place at any industrial, servicing and trading premises, etc.

1.2 This standard is applied to control of quality of industrial waste waters before being discharged into a water body.

Water body means: inland water, include any reservoir, pond, lake, river, stream, canal, drain, spring or well, any part of the sea abutting on the foreshore, and any other body of natural or artificial surface or subsurface water.

b. Limitation Values

2.1 Values of parameters and maximum allowable concentrations of substances in industrial waste waters before being discharged into water bodies are shown in the table A1.

2.2 Discharge standards applying for waste waters produced by specific industry such as paper, textile or oil industries are specified in a separate standard, respectively.

2.3 Industrial waste waters containing the values of parameters and concentrations of substances which are equal to or lower than the values specified in the column A (table A2) may be discharged into the water bodies using for sources of domestic water supply.

2.4 Industrial waste waters containing the values of parameters and concentration of substances which are lower than or equal to those specified in the column B (table A2) are discharged only into the water bodies using for navigation, irrigation purposes or for bathing, aquatic breeding and cultivation, etc.

2.5 Industrial waste waters containing the values of parameters and concentrations of substances which are greater than those specified in the column B but not exceeding those specified in the column C (table A2) are discharged only into specific water bodies permitted by authority agencies.

2.6 Industrial waste water containing the values of parameters and concentrations of substances which are greater than those specified in the column C (table A2) shall not be discharged into surroundings.

2.7 Standard methods of analysis of parameters and concentration of substances in industrial waste waters are specified in available current TCVNs.

Table A2 Limit value of Industrial Wastewater

No	Parameters and Substances	Unit	Limitation Values		
			A	B	C
1	Temperature	ºC	40	40	45
2	pH value		6 - 9	5,5 - 9	5 - 9
3	BOD5 (20ºC)	mg/L	20	50	100
4	COD	mg/L	50	100	400
5	Suspended solids	mg/L	50	100	200
6	Arsenic	mg/L	0,05	0,1	0,5
7	Cadmium	mg/L	0,01	0,02	0,5
8	Lead	mg/L	0,1	0,5	1
9	Residual Chlorine	mg/L	1	2	2
10	Chromium (VI)	mg/L	0,05	0,1	0,5
11	Chromium (III)	mg/L	0,2	1	2
12	Mineral oil and fat	mg/L	Not detectable	1	5
13	Animal-vegetable fat and oil	mg/L	5	10	30
14	Copper	mg/L	0,2	1	5
15	Zinc	mg/L	1	2	5
16	Manganese	mg/L	0,2	1	5
17	Nickel	mg/L	0,2	1	2
18	Organic phosphorous	mg/L	0,2	0,5	1
19	Total phosphorous	mg/L	4	6	8
20	Iron	mg/L	1	5	10
21	Tetrachlorethylene	mg/L	0,02	0,1	0,1
22	Tin	mg/L	0,2	1	5
23	Mercury	mg/L	0,005	0,005	0,01
24	Total nitrogen	mg/L	30	60	60
25	Trichlorethylene	mg/L	0,05	0,3	0,3
26	Ammonia (as N)	mg/L	0,1	1	10
27	Fluoride	mg/L	1	2	5
28	Phenol	mg/L	0,001	0,05	1
29	Sulfide	mg/L	0,2	0,5	1
30	Cyanide	mg/L	0,05	0,1	0,2
31	Coliform	MPN/100 ml	5000	10000	--
32	Gross alpha activity	Bq/L	0,1	0,1	--

3. Water quality – Fresh water quality guidelines for protection of aquatic life – TCVN 6774:2000

1 Scope

This standard is applied as a Quality Evaluation Guideline of Surface Water that suitable and safety for aquatic life.

This standard is applied as an basic on establishing the Water Resources Quality Management Requirements which purpose on aquatic life protection.

2 Fresh water quality standards for aquatic life protection.

To protect the aquatic life, all of social – economic activities that relate to wastewater and exploiting, using surface water must not cause the changing of water quality parameters differ from the values in Table 1.

Table A3 Water quality for aquatic life protection

No	Parameters and Substances	Unit	Limitation Value	Note
1	DO	mg/L	5	Day average
2	Temperature	^{0}C	Natural temperature of water area	Correlative with season
3	BOD_5 (20^0 C)	mg/L	<10	
4	Organic Chlorides Plant Protection medicine Aldrin/Dieldrin Endrin B.H.C DDT Endosulfan Lindan Clordan Heptaclo	 mg/L mg/L mg/L mg/L mg/L mg/L mg/L mg/L	 < 0,008 < 0,014 < 0,13 < 0,004 < 0,01 0,38 0,02 0,06	
5	Organic Phosphorous Plant Protection medicine Paration Malation	 mg/L mg/L	 0,40 0,32	
6	Herbicide 2,4D 2,4,5T Paraquat	 mg/L mg/L mg/L	 0,45 0,16 1,80	
7	CO_2	mg/L	< 12	
8	pH		6,5 - 8,5	
9	NH_3	mg/L	2,20 1,33 1,49 0,93	pH = 6,5; T^0C = 15 pH = 8,0; T^0C = 15 pH = 6,5; T^0C = 20 pH = 8,0; T^0C = 20

10	Cyanide	mg/L	£ 0,005	
11	Copper	mg/L	0,002 - 0,004	Depend on water hardness ($CaCO_3$)
12	Arsenic	mg/L	£ 0,02	
13	Chromium	mg/L	£ 0,02	
14	Cadmium	mg/L	0,08 - 1,80	Depend on water hardness
15	Lead	mg/L	0,002 - 0,007	Depend on water hardness
16	Selen	mg/L	£ 0,001	
17	Mercury (Total)	mg/L	£ 0,10	
18	Oil and grease (mineral)	mg/L	not detectable	
19	Phenol (Total)	mg/L	0,02	
20	Dissolve Solid	mg/L	1000	
21	Suspended solid	mg/L	100	

Appendix B

Questionnaires

QUESTIONNAIR FOR FISH CULTIVATION HOUSEHOLD IN AN GIANG

Eco cluster Development and Management – Tra – Basa Fish Cultivation, Process and Export in An Giang Province Vietnam

Fish pond☐ Fish pens ☐ Fish cage ☐

Interviewee's name :……Cage number.……...
Address on land : ……Tel:……..……

I – GENERAL
Age:…….Educating Level:…….Gender : Male ☐ Female☐
Interviewee: Owner ☐ Worker ☐
Number of people living on the cage ……
Number of worker living on the cage
Drinking water source: …….. Amount (lit/day):…….
Household Water …….Amount (litter/day):……....
Solids waste:

Type of solid waste	Place of disposal	Weight	Treatment method

II – REARING TECHNIQUE:
Rearing Procedure: One type of fish species in the same pond/cage ☐
Many types of fish species in the same pond/cage ☐
How many type……..list those:

Describe:

Fish feeding food:
Industrial food ☐ Home made ☐ Both☐

	Young fish	Finish Fish
Lvie Stock (kg/hầm)		
Dead fish (%)		
Feeding times		
Amount of feeding food each time		

Industrial food Home made food		
Rearing time		

Volume of fish pond/cage (length x width x height)…….

Number of cage/pond:

Initial investigation: Source of money
……..
Invest fee: …….VND
Pond/cage treatment:…….VND
Small fish:…….VND
Fish feeding food :…….. ……VND
Labor: …….VND
Fuel: …….VND
Other: ……. VND

Chemical use (include pretreating pond/cage chemical and curing medicine for fish) (detail with amount, price)
Volume of water come out the pond :……Volume of water enter the pond: ……
Water changing frequency :
……..

Used chemical	Frequency	Amount	Price
Pretreatment			
Medicine			

Where is the out going water dispose? Is there any treatment before disposing?
……...
Do you use any tool that use electric/fuel? Capacity?
-Electric that use for every day activities (domestic tools)
-Television
-Fridge

-Electric that use for production
-Electric generation

Do you know bio diesel? Yes☐ No ☐
Can the above tool use bio-diesel? Yes ☐No ☐
Do you want to change to use bio diesel? Yes ☐ No☐

If no, why?

Price ☐ Not convenience ☐ Not good quality ☐ Other ☐

If changing the fish cultivating type, which one will you choose? Why?

Pond ☐ Pens ☐ Cage ☐

III. RELATIONSHIP BETWEEN FISH FARMS AND OTHER INDUSTRIES:

Is there any company purchase or fish farm find the buyer by themselves?

Company name

Private ☐ Government ☐ Joint-Stock ☐ Other ☐

Form fish farm to fish processing, who do the transportation?

Fish farm ☐ Expenses VND/ton. Vehicle ……

Fish processing ☐ Expenses VND/ton. Vehicle ……

Third party company ☐ Expenses VND/ton. Vehicle ……

Other,…… Expenses VND/ton. Vehicle ……

Fishes loss during tranportation?.....

IV. MANAGEMENT

Do you need an license when cultivating fish? Yes ☐ No ☐

Which organization issue the license

Your working activities being affected by which government organizations?

Your working activities being monitor by which government organizations?

Frequency?

Policies that affect your working activities?

How do you know this policies?

Do you have any suggestion about those policies?

Do you have financial support from Government No ☐

Yes ☐ , How much (million Vietnam dong) ……

Source of subsidize……..

Lending condition……..

Lending process……..

Do you have technique supporting from government?

Yes ☐ No ☐
If yes, Does they guide you about the environment protection? No ☐
Yes ☐, list detail

V – ORIENTATION
If forming an Association of fish cultivation, processing, do you join this association? Why?
Yes ☐
Because ……
No ☐
because ……...
If there is a clean fish cultivation and processing cluster, do you want to join? Why?
Yes ☐
Because……
No ☐ Because……...

Thank you very much

Signature

Appendix C
Government system in Vietnam

Table C1 Function of some administrative organizations of Vietnamese Government

No	Name	Short name	Function
1	Ministry of Fishery	MOFI	The Ministry of Fishery is an agency of the Government, which performs the function of State management over aquatic resources, including: aquaculture, exploitation, processing, protection and development of aquatic resources in the inland areas and on the sea throughout the country; the State management over public services and acts as representative of the owner of the State capital portion at State-invested enterprises under its management as prescribed by laws. In FEIN, this ministry play an important role in manages all of the relate activities in Fishery sector: technical support, management, planning on cultivation areas; cooperative with other ministry in order to create a comprehensive planning for the areas.
1	Ministry of Natural Resources and Environment	MONRE	The Ministry of Natural Resources and Environment is a government body to exercise the state function of management over the land, water resources, minerals, environment, meteorology, hydro geography, measuring and mapping in the national scope; exercise the governance over the public services and represent the owner of state capital in enterprises using state budgets relating to natural resources of land, water, minerals, environment, meteorology, hydro geography, measuring and mapping specified by laws.
	Ministry of Agriculture and Rural Development	MARD	The ministry manage on agriculture, forestry, irrigation/water services and rural development nationwide; state management over public services and acts as representative of state ownership in enterprises under the management of the ministry that have state share of capital.
	Ministry of Labour, Invalids and Social Affairs	MOLISA	State administration over issues related to labour, employment, occupational safety and health, vocational training, benefits for injured soldiers and martyrs, national devotees, social assistance, anti-social evils (generally addressed as labour, invalids and social affairs) all over the country; the administration of public services and act as the representative of the State's ownership in State-owned enterprises under the management of the Ministry in accordance with applicable laws.
	Ministry of Industry	MOI	The Ministry of Industry is established by the Government and responsible to the Government

			for state management of the industrial sector namely mechanical engineering, metallurgy, new energy, renewable energy, oil and gas, minerals mining, chemicals (including pharmaceutical industry), industrial explosion materials, consumer-goods industry, foodstuff industry and other processing industries throughout the country; implements state management of public services and represents the state ownership in state shared enterprises in the industries managed by the Ministry under the law.
	Ministry of Trade	MOT	Ministry of Trade is official body of the Government in charge of state management over trade, public services, and is presented as representative of state ownership in state-owned enterprises under the Ministry's management in accordance with laws.
	Ministry of Science and Technology	MOST	The Ministry of Science and Technology is a governmental agency which performs the function of State management over scientific and technological activities, as well as development of scientific and technological potentiality; product and goods quality, measurement and standards; intellectual property; atomic energy as well as radiation and nuclear safety; performs the State management over public services in the domains under its management; acts as representative of the owner of State capital portions at the State-invested enterprises under its management according to law provisions."
	Department of Statistic	DOS	Performing several tasks and exercises several powers of State management over statistics; organizes statistical activities and provides socio-economic statistical information to agencies, organizations and individuals according to law provisions; performs the State management over public services and performs some specific tasks and exercises some specific powers in representing the owner of the State capital portions at State-invested enterprises under its management as prescribed by law.
	Ministry of Construction	MOC	This ministry manage over construction; construction materials; dwelling houses and working offices; architectures, urban construction planning and rural construction planning; and urban technical infrastructures; performs the State management over public services and acts as representative of the owner of State capital portions at enterprises with State capital within the Ministry's State management domains according

			to law provisions. In FEIN=, this ministry participate in the planning and building ministry level's industrial parks, zones and other infrastructure such as traffic system (cooperating with Ministry of

Industrial Environmental Management through Eco-Industrial Network Formation: Case study in Fishery Industry in An Giang Province, Vietnam

by

NGUYEN THU PHUONG

Examination Committee:

Prof. C Visvanathan (Chairperson)

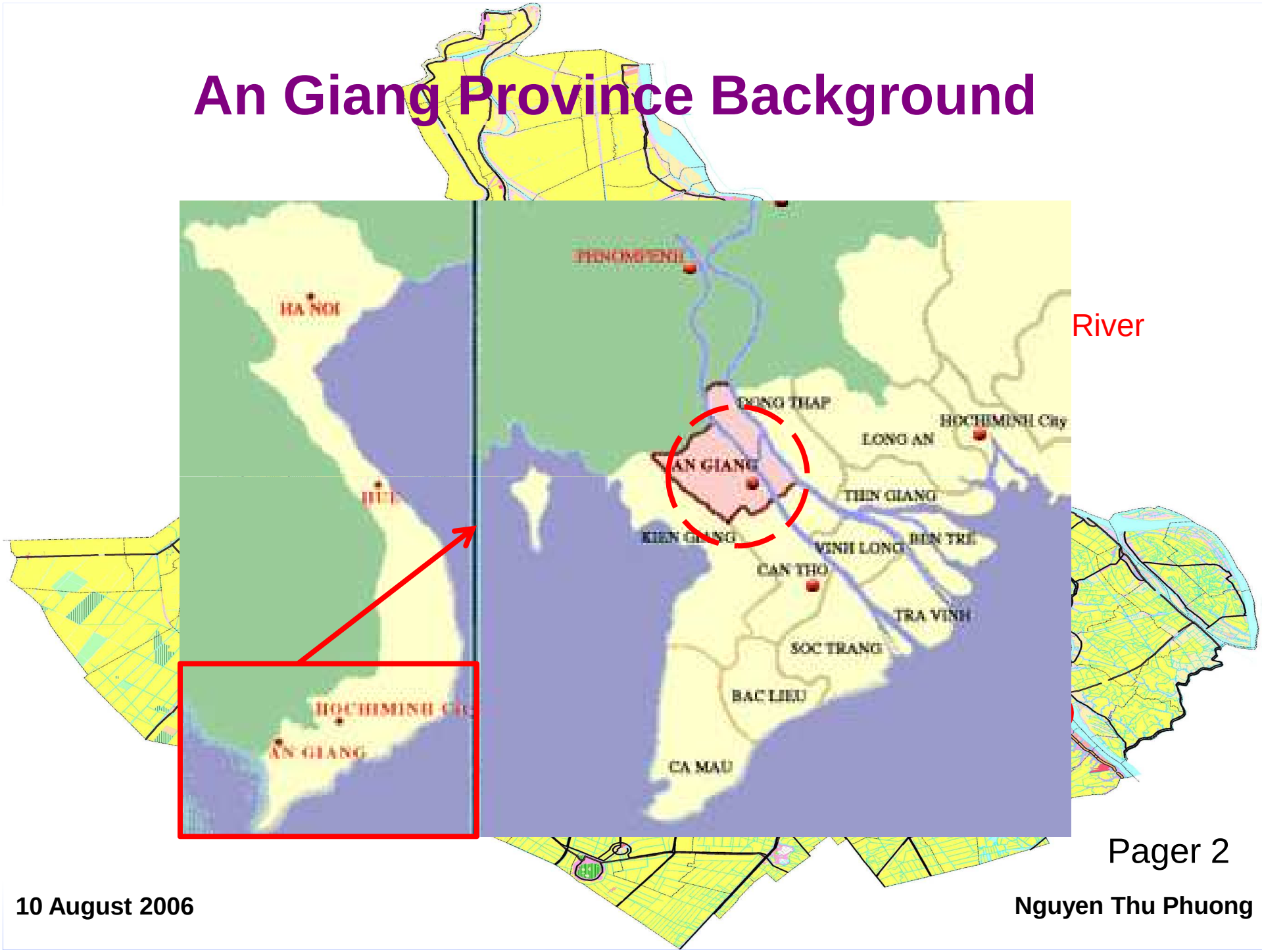
Prof. Nguyen Cong Thanh

Dr. Preeda Parkpian

Dr. Ranjith Perera

Contents

An Giang Province Background



River

Pager 2

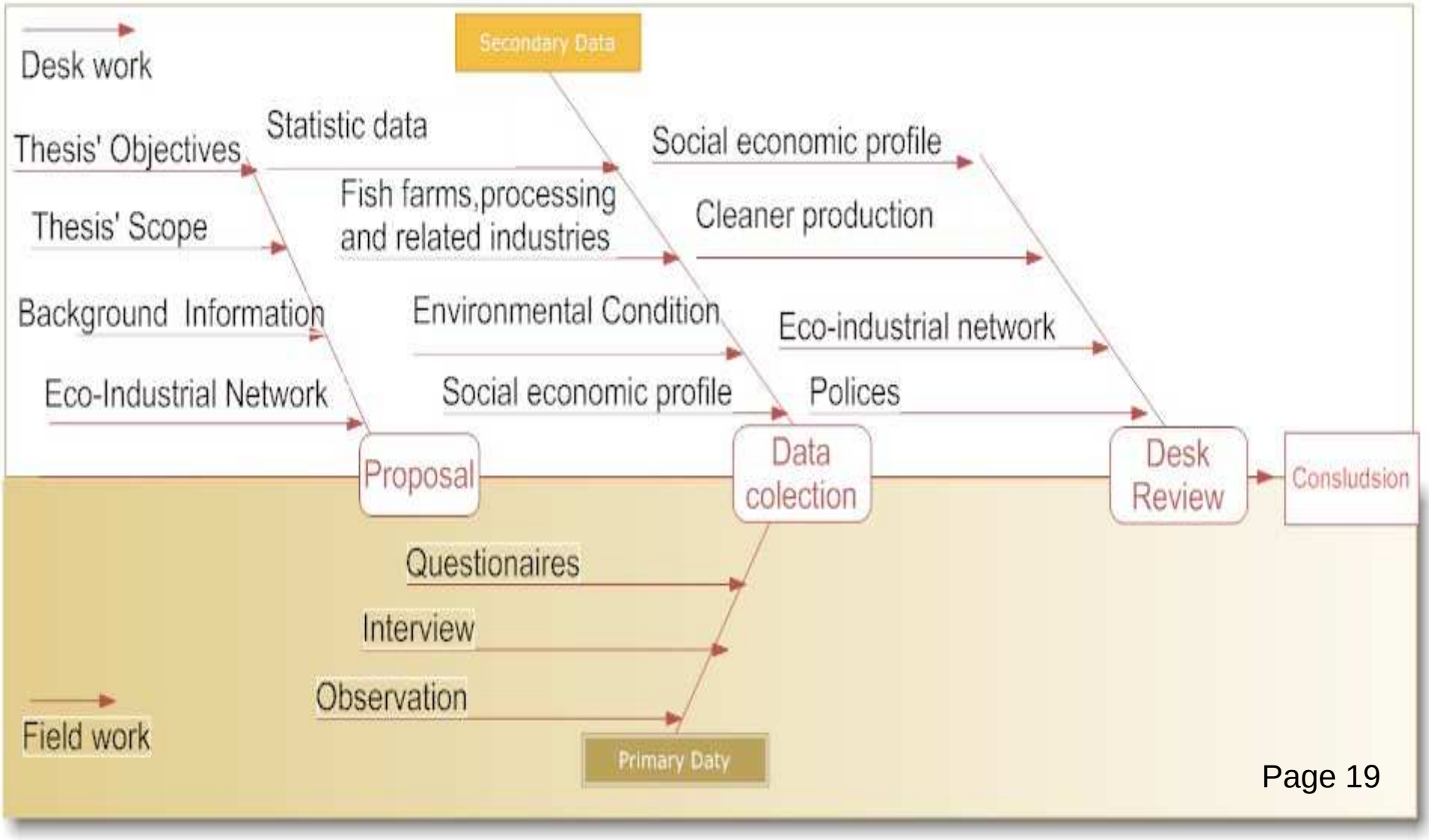
10 August 2006

Nguyen Thu Phuong

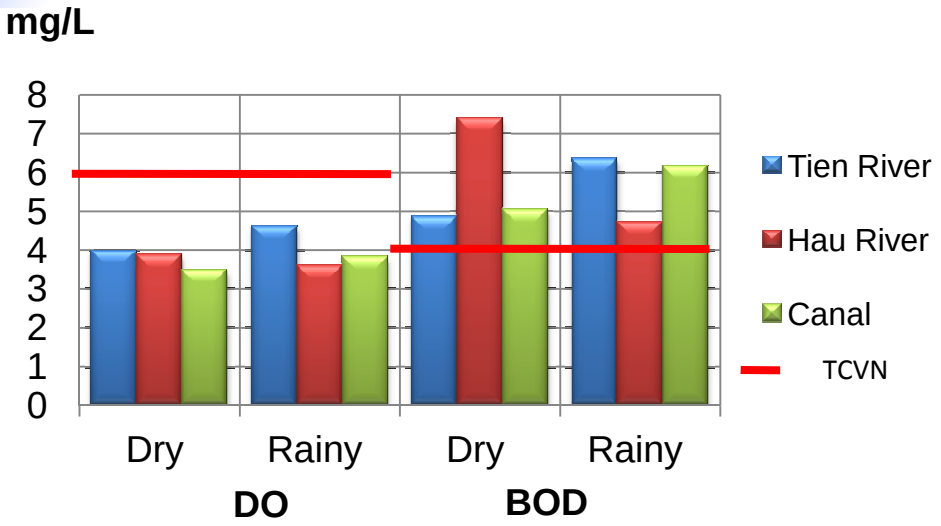
Objectives of study

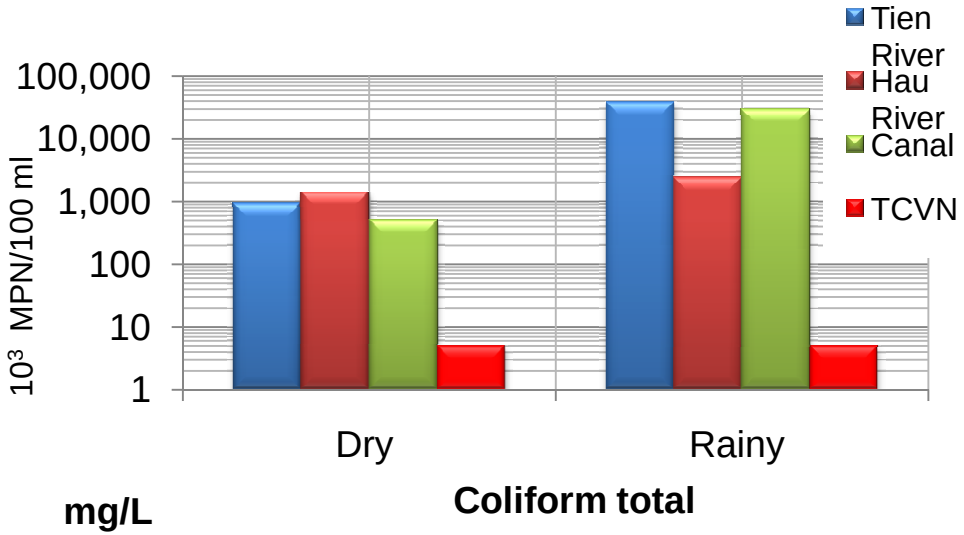
- To investigate the present economic and environment condition in An Giang province with special reference to fish processing network.
- To examine the relevant policies, authorities and government management system of fishery industry in An Giang Province
- To study conduct the in depth study in terms of material flow, production process, resources usages and process technology within this network
- To link this network to other industries in the region in order to optimize the resources and energy to achieve the economic and environmental development.
- To develop an effective environmental management system and appropriate policies framework for this eco-industrial network.

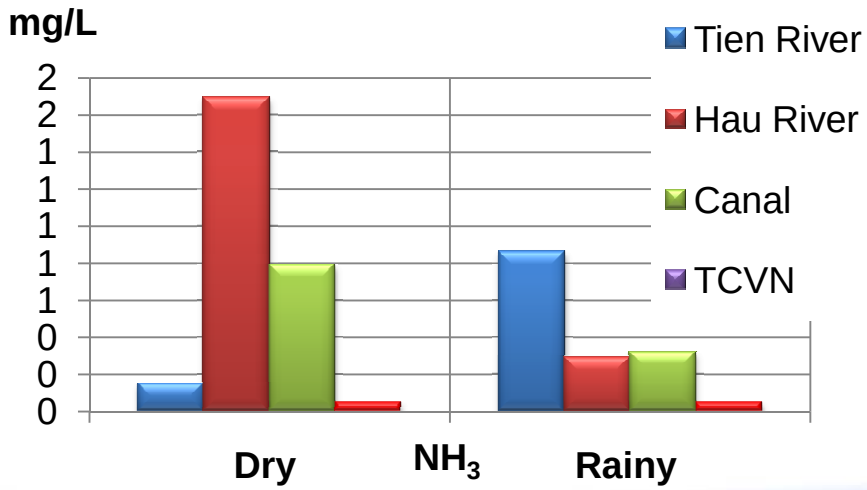
Methodology

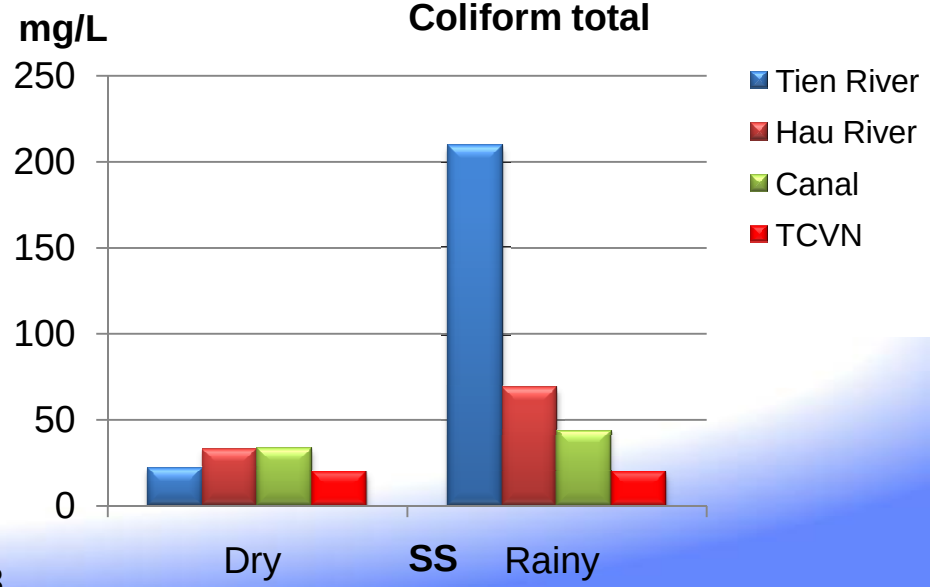


Environmental Problems
Surface water



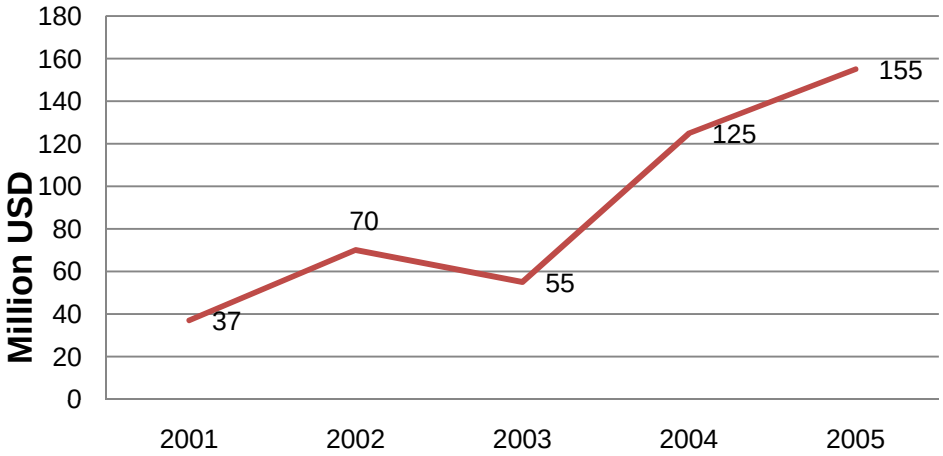




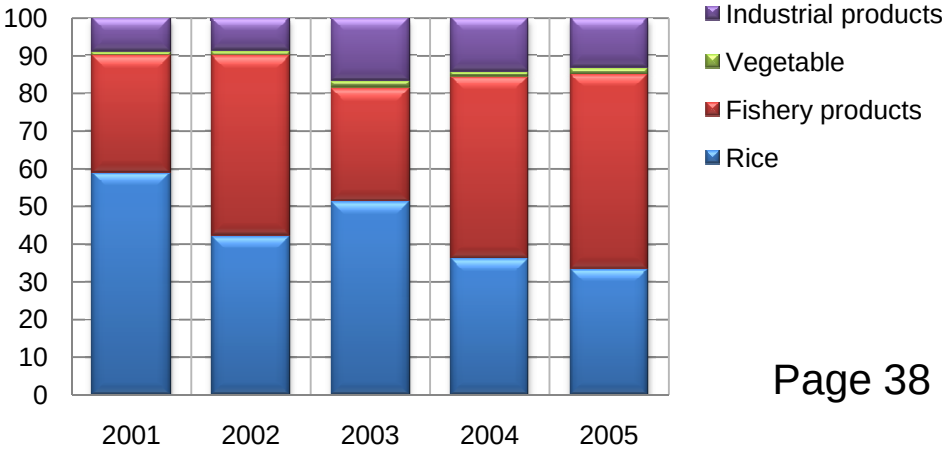


TCVN 5942 : 1995 Vietnamese Standard for Surface water
Source: DONRE, 2005

Fish Industry– Wealth and Wastes



Fish product export turnover in An Giang

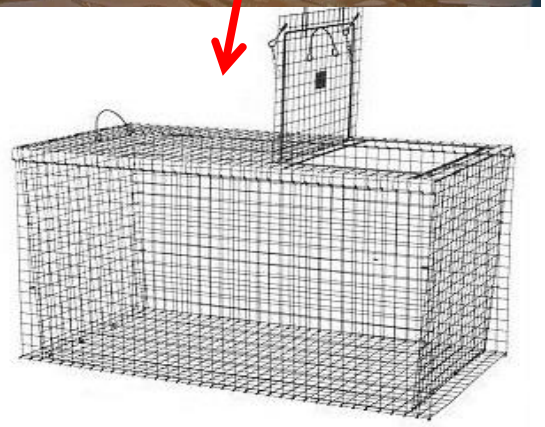


Export turnover percentage in An Giang

Fishery Statistics in An Giang Province

Description	Unit	Year					
		2000	2001	2002	2003	2004	2005
A. Aquaculture	ha	1,215	1,219	1,788	1,561	1,896	1,836
1.1 Fish cage		3,086	3,237	4,053	3,178	3,504	3,058
1.2 Fish farm	ha	1,210	984	1,465	1,123	1,217	1,122
- Fish pond	ha	1,080	722	1,415	1,056	1,167	1,016
- Fish pens	ha	-	-	-	22	32	53
B. Production	**ton**	**80**	**83**	**111**	**136**	**157**	**179**
- Fish cage	ton	42	45	58	96	71	53
-Fish pond	ton	38	38	53	41	81	126

Fishery cultivations

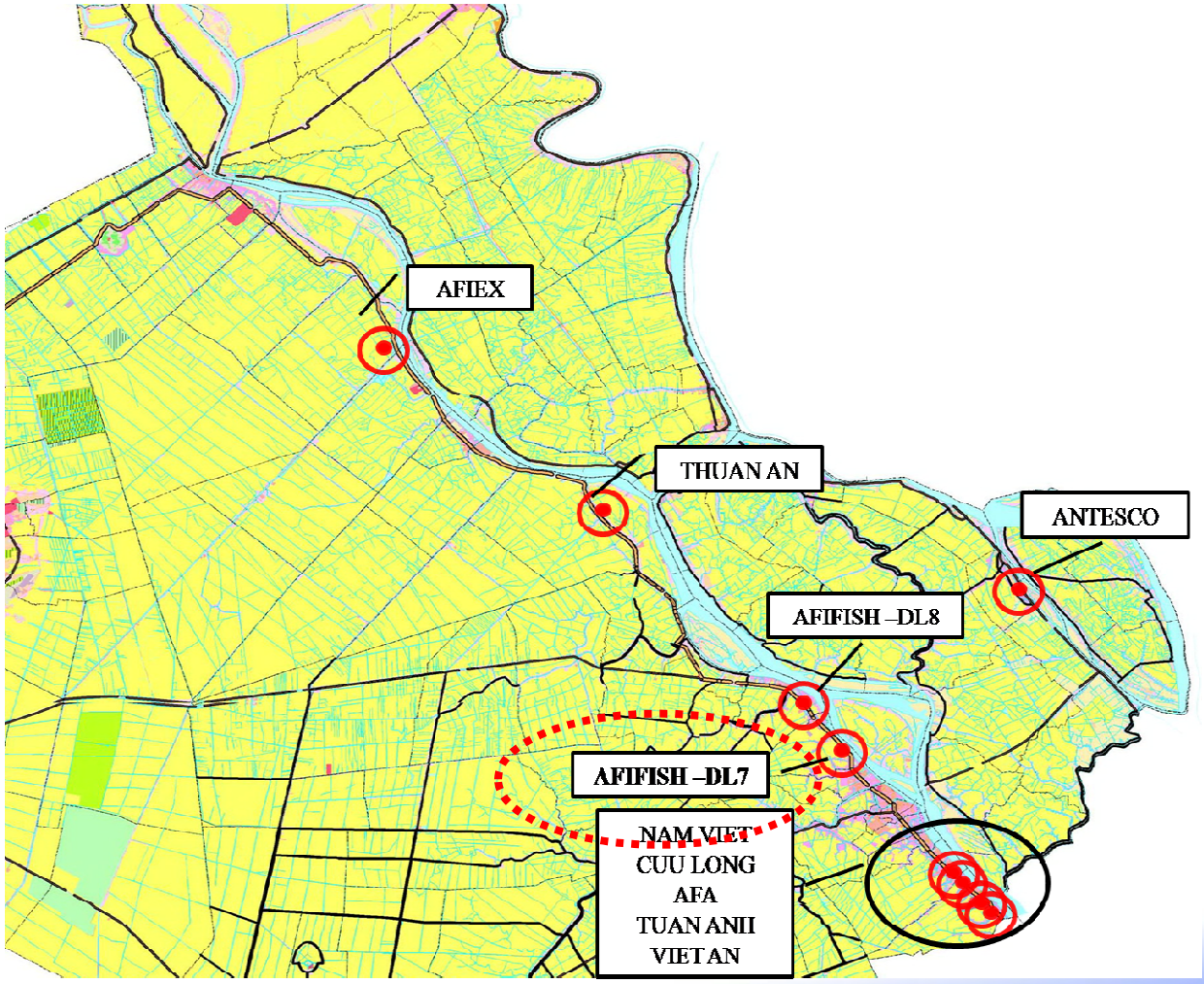


Fish transporting

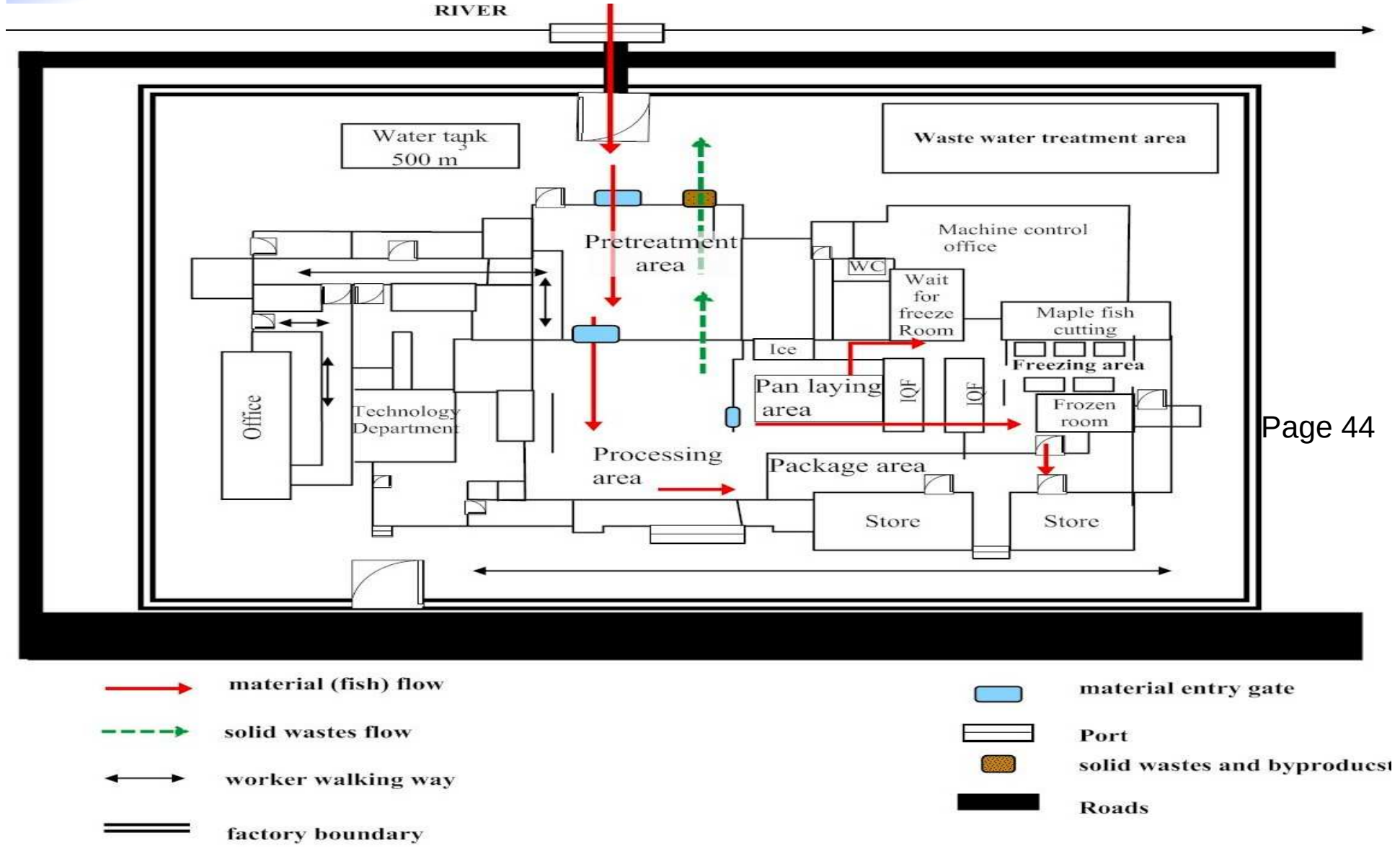
- **By boat**

- **By truck**

Fish fillet factory in An Giang province



Factory layout



Fish Processing

Raw material

Fish killing

Skinning

Filleting

Trimming

Freezing

Product

Wastes checklist

Process	Wastewater	Solid wastes
Fish killing	***	
Skinning	**	***
Fillet	***	***
Trimming	***	***
Freezing	**	*
Cleaning water for equipment, factory and workers.	**	**
Others (Office, canteen..)	*	*

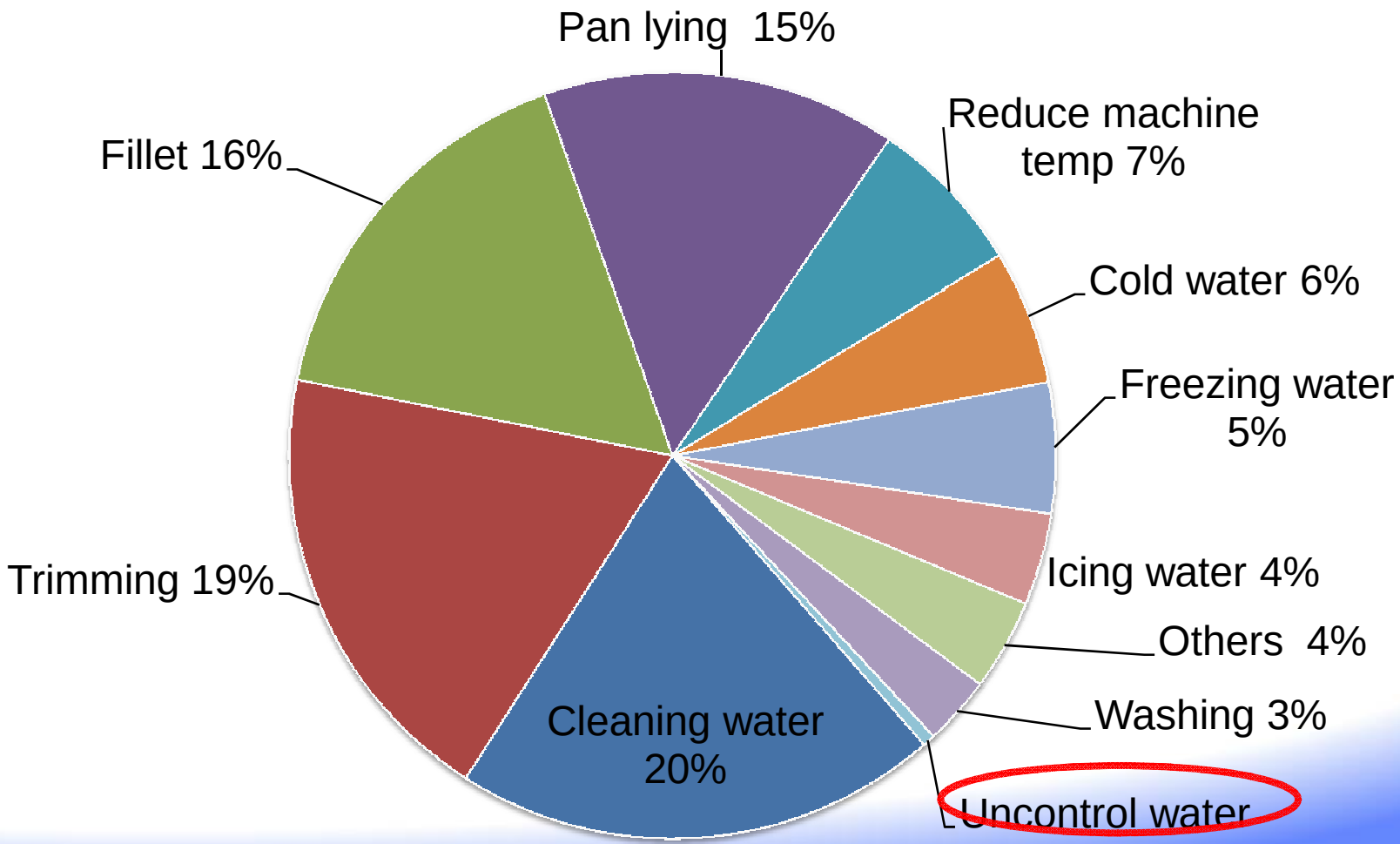
Note

* Low

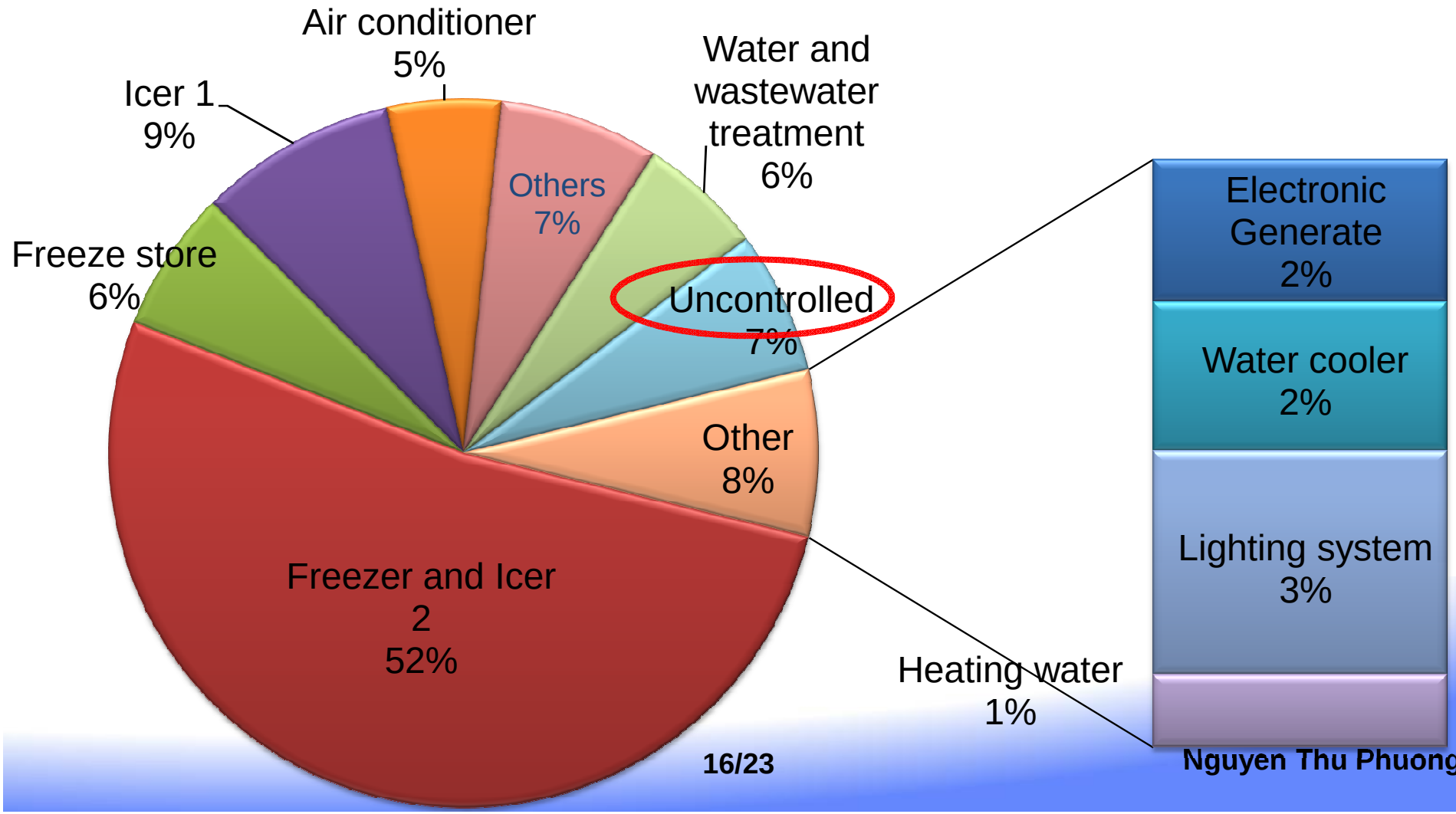
** Medium

***High

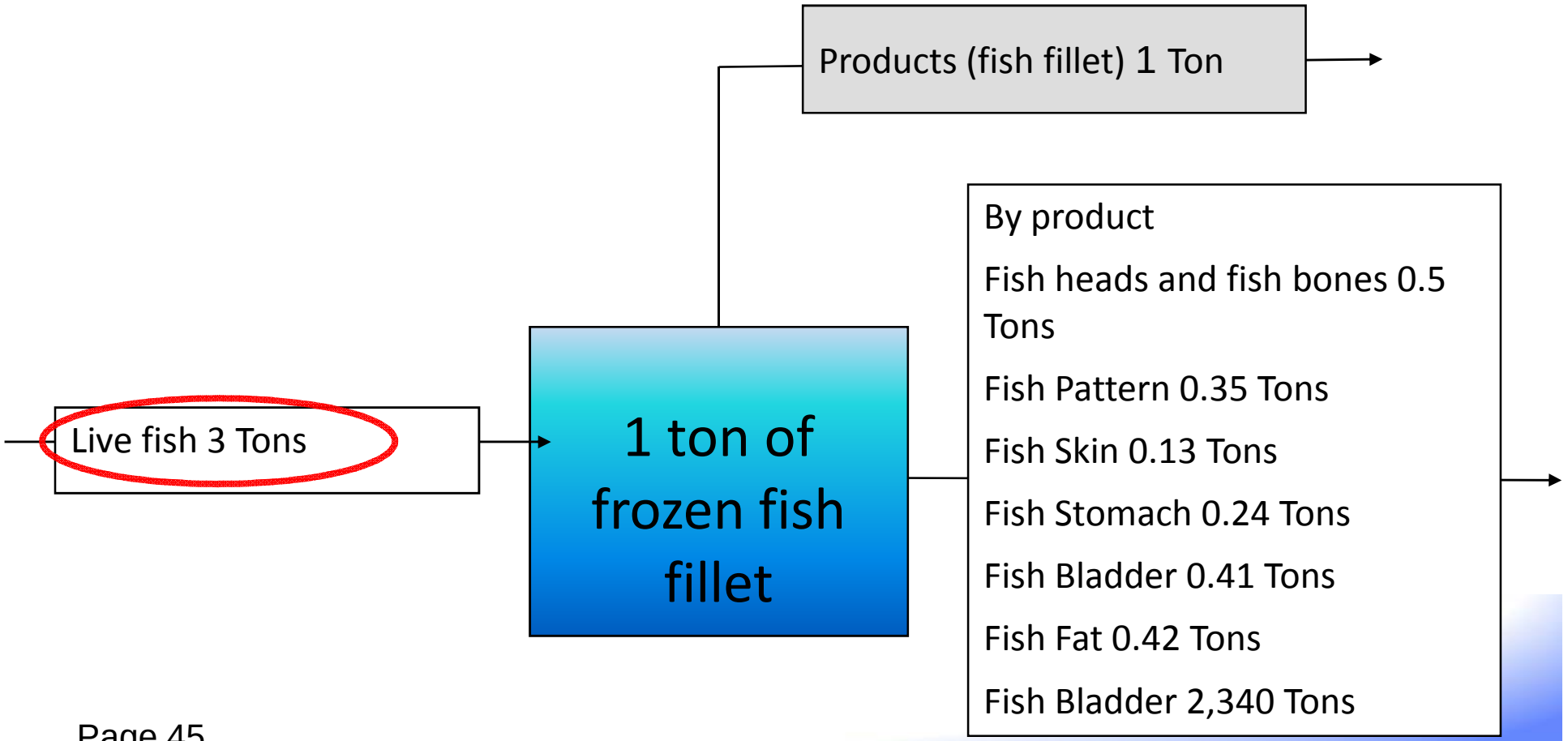
Consumed water percentage



Consumed electricity percentage



Mass balance in Fish process factory

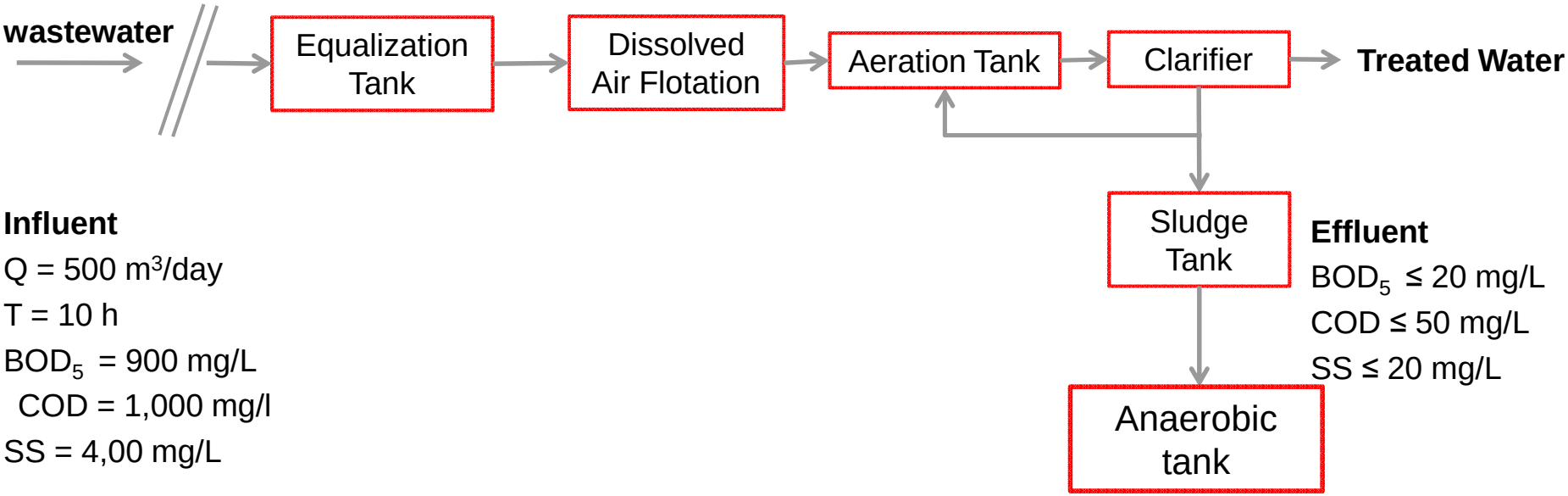


Wastes in Fish Processing

Solid wastes

Wastewater

Wastewater treatment system



Influent

Q = 500 m^3/day

T = 10 h

BOD_5 = 900 mg/L

COD = 1,000 mg/l

SS = 4,00 mg/L

Effluent

BOD_5 ≤ 20 mg/L

COD ≤ 50 mg/L

SS ≤ 20 mg/L

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Wastewater treatment system - problems

Screening

Sludge tank

Flotation tank

By-products process - Classifying

By-product process

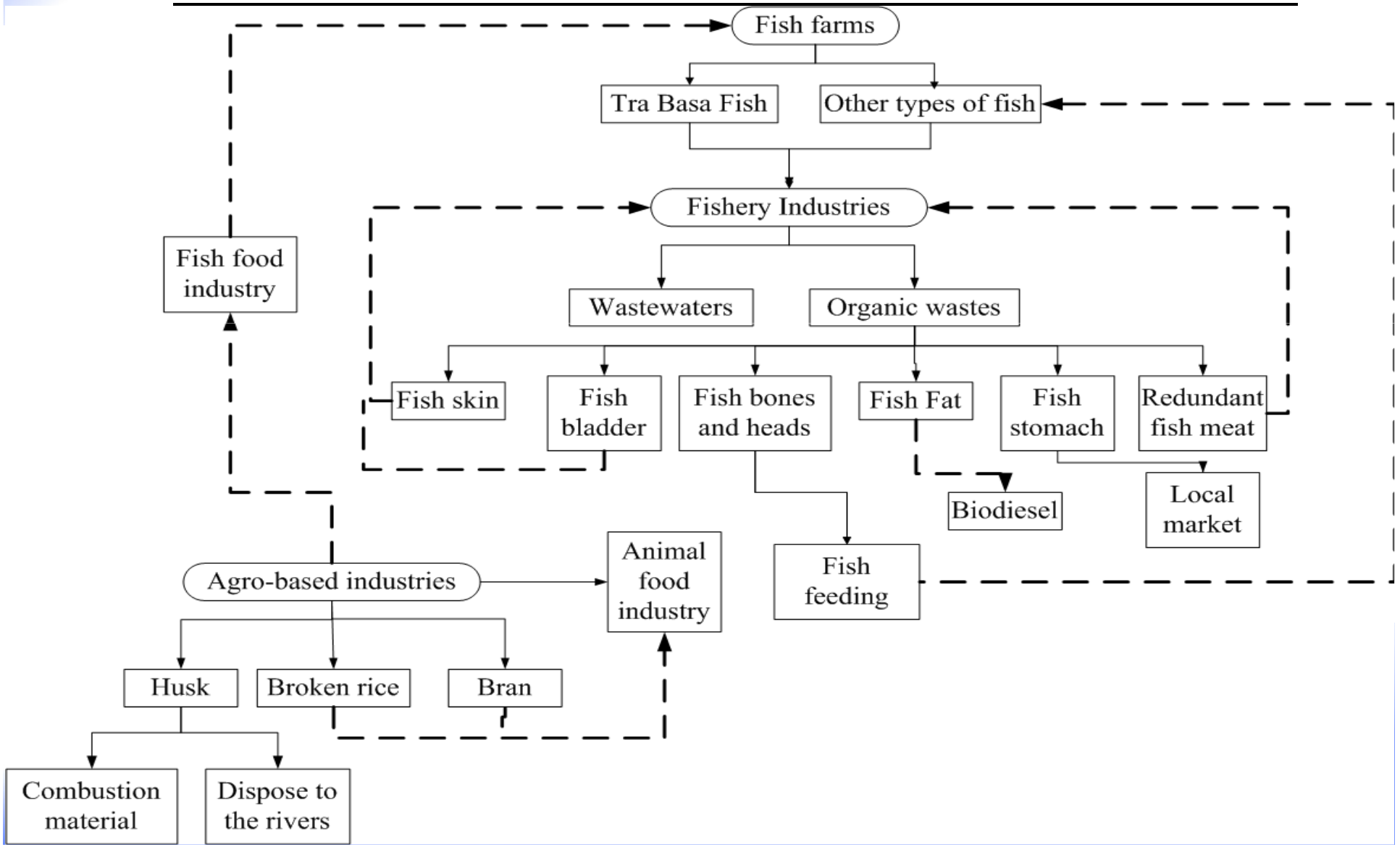
By-products process - Cooking

Cooking store

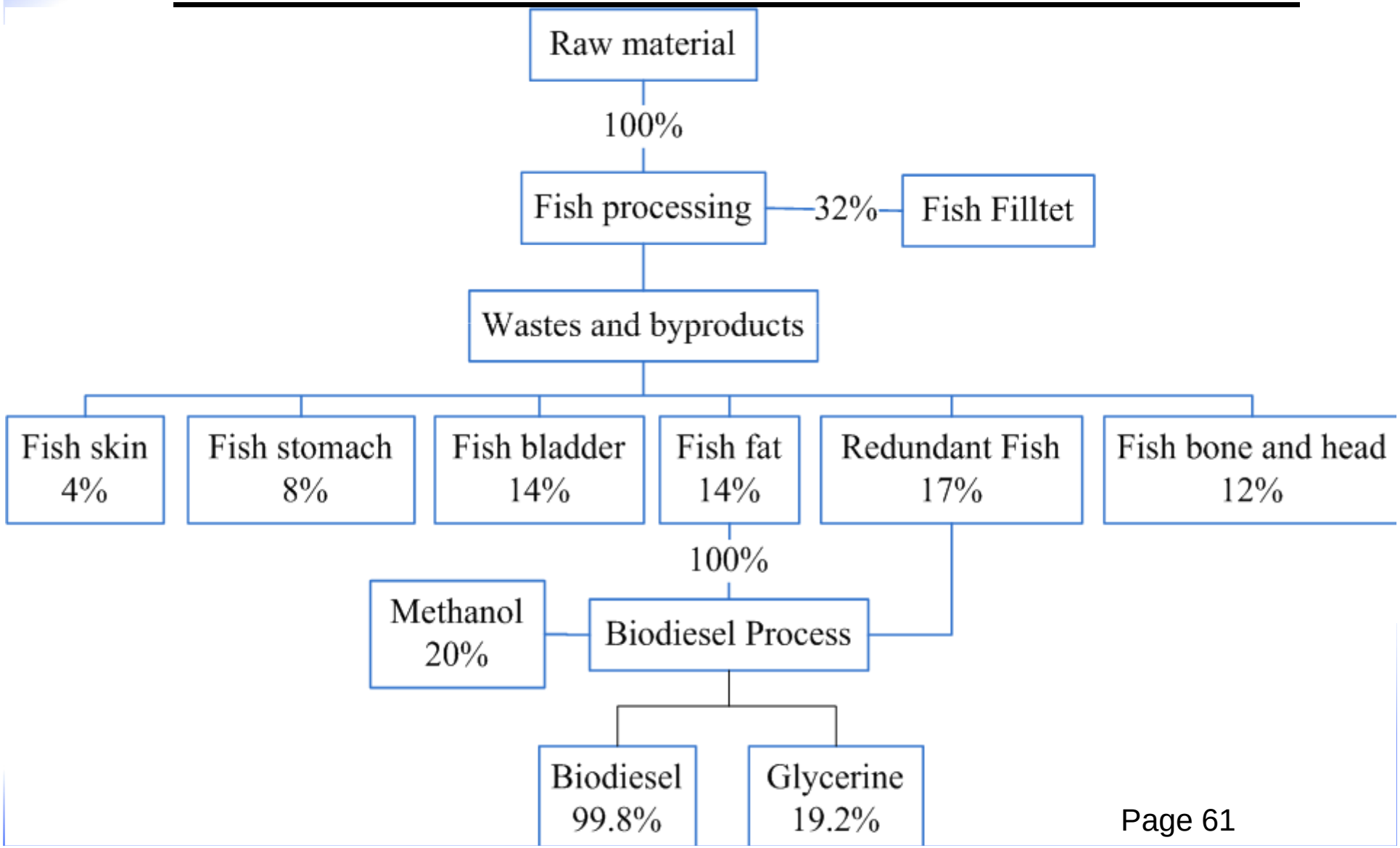
Final product

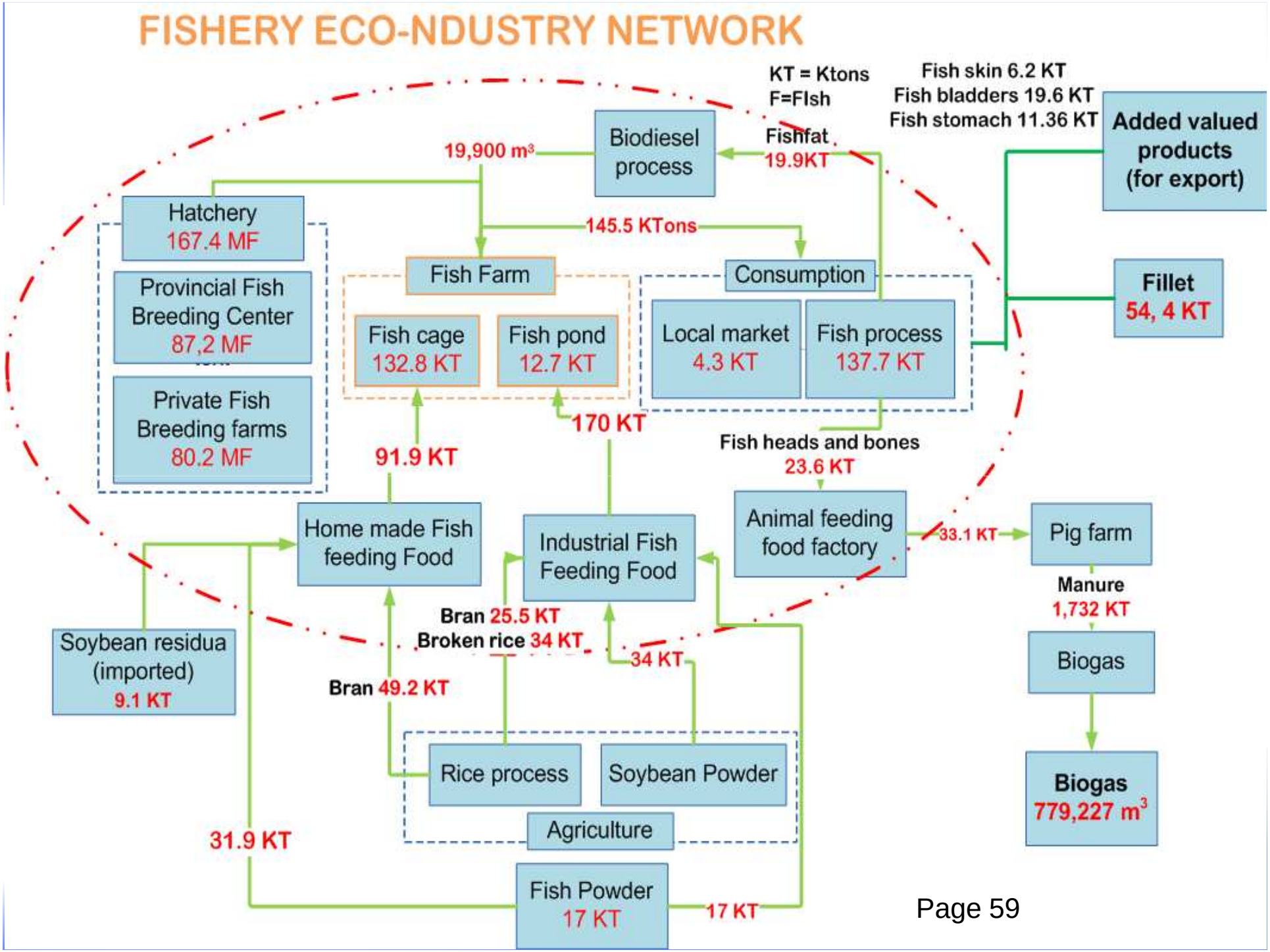
Bran + soya residue

Actual material linkages in the province



Calculation Ratios




FISHERY ECO-NDUSTRY NETWORK
KT = Ktons
F=FIsh
Fish skin 6.2 KT
Fish bladders 19.6 KT
Fish stomach 11.36 KT
Added valued products (for export)
Biodiesel process
19,900 m3
Fishfat 19.9KT
Hatchery 167.4 MF
Provincial Fish Breeding Center 87,2 MF
Private Fish Breeding farms 80.2 MF
145.5 KTons
Fish Farm
Fish cage 132.8 KT
Fish pond 12.7 KT
Consumption
Local market 4.3 KT
Fish process 137.7 KT
Fillet 54, 4 KT
91.9 KT
170 KT
Fish heads and bones 23.6 KT
Home made Fish feeding Food
Industrial Fish Feeding Food
Animal feeding food factory
33.1 KT
Pig farm
Manure 1,732 KT
Biogas
Soybean residua (imported) 9.1 KT
Bran 25.5 KT
Broken rice 34 KT
34 KT
Bran 49.2 KT
Rice process
Soybean Powder
Agriculture
Biogas 779,227 m3
31.9 KT
Fish Powder 17 KT
17 KT

Fish Eco-Industrial Network (FEIN)

Typical home made food recipe

	Percentage (%)	Amount (Kilotons)
Brian	54	49.2
Fish powder	35	31.9
Soybean residue	10	9.1
Mineral, vitamins	1	0.9

Pig farm in An Giang Province

Cattle	Number	Meat production (kilotons)	Manure production (kilotons)	Biogas production ** ($m^{3)}$
Pig	209,197	24	1,732	779,000

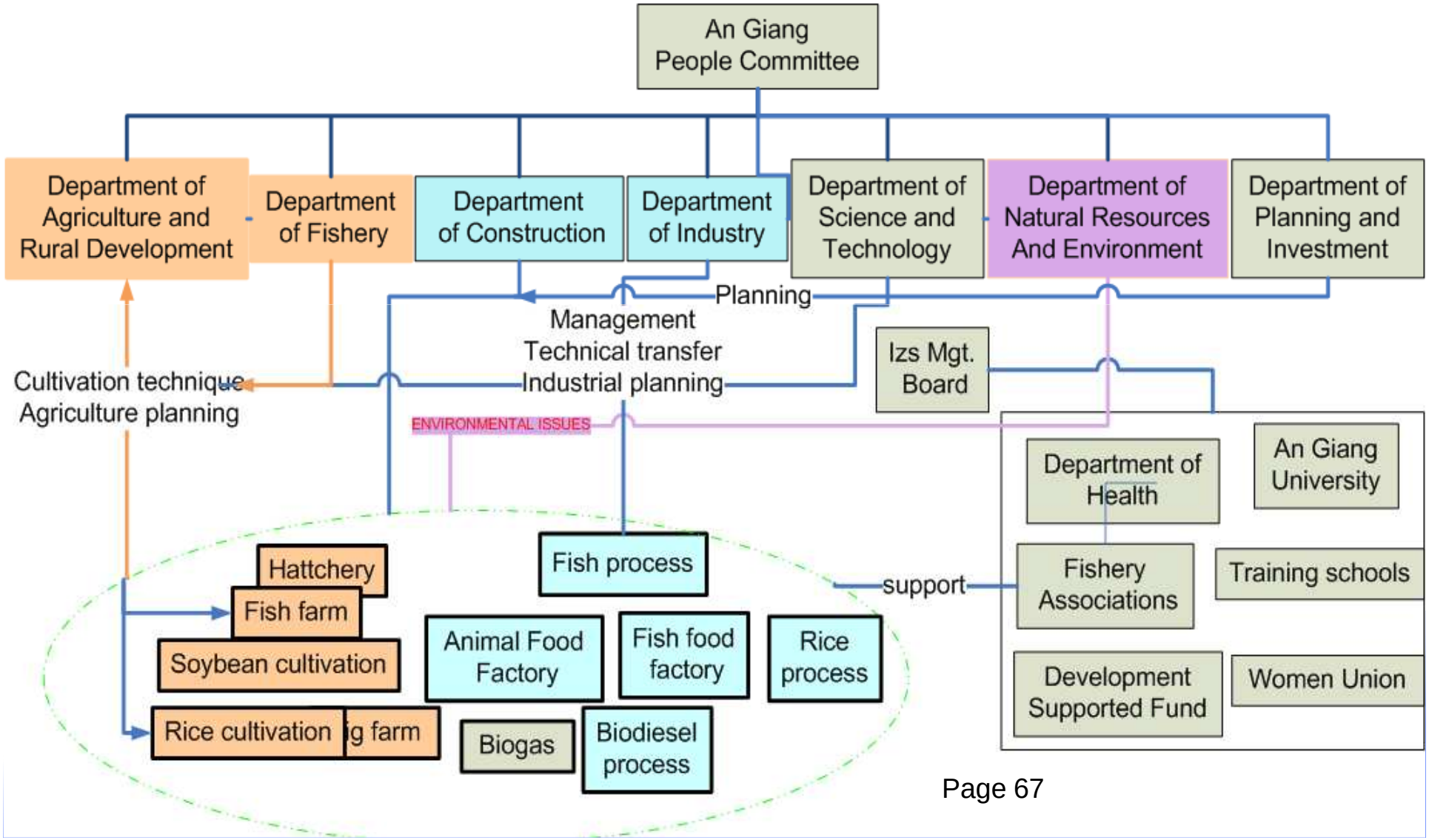
Typical industrial fish feeding food recipe

	Percentage (%)	Amount (Kilotons)
Corn	12	20.4
Broken rice	20	34
Brain	25	25.5
Soybean	20	34
Fish Power	10	17
Mineral, vitamins and other components	13	22.1

Present Product s and FIEN needs

	Unit	Provincial actual condition	Network use
Soya bean	kilotons	1,709	34
Soybean residues	Tons	11,651	9,100
Broken rice	kilotons	782	34
Husk	kilotons	626	15
Bran	kilotons	313	75

Local administration that effect FEIN



Conclusions and recommendations

- Investigate the present economic and environment condition in An Giang province
- Examine the relevant policies, authorities system of fishery industry
- Study deeply inside the network
- Linking the Network to other industry in the region
- Develop an effective management system and appropriate policies framework.

Thank you for your attention