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Resilient or Vulnerable? A study of the Livelihoods of Inshore Fishers and Aquaculturists in Penang, Malaysia

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Declaration

I, Jiunmin Lim declare that this thesis is a result of my research investigations and findings. Sources of information other than my own have been acknowledged and a reference list has been appended. This work has not been previously submitted to any other university for award of any type of academic degree.

Signature……..

Date……

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ABSTRACT

The marine and coastal ecosystem of Penang experiences problems with water pollution and overexploitation of fish stock is not a new phenomenon. The degradation of the marine and coastal ecosystem, coupled with natural hazards such as the 2004 tsunami, have affected the livelihoods of the inshore fishers and aquaculturists who depend on marine and coastal resources for a living. This study addresses the vulnerability and the coping strategies of the inshore fishers and aquaculturists (shrimp, fish and cockle aquaculturists) in Penang by applying the sustainable livelihood framework and resilience theory. In order to gain an in-depth understanding their livelihoods, a qualitative research method was applied. Interviews with the inshore fishers and aquaculturists were conducted to explore their perceptions of their access to various capitals, distribution of assets, and challenges in fisheries. It was found that both fishers and cockle aquaculturists are more vulnerable than shrimp and fish aquaculturists, who have higher levels of livelihood capitals, which made them more resilient in recovery from shortfalls. This study also reveals the political and economic factors that have worsened the livelihoods of the inshore fishers and aquaculturists in Penang, while weakening their chances of coping with various stressors. Stressors from anthropogenic impacts coupled with corruption and policies that favor economic development over the marine and coastal environment have increased vulnerability amongst the inshore fishers and aquaculturists in Penang.

Keywords: marine and coastal pollution, overfishing, livelihood, resilience, coping strategies

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ASEAN	Association of Southeast Asian Nations
AFTA	ASEAN Free Trade Area
CITES	Convention on International Trade of Endangered Species
EEZ	Exclusive Economic Zone
EXCO	Executive Council (Penang State)
DDG	Deputy Director Generals
DFID	Department for International Development
DID	Department of Irrigation and Drainage (Penang).
EMS	Early Mortality Syndrome
DOEM	Department of Environment Malaysia
DEIA	Detailed Environment Impact Assessment
DOFM	Department of Fisheries Malaysia
FAO	Food and Agriculture Organization of United Nations
FDAM	Fisheries Development Authority of Malaysia
FCR	Feed Conversion Ratio
FIZ	Free Industrial Zone
FRI	Fisheries Research Institute
Gaqp	Good Aquaculture Practice
GPS	Global Positioning System
GRT	Gross Register Tonnage
IGO	International Non-governmental Organization
JAKIM	Department of Islamic Development Malaysia
NGO	Non-Governmental Originations
NEP	New Economic Policy
PDC	Penang Development Corporation
PENKUA	Aquaculture Operators Association of Penang
MOABI	Ministry of Agriculture and Agro-Based Industry
MOE	Ministry of Environment
MyGAP	Malaysia Good Agriculture Practice
NACA	Network of Aquaculture Centres in Asia-Pacific

NEP	New Economic Policy
PIFWA	Penang Inshore Fishermen Association
PEMANDU	Performance Management Delivery Unit (Malaysia)
SAM	Friends of the Earth Malaysia
SLF	Sustainable Livelihood Framework
TOL	Temporary Occupation License
UNCLOS	United Nations Convention on the Law of the Sea
USM	University Science Malaysia
WTO	World Trade Organization
ZIA	Zone Industry Aquaculture

1.0 Introduction

About 805 million people in the world suffered from malnutrition between 2012-2014 (FAO 2014a). With the world population estimated to be 9 billion people in 2050, meeting the food supply while maintaining sustainable food production is a major challenge. Several global actors have made efforts to tackle these issues including actors in the fish food production from marine capture and aquaculture.

Fisheries and aquaculture play an important role in providing sufficient food proteins and improving the livelihoods of people around the world, especially the poor, providing an important source of income and employment. About 10-12% of the world´s population depends on fisheries for their livelihoods and most of them are located in Asia. The total fish trade in the world in 2012 was worth about US$ 130 billion. Total world marine catch stood at 91.3 million tons, and aquaculture production was about 66.7 million tons (FAO 2014b). The report further added, the average world fish consumption per capita has increased from 9.9 kg in 1960 to 19.2 kg in 2012 (FAO 2014b).

Currently, a significant fraction of the world´s fish supply is from the Association of Southeast Asian Nations (ASEAN) consisting of Malaysia, Thailand, Brunei, Vietnam, Laos, Myanmar, Singapore, Cambodia and Philippines. ASEAN fish production constitutes 21 million tons per annum and has been one of the keys for economic development for ASEAN countries. The income generated from the fish trading has improved the livelihoods of the people in ASEAN (Pandya et al. 2008). However, economic development has undermined environmental sustainability when poor aquaculture practices, weak institutional management and destructive fishing practices occurred.

Commercial fishers have used destructive fishing equipment such as trawlers, dynamite and cyanide fishing to increase their catch. In the past three decades, marine fish capture has been declining in South East Asia (SCTR 2014). The decline of marine fish capture is due to more fishing efficient equipment being used to increase the catch in the sea. Unfortunately, such short-term solutions have further aggravated

the fish resources condition. Destructive fishing equipment such as trawlers, dynamite and cyanide fishing has contributed to destroying coastal ecosystems, and threatening the livelihoods of the inshore fishers (Pandya et al. 2008; SCTR 2014)

In order to support the demand for fish protein, aquaculture production is an option and opportunity to offset the fish shortages issues. Aquaculture production in the world has increased about eleven folds for the past eleven years and it has outpaced the population growth, with the total world supply of 0.7 kg per capital in 1970 to 7.8 kg per capital in 2008 (FAO 2010). Moreover, the WHO and FAO (2003) pointed out that since 1970, marine fish capture in many countries have either been fully exploited or over overexploited. Therefore, future world marine fish capture is likely to diminish.

In Malaysia, aquaculture production has been expanding rapidly. This sector has been an important contributor to foreign trade and exchange as well as local consumption. It is considered a high profit sub-sector compared to other agricultural sectors. The fish value had increased 2.56% in 2010 compared to 2009; the total marine fish landing was 1,428,881 metric tons with a total value of RM 6,651,890 million. In 2010, the total number of registered fishers and aquaculturists was 11,508 consisting of 4,624 fishers and 6,884 aquaculturists (DOS 2011:41).

Malaysia is a tropical country where the coastal ecosystem is rich in natural resources. It consists of highly productive coral reefs, seagrass beds, sandy beaches and estuarine environments. The west coast of Peninsular Malaysia is rich in mangrove forests. In Penang, there are 1,040 hectares of mangrove forest being reserved (WWF 2003). The mangrove swamp can be seen mostly along the coastal areas segregating the land and the sea. These natural resources provide important ecosystem services for fishers, aquaculturists and habitats for the tropical aquatic life. However, from 1973 to 2005, there has been a total loss of 64% mangroves in Penang (Tan 2005 in WWF, 2003:25).

Although fish commodities contribute to social and economic development, many fishers´ and aquaculturists´ livelihoods are affected by social and environmental changes such as: pollutions, natural hazards, climate change, and institutional change.

Ferror-Sculte et al. (2013) stated that he agrees that anthropogenic effects have degraded the coastal environment. In Penang, eight rivers are classified as polluted, which threaten the biodiversity and affect people´s livelihood (Noordin 2014a). According to Compendium of Statistic of Environment Malaysia (2013), many rivers in Penang are in class III category (Extensive water treatment required) and class IV category (only for irrigation) (for more information please refer to Appendix 1).

River pollution has been an ongoing issue affecting the people and biodiversity. As such, linkages between humans and the environment are inseparable. The more human livelihoods and natural environment relate to each other, the more attention is needed to ensure productivity and environmental sustainability is not compromised (Ferrol-Schulte et al. 2013). Livelihood and environment are considered resilient if they are able to cope with environmental and social changes. However, coastal environment degradation causing habitat destruction may lead to a decrease of fish breeding grounds and biodiversity in the coastal areas (Shelton 2014). This could also lead to loss of resilience.

This thesis focuses on the livelihoods of the inshore fishers, cockle aquaculturists and marine fish aquaculturists in Penang. I use the Sustainable Livelihood Framework (SLF) in addition to Resilience theory to study the linkages and the feedback of the marine ecosystem to the social system. In addition, this thesis also studies the institutional influences on the inshore fishers and aquaculturists in Penang. SLF has been used by many Non Governmental Organizations (NGO) to alleviate poverty in developing countries (Krantz 2001). The framework aims to identify and improve the livelihoods of a certain group of people, as it enables them to understand the condition of their assets while coping with vulnerabilities and complexities of the social and environment systems in their livelihood strategies (Allison & Ellis 2001).

1.1 Statement of Problem

There has been an upsurge in environment degradation in Malaysia affecting the marine and coastal areas and the livelihoods of the fishers and aquaculturists. In Penang, rapid economic development, industrialization, urbanization and increasing problems of land shortage have resulted in land expansion and water pollution. The government has been spending millions of Ringgit cleaning up the rivers and promoting "river restoration", however, the rivers are not maintained sustainably after restorations (Weng 2005). Two of the rivers in Penang, the Juru River and the Pinang River, have been considered the most polluted rivers in Malaysia for many years. In addition, overfishing and natural hazards have worsened the conditions for the inshore-fishers and aquaculturists. There have been limited studies on the impacts of environmental degradation toward the inshore fishers´ and aquaculturists' livelihoods in Penang.

1.2 Significance of study

Social and environmental changes include the clearance of mangrove areas, pollution, and unsustainable fisheries, which have increased pressure on the marine and coastal ecosystem in west coast of Peninsular Malaysia (WWF 2003). Since fishers and aquaculturists depend on marine and coastal ecosystem for their living, their livelihood strategies play an important part in adapting and coping with the various stressors. The ability to cope or adapt to stressors depends on the level of resilience. People who are able to cope and adapt are less vulnerable to perturbations as they are able to expect the unexpected through iterative learning from past experiences. Learning from the past experiences could enhance their memory to prevent them from being vulnerable in the future. Hence, this dissertation aims to understand what causes the fishers´ and aquaculturists´ livelihoods in Penang to be either vulnerable or resilient, while also analyzing the outcomes of their coping strategies.

Allison and Ellis (2001) emphasized that the understanding of livelihood studies is vital. If livelihoods are not studied comprehensively, it may impede both the resource conservation effort and sustainable social and economic development for people.

1.3 Research Objectives

The objective of this thesis is to investigate how the inshore fishers and aquaculturists cope with social and environmental changes in Penang. This study will also analyze the social changes associated with governmental and non-governmental institutions that influence and interact with the fishers and aquaculturists. This thesis examines how fishers´ and aquaculturists' livelihoods respond to these changes by using SLF and resilience theory.

1.4 Research questions

- What are the inshore fishers´ and aquaculturists´ livelihoods capitals (human capital, physical capital, financial capital, natural capital and social capital)?
- What makes the inshore fishers and aquaculturists either resilient or vulnerable?
- What are the outcomes of inshore fishers´ and aquaculturists´ coping strategies in the context of resilience and vulnerability?

1.5 Thesis structure

This thesis will be divided into the following sections; the first section includes the introduction of this thesis. The second section is the background information about the country and the country´s historical background in fisheries. The third section is furnished with literature review. The literature review deals with past studies of SLF in regards to fisheries. The fourth section describes the methods and the theoretical framework for this study. The fifth and sixth section of this thesis present the results obtained from the interviews and discussion in relation to fishers´ and aquaculturists´ coping strategies. Finally, seventh section is the conclusion of this paper, sets out to provide an in-depth understanding of the livelihoods of the fishers and aquaculturists in Penang.

2.0 Background

In this section, a brief introduction about the political structure of the country and institutional setting in relation to fisheries and aquaculture is presented. In addition, historical information of the fisheries in Malaysia is furnished to provide a better understanding of the social structures and policy formation for the fisheries sector in Malaysia.

2.1 Country Description

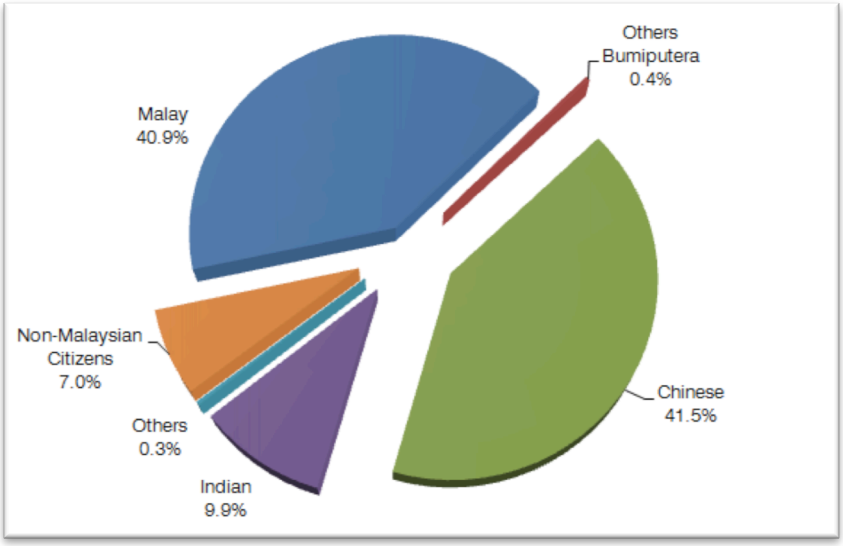
Malaysia became fully independent from British colonialism on 31st of August 1957. The country´s federation consisted of Peninsular Malaysia, Sabah, Sarawak and Singapore. However, Singapore seceded from the Malaysian federation in 1965. Hence, borders were formed in between Peninsular Malaysia and Singapore in the south.

Malaysia has a tropical climate with its geographical location situated in the equatorial zone. The weather is hot and humid throughout the year with abundant of rainfall. Rainfalls are influence by the two monsoons, the northeast monsoon (October to March) and the southwest monsoon (May to September) (Straker 2005).

Population

The pluralistic and multicultural country has multiple ethnic groups. The main ethnicities are Malay, Chinese and Indian. The country´s population has reached 30 million people in 2014. About 1.6 million people are living in Penang, and the majority of the population are of Chinese ethnicity (41.5%) and Malay (40.9%) as shown in Figure 1. Penang is one of the most urbanized states in Malaysia.

Figure 1: Percentage of Estimated Population by Ethnic Group in Penang 2013



Source: SERI, 2013

Social Economy

In 1969, locals who depended on trade and commerce were badly impacted by the issues of declining seaport trade. The disparity between the rich and poor had instigated 13th May riots and bloodshed among the Malay ethnic and Chinese ethnic in Malaysia. This incident had marked the start of New Economic Policy (NEP), with the aim to restructure the society and eradicate poverty. A New Economic Policy (NEP) was formed after racial riots in 1969, and aimed to restructure the society and eradicate poverty. In NEP, Malays and the aboriginals categorized as "Bumiputera" are entitled to social and economic benefits from government. The entitlements include, 60% university candidates reserved, job opportunities and housing properties reserved for Bumiputera (Snodgrass 1995). Data from Malaysia´s government statistic shows that there was a significant decrease of poverty level for the population in Malaysia from year 1970 (49.7%) to 2012 (1.7%) (EPU n.d). This policy is applied to all economic sectors in Malaysia, including the fisheries sector. Most of the fishing equipment provided or subsidized by the government is given mostly to the Bumiputera.

2.2 Political and Legal Structure in Malaysia

There are 13 states and 3 federal territories in Malaysia. The states are Penang, Perlis, Kelantan, Terengganu, Pahang, Johor, Malacca, Negeri Sembilan, Perak, and Selangor, Kedah in the West of Malaysia and Sabah and Sarawak in the East of Malaysia. In addition, there are three federal territories; Kuala Lumpur, Labuan and Putrajaya.

Malaysia is an Islamic country with a democratic constitutional monarchy. The Sultan is the head of state while the Prime Minister as the head of the government. The bicameral parliament legislative has the House of Representatives (Dewan Rakyat) and the Senate (Dewan Negara). The federal government has the jurisdiction over lands in federal territory. However, land matters are ruled by each of the state governments (Ong 2006; Straker 2005). For instance, state owned mangroves are under the state´s jurisdiction and not the forestry department in the federal government (Ong 2006).

2.2.1 Fisheries laws and regulations in Malaysia

Fisheries Act 1985

The main Act that governs the Malaysia Fisheries is the Fisheries Act 1985. This Act aims to manage, develop, conserve, and control marine fishing and fisheries resources. After Malaysia ratified the United Nations Convention on the Law of the Sea (UNCLOS) in 1996, the act has expanded to include the Exclusive Economic Zone (EZZ). The objectives EZZ covers (Mazuki 2008):

- Administration of fisheries in Malaysia
- Licensing and management of local and estuarine fishing operations
- Control of fishing by foreign fishing vessels in Malaysian fishing waters
- Offences, prohibitions and control of certain methods of fishing
- Establishment of marine parks and marine reserves
- Offences and legal procedures relating to the implementation of the Act

The Ministry of Agriculture and Agro-Based Industry (MOABI) is given the authority to enact subsidiary legislation for the management and conservation of marine resources. According to FAO (2001) the subsidiary legislation covers:

- **Fisheries (Marine Culture System) Regulations 1990**
  This regulates the establishment of brackish aquaculture production in application for licensing, operations and controls pollution from such aquaculture activities.

- **Fisheries (Maritime) Regulations 1967**
  It provides licenses for fishing equipment and gear for maritime waters off the east and west coasts of Peninsular Malaysia.

- **Establishment of Marine Parks & Marine Reserves Order 1994**
  Marine parks are considered gazette areas which fishing and collection of other aquatic animal are prohibited.

- **Fisheries (Conservation & Culture of Cockles) Regulations 1964**
  This act aims to manage, control and provide licensing for collection of adult cockles and cockle spats from natural spat fall areas and cultured areas. In addition, it regulates the allowable size for cockle harvest.

- **Fisheries (Prohibition of Methods of Fishing) Regulations 1980**
  This act bans any types of unsustainable fishing methods (explosives, poison and electric fishing, pair trawls, beam trawls and drift gill nets of more than 10 inches for catching rays).

- **Fisheries (Licensing of Local Fishing Vessels) Regulations 1985**
  This act regulates licensing for local fishers´ fishing vessel. Local fishers are required to pay fess and deposits in order for their fishing vessel in Malaysia waters legally.

- **Fisheries (Prohibited Fishing Methods for the Catching of Grouper Fries) Regulations 1996**

  Grouper fry collection is prohibited in the river, lagoon and estuary except:

  a. Fish trap is used
  b. Authorized license is obtained from the fisheries authority.

- **Fisheries (Prohibition of Import etc. of Fish) Regulations 1990**

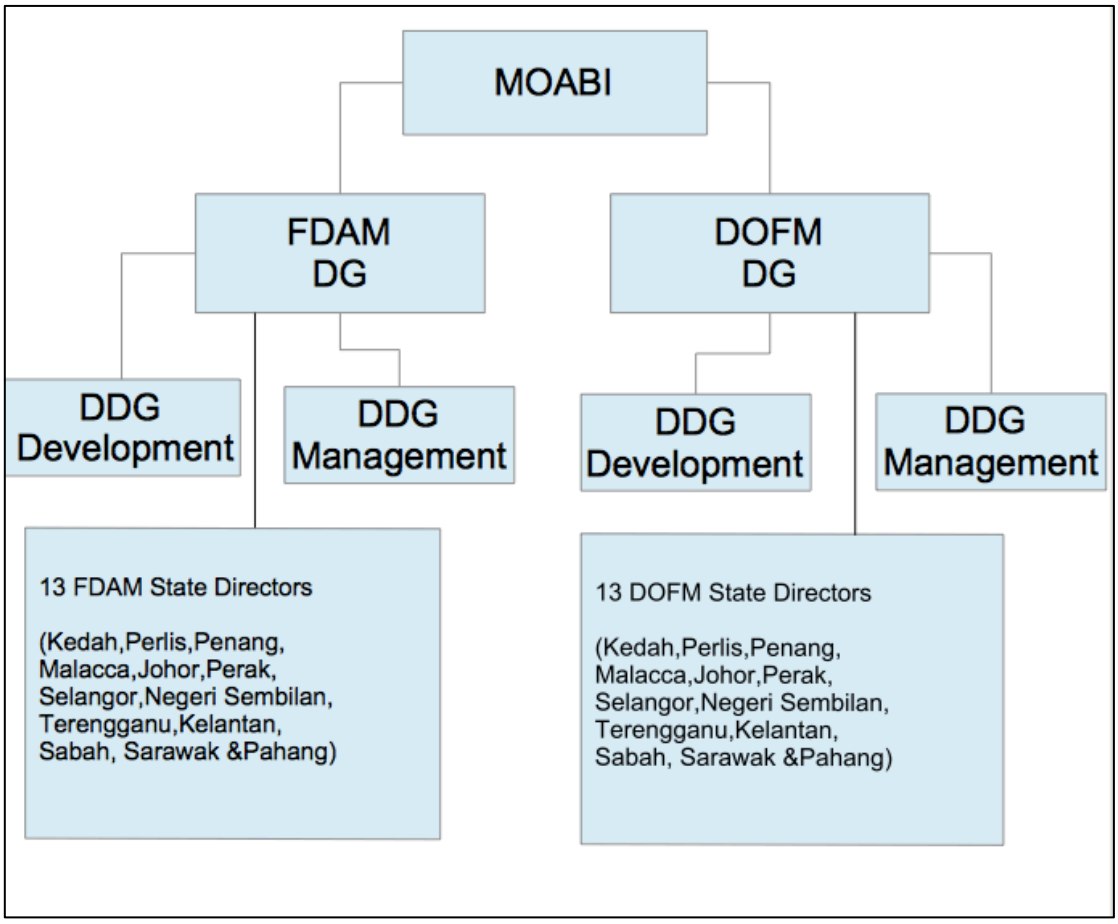
  Imported, exported, sold or kept fishes must to comply with the regulated fish lists species unless Director-General MOABI permits it.

- **Fisheries (Control of Endangered Species of Fish) Regulations 1999**

  This act is aligned with Convention on International Trade of Endangered Species (CITES). It is an offence to fish, harass, catch, kill, possess, sell, buy, export or transport any fish or mammal species listed in the endangered and protected list. Any unintentionally catch shall be released immediately.

2.3 Institutions in relation to fisheries in Malaysia

Figure 2: High level organization chart of Fisheries Institutions in Malaysia



Source: MOABI, 2015, FDAM 2015 & DOFM 2015 (refer to appendix 2)
(MOABI=Ministry of Agriculture & Agro Based Industry Malaysia, DOFM= Department of Fisheries Malaysia, FDAM= Fisheries Development Authority of Malaysia, DG= Director General, DDG= Deputy Director General)

2.3.1 Department of Fisheries Malaysia (DOFM)

The MOABI administer both the DOFM and Fisheries Development Authority of Malaysia (FDAM). The DOFM governs and plans the marine parks and aquaculture sector in Malaysia (De Young 2006). In addition, it has branches in every state of Malaysia. According to Starker (2005:148), the DOFM functions are as below:

- Enforce the Fisheries Act 1985 and the Exclusive Economic Act 1984;
- Manage, conserve and rehabilitate fisheries resources;
- Conduct fisheries research;
- Promote sustainable aquaculture;

- Provide fisheries extension services;
- Train fishers, farmers and downstream industry entrepreneurs;
- Control fish diseases and provide quarantine services;
- Promote recreational fisheries;
- Monitor the pollution affecting fisheries resources;
- Provide basic fisheries data; and
- Establish standards and inspect fisheries products with the cooperation of related agencies.

DOFM regulates fisheries affairs, resource management, engineering and development in fisheries. The DOFM is headed by a Director General (DG) and assisted by two Deputy Director Generals (DDG), they are the DDG (development) and DDG (operations).

DDG (Development) supervised seven divisions (Mazuki 2008):

- Division of Aquaculture Development
- Division of Fisheries Extension
- Division of Recreation Fisheries and Marine Park
- Division of Licensing and Resource Management
- Division of Planning and International Relation
- Division of Development and Legal Service
- Division of Research.

DDG (Management) has control over the six divisions (Mazuki 2008):

- Division of Administration and Finance
- Division of Fish Quarantine and Quality Assurance
- Division of Human Resource Development
- Division of Resource Protection
- Division of Fisheries Information Management
- Division of Engineering

Besides the DDGs, DOFM has State Directors that report directly to the DDG. State Directors has a smaller organization bodies that resemble the DOFM organization (Mazuki 2008).

2.3.2 Fisheries Department Authorities Malaysia (FDAM)

The FDAM, the sister agency to DOF, is responsible for the social, economic and the livelihoods of the fishers in Malaysia (Mazuki 2008). The head of FDAM is the Director General who is supported by two deputy director generals, one of them in charge of the fisheries management and the other on the fishers' development. These deputy director generals have five other directors from different divisions reporting to each of them. In addition, every state in Malaysia has FDAM branches as a channel to proliferate all the programs and development to the local fishers. All other individual divisions like the fishers registration office, internal audit, corporate communication, integrity and law unit that reports directly to the FDAM Director General.

According to FDAM (2014), the agency aims to achieve the goals as below: -

- Establish a progressive fishermen's community by 2015
- Increase the national fishery harvesting sector productivity to 1.7% annually
- Facilitate the increase of aquaculture production up to 10% by 2015
- Support the Agro-based Industry development
- Increase marketing efficiency and marketing pathway
- Transform the national fishery infrastructure by 2015
- Increase competency of officers and staff-members effective as of 2011
- Establish a permanent communication system by 2015.

In addition, MOABI has promoted Malaysia Good Agriculture Practice (MyGAP) licensing in all agricultural sectors including the aquaculture sector since 2013. MyGAP focuses on the social, environmental and economical aspects of the safe food production. The certifications called Good Aquaculture Practice (GaqP), Aquaculture Farm General Guidelines and MS 2467:2012 from the Code of Practice for Seaweed Cultivation are used in aquaculture sector module. It had provided opportunities for the aquaculturists to increase their competitiveness in the international market. This is

because MyGap certification is aligned with ASEAN GaqP and Global GaqP. In additional, products with MyGaP have allowed consumers to be aware of food safety and quality production in the market.

2.3.3 Fishermen´s Associations Malaysia

Historically, fishers in Malaysia formed their own cooperative associations in small fishing villages in the 1970´s. Government had recognized the importance for these groups to be established in a standardized manner and thus, these associations had become a channel of communication and were able to represent the local fishers interests. In order to encourage local fishers' participation in decision making, the Fishermen´s Association Act 1971 was enacted to support and strengthen fisheries management and development amongst the local fishers (Straker 2005). Registered fishermen associations are governed and regulated by FDAM (Mazuki 2008). In Malaysia there are the National Fishermen´s Association, the State Fishermen Association, the Area Fishermen Association and Fishermen Co-operative. According to FAO (2001), the Fishermen´s Association in Malaysia in collaboration with Malaysia Investment Co-operative aid fishers in saving, business opportunities and investment schemes. The fishermen´s association is also the channel for the government to provide inputs, decision-making, technical support and development for the fishers.

In 1994, Penang Inshore Fishermen Association (PIFWA) was established to aid inshore fishers in trawling issues and conserve the ecosystem in shores and mangroves. Besides PIFWA, CAP has been aiding fishers and cockle aquaculturists since the 1970´s, and acts as a channel that helps the fishers to voice out their problems related to their fishing activities (Sangaralingam 2010).

2.3.4 Ministry of Natural Resources and Environment

There are various governmental departments that link to each other and indirectly affect the fishers´ and aquaculturists´ livelihood in Malaysia. The Ministry of Environment (MOE) governs and controls the pollutions in the country. For instance, industrial and domestic waste, erosions, eutrophication and siltation in the rivers and other pollutants released into the seas are evaluated through impact assessments and environment quality control assessments. Land use and management is controlled by

the state authorities jurisdiction. Based on the Detailed Environment Impact Assessment (DEIA), the MOE is to determine whether the land use is sustainable or not (Tan, 1998 in Straker 2005). Meanwhile, the Forestry Department, which is under the Ministry of Natural Resources, is responsible for the mangrove management in the coastal areas. The National Forestry Act 1984 is one of the acts that determines mangrove land´s usage for conservation or for aquaculture activities (Straker 2005). All these sanctions and assessments can affect the fishers and aquaculturists directly.

2.3.5 Department of Islamic Development Malaysia (JAKIM)

Since Malaysia is an Islamic country, most of the aquaculturists need to obtain halal certification from JAKIM in order to expand their business to the Muslim market nationally as well as internationally. The halal certification ensures that the products are free what Muslims consider forbidden animals, or animals that had been slaughter according to Islamic law. With the halal certification sign on the goods, aquaculturists are able to ship their goods and expand their businesses to other Muslim countries in the Middle East. Also, the local biosecurity department, which lies under the DOFM, screens all the goods and ensures that the fishes and shrimps meet the food safety in the national and international level.

2.3.6 Non-governmental organizations

Consumers´ Association of Penang (CAP)

CAP is one of the active NGOs in Malaysia, which was established in 1969. CAP is known as grassroots association that researches and reports on issues at the community level to the public and to the authorities. The organization aims to provide assistance regarding individual rights for basic needs such as food, water, education, health care, sanitation, education, public transport and a clean environment. Other concerns include issues related to sustainable development, environment and human rights. Prevalent work of the CAP includes product safety, food, health, culture, consumer rights, legal issues, development and environment issues. The sister organization, Sahabat Alam Malaysia (SAM) is also known as Friends of the Earth Malaysia, affiliated with Friends of the Earth International addresses more on environment related issues. For instance, CAP and SAM campaigned on a dam that affected indigenous people in Sarawak, and fought for fishers´ rights in relations to

pollution issues in the Juru River in 1970´s. CAP successfully brought forth the struggles of the people in the national and international level through its network and media (Heryanto & Mandal 2003).

2.3.6 Intergovernmental organizations

Southeast Asian Fisheries Development Center (SEAFDEC)

SEAFDEC is an intergovernmental body, which is, established 1976. It consists of eleven member countries, which include Brunei Darussalam, Cambodia, Indonesia, Japan, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam. One of SEAFDEC´s technical research departments is located in Malaysia, and is under the Marine Fisheries Resources Development and the Management Department. Its functions are to plan, coordinate and implement the research programs. According Straker (2005:162) , SEAFDEC has sponsored numerous development programs managed by the FDAM, as listed below:

- Fisheries Development Program
- Fishermen Community Development Program
    - Coastal fisheries industry development;
    - Deep-sea fisheries industry development;
    - Aquaculture development;
    - Upstream fisheries industry development;
    - Downstream fisheries industry development;
    - Marketing support services; and
    - FDAM commercial development.

SEAFDEC-ASEAN Task Force

The SEAFDEC-ASEAN Task Force is an international body, which aims to set a platform for public and private sector to establish sustainable fisheries and aquaculture practices in ASEAN regions. The task force team provides innovation and development sharing among the stakeholders in ASEAN, which it helps to strengthen the stakeholders to deal with the emerging issues in aquaculture. Based on ASEAN-SEAFDEC (2014), the task force team had identified a few key issues such as, aquatic animal health management, sustainable aquatic feed and capture fisheries.

Other international organizations

FAO (2013a) quoted that there are also some other international organizations that is in relation to fisheries in Malaysia as below:

- World Trade Organization (WTO)
- ASEAN Free Trade Area (AFTA)
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and to both the Convention on Biological Diversity (CBD) and the Biosafety Protocol.
- Malaysia had ratified the Ramsar Convention in 1994 treat and had been part of the conservation and sustainable use of the wetlands to improve the coastal ecosystem (Compendium of Environment Statistics Malaysia 2013)
- Agreement on the Network of Aquaculture Centres in Asia and the Pacific (NACA) 1988, together with Australia, Bangladesh, Cambodia, China, Hong Kong, India, Korea, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand and Viet Nam.

2.3.7 European Commission's Directorate General for Health and Consumers (SANCO)

Besides JAKIM certification, there are other international institutions that ensure that aquaculturists' goods are safe for consumption before they export them to other regions. Under the European Commission, SANCO ensures fish product imports are in compliance to their standards, including hygiene, food safety, fish feed, and animal health.

2.4 Historical Background of Fisheries in Malaysia

2.4.1 Marine Capture Fisheries in Malaysia

A fisher is a person who has worked in fishing activities for at least 120 days a year, whilst a fisher working less than 120 days is considered a part-time fisher (SCTR 2014). Fishing operations in Malaysia can be categorized as commercial fishers and non-commercial fishers (traditional, artisanal, inshore fishers, small scale fishers). According to Ahmad et al. (2003) , 63.1% (15611) of the fishers were traditional inshore fishers. Fishing gears such as hook and lines, traps, and lift nets are used in their fishing operations. The remaining 36.9% were the commercial fishers that use trawl nets, fish purse seines, shrimp trawl nets and anchovy purse seines.

Fishers started to to use trawl nets and drift nets in the1960´s, after the introduction of synthetic and trawl fishing gear. These new introductions had a substantial effect on marine capture sector, fishers and the coastal ecosystem. Nets made of synthetic material are durable, economical and require less manpower and maintenance compared to traditional nets. Demand for synthetic fishing nets increased rapidly and the usage expanded from the West coast to East coast of Malaysia. The first trawl net was used on a twenty meters long boat in 1963 and the number of trawlers had increased to forty boats by the end of 1966. Many artisanal fishers had converted to commercial fishers as trawl boats are more efficient in marine fish capture compared to traditional fishing methods. The government had also opened new Exclusive Economic Zone (EEZ) in the seas of Malaysia in order to support trawling operations amongst the commercial fishers (FAO 2009).

Although there was not much information or record on fish populations, the landings of fishes in the marine catch were plentiful as quoted by Mohd and Mohd (2003:128):

> "Information on fish abundance during these early times is scant due to the absence of any credible resource surveys, but it is generally agreed that the waters were greatly infested with fish. Tiews (1965) estimated fish density in the continental shelf area of Malaysia less than 50 m deep as 12 tons/sq. nm, not considering the shallower near-shore waters would generally have higher concentration of fish than offshore waters"

However, conflicts between commercial and inshore fishers arose when commercial trawlers started to overexploit the fish resources. The trawlers had destroyed inshore fishing ground, boats and fishers´ nets. The government imposed strict regulations to ensure sustainable fishing by issuing trawling license to fishers´ cooperative. The enforcement of law, however, was weak. Many fishers from commercial trawling practiced unreported fishing. In addition, corruption and inadequate sanctions worsened the tension between the inshore and commercial fishers as quoted by Sebastian (1990:43):

> The discontent and anger of traditional fishermen were precipitated by an incident in late 1965 when an illegal trawler rammed into an inshore boat leading to the destruction of the boat and drowning of the crew. Inshore fishermen attacked a trawler in the same area, murdering eight of the crew and burning the boat. In December 1966 about 1,000 inshore boats rallied to Weld Quay (Penang) with the objective of burning the office of the George Town Co-operative Trawling Society.

There was a substantial increase for the number commercial and inshore fishers and marine catch. Overfishing issues and the excess of fishers had resulted government to siphon off some of the fishers to other economic sectors (Mahmood 1993). From 1980 till 1987, there was a 30% decrease in marine fishers as the government had relocated 10,500 fishers in the Fifth Malaysia Plan (1986-1990) (Sebastian 1990). The committee of the relocation program had provided assistance, compensations and divided the fishers to work in other different economic sectors. However, the fishers´ relocation program was a not an obligation and fishers were given choices to accept or decline the relocation program (Mahmood 1993).

In 1989, the Department of Fisheries Malaysia (DOFM) had issued 6,384 licenses to the fishers but the licensing was reduced to 5,619 units of trawlers at the end of the year (FAO 2009). Overexploitation of fish resources in the coastal areas has continued to increase the pressure on Malaysia´s coastal ecosystem. Measures taken by the DOFM to reduce overfishing appeared consistent, however, the attempts have not been successful (FAO 2009) as some still practiced illegal and unreported fishing.

Marine capture remained the highest with catches amounting at 1,428,881 tons and with a value at about RM6, 651.89 million (DOF 2010). Inshore fishers were the

main contributors, with fish landing 1,108,897 tons and approximate RM5, 362.97 million of value (DOF 2010). Deep-sea fisheries only accounted 319,984 tons production and RM1, 288.92 million (DOF 2010). According to DOF (2010) report, the total labor force in fisheries consisted of 129,622 licensed fishers and 26,291 aquaculturists. The labor force was approximately 0.55% of the estimated 28.3 million Malaysian population in 2010 (*World development Indicator* 2015).

As a result of overexploitation in the marine fisheries, several measures were taken by the government in the effort to prevent and control overfishing (FAO 2001):

- **Direct limitation of fishing effort**

  Limiting issuance or additional issuance for fishing license.

- **Regulating volume of the fishing vessels fishing**

  Fishers are obligated to obtain approval from the Director – General of Fisheries to modify their boat´s capacity or engine.

- **Fisher and boat registration**

  Government had imposed new rules to ensure new registered fisher will be issued a fishermen registration card.

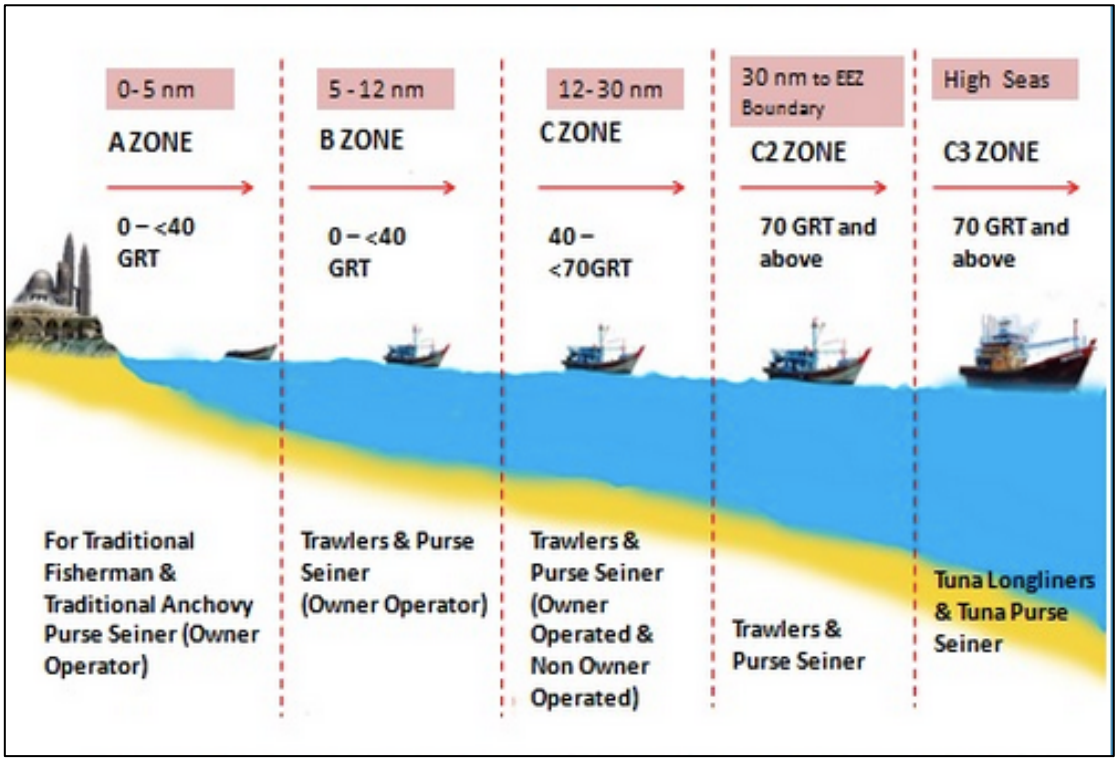
- **Fishermen relocation programmed**

  Government had encouraged the excess fishers to be relocated to other economic by providing other job opportunities.

- **Fishing zones**

  Government had imposed fishing zones sanctions by categorizing the fishing zone according to the types of fishing gear and Gross Registered Tonnage (GRT) of the fishing vessel.

Figure 3: Fishing zones based on types of fishing gear GRT



Source: DOF, 2015

Zone A (0-5 nautical miles)– Fishing zone catered for inshore fisher using traditional fishing gears and vessel less than 40 GRT.

Zone B (5-12 nautical miles)– – Fishing zone catered for commercial trawlers using trawls nets and purse seiner nets fishing gears; vessel less than 40 GRT.

Zone C (12-30 nautical miles)– – Fishing zone catered for commercial trawlers with bigger GRT; 40 - <70 GRT. Trawls nets and purse seiner nets are used in this area.

Zone C2 (30 nautical miles till EZZ)- Fishing zone catered for commercial trawlers with capacity more than 70 GRT. Trawls nets and purse seiner nets are used in this area.

Zone 3- Deep-sea fish operators are vessels above 70 GRT using tuna long liners nets or tuna purse seine.

However, fishing zones mentioned above is not applicable for Penang state, Kedah state, Perak state and Selangor state (DOF 2015). Penang fishing zones for the inshore fishers had been extended from 5 nautical meters to 8 nautical meters. Fishing license with A, B, C and C2 zones is no longer issued (FRI 2014). These measures are to prevent disputes between inshore fishers and commercial fishers and address the issues of overexploitation one (EEZ) (Straker 2005).

2.4.2 Aquaculture in Malaysia

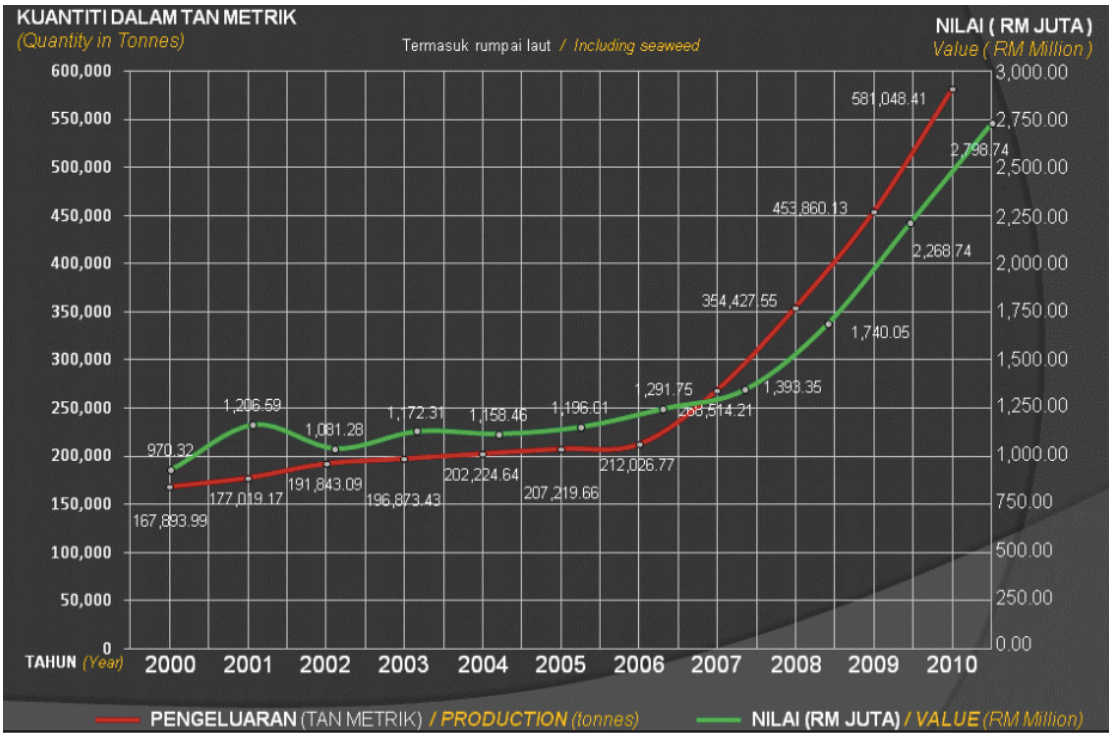
The first fish culture started in 1920´s was a polyculture system, with farming various types of carps in ex-tin mining pools. Subsequently, in the 1930´s, marine shrimp trapping ponds were established in Johor, blood cockles in the 1940´s and other freshwater fishes in the 1950´s (FAO 2013a).

Aquaculture production in Malaysia has expanded to marine fish floating cage culture, freshwater fish, seaweed, ornamental fish and cockle farming. The increase was mainly in the West Peninsular part of Malaysia, which is geographically surrounded by coast with rivers, that that have conributed to brackish water aquaculture production. Brackish water aquaculture production dominated the total aquaculture production in 2003 (Anon 2003 in FAO 2013a). In addition, favorable government aquaculture policies encouraged more people to become involved in commercial production (FAO 2013a).

The Malaysian government has prioritized development in this sector through the National Agricultural Plan (NAP). Malaysian aquaculturists practice various fish cultures as listed as below (Mazuki 2008):

- Cockle culture on coastal mudflats.
- Freshwater fish culture in ponds, in ex-mining pool, concrete ponds and pen culture in inland wetlands or shallow lakes.
- Freshwater fish culture in floating net-cages.
- Brackish water/marine shrimp culture in brackish water ponds.
- Marine finfish culture in floating net-cages.
- Mussel culture using floating raft (off-bottom).
- Oyster culture using floating raft and longlines.
- Ornamental fish culture in ponds, tanks, aquaria and floating net-cages
- Seaweed culture using the hanging method.

Figure 4: Estimated Aquaculture Production and Value 2000-2010.



Source: DOF, 2010

Figure 4 indicates the national aquaculture production in 2010 (581,048.41 tons) had increased 28% with the total value approximately RM2.8 million since 2009. The major contributors were seaweed production, brackish water ponds and freshwater ponds.

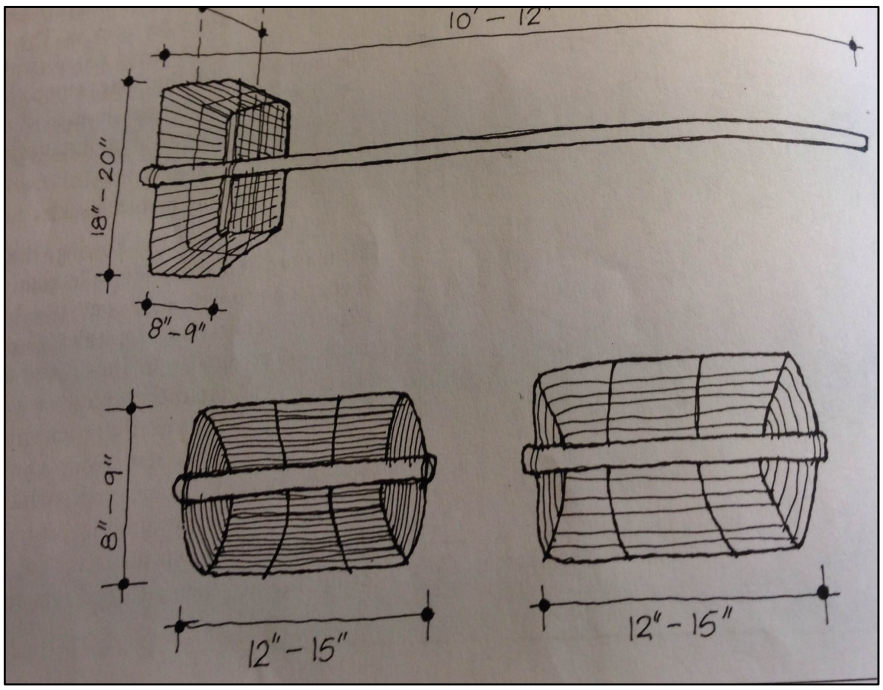
Malaysia has been a net fish importer of cheaper fishes from other neighboring countries while exporting high value fishes and shrimp to overseas. Despite fish trade loss and insufficient locally produced fish, the country´s fish food security is on the high side with 90% sufficiency for local consumption. This is because the net profit from the fish export is able to offset the expenditure for the imported fishes (Mazuki 2008)

2.4.2.1 Cockle Aquaculture

The first blood cockle aquaculture (*Anadara granosa)* production began in 1948 by the headman of the village in Began Panchor, Perak. Due to the high demand and high market price for cockles, cockle cultivation increased significantly in the West Peninsular of Malaysia after the 1948. The coast of the West Peninsular Malaysia

stretches from the Kedah state till the Johor state, and is rich in natural mudflats that are suitable breeding areas for the cockles. Natural cockles can also be found in Pahang in the east of Malaysia in the sheltered area but mudflats in the West Coast of Peninsula Malaysia are still the biggest breeding ground compared to the East Coast. Mass cockle cultivation had a total expansion of 4000 hectares and was run by cooperatives along the west coast and in the lagoon in the east coast. In the 1980, the cockle production had reached 121,000 tons. From the 1950´s till 1980´s, cockle production had represented 85% of total aquaculture production in Malaysia (FAO 1991).

Figure 5: Cockle scoops



Source: CAP, 1980

In Penang, cockle aquaculturists in Juru Village formed a cooperative body to organize cockle-cultivation activities in the 1980´s. In 1993, the government had registered cockle aquaculturist members of the cooperative under the Co-operative Act 1993. A co-operative is a voluntary association with various members with funding collectively shared among the members. According to CAP (1980), cockle aquaculturists were divided into working teams and had a rotation basis with five steps of process:

1. Selecting the cultivation area

2. Sowing the baby cockles
3. Removing the “cockle menace”
4. Transplanting the half-grown cockles
5. Collected the mature cockles

Cockle aquaculturists in Penang still use traditional cockle scoop in cockle cultivation. Two types of cockle scoop are used in cockle cultivation, wired basket attached to a long stick or a short stick. The former is used for harvesting matured cockles when they have reached minimum size 31.8mm and the latter is used for transplanting the half grown cockles ranging from 4-10mm to other areas of the mudflats to avoid suffocation and congestion (FAO 1991). Cockles are menaced by gastropods that are predators to cockles. The cockle aquaculturists remove predators manually when they are spotted in the early stage of cockle growth, or in the latter stage when matured cockles are harvested together with the gastropods (CAP 1980).

3.0 Literature review

This section is the review of literature on the past studies of SLF applied in fisheries and academic writings in relation to fisheries in Malaysia. Although there are limited studies on the fishers´ and aquaculturists´ livelihoods in Penang, these literatures underlines the issues and challenges in fisheries in the past.

3.1 Sustainable Livelihood Framework in Fisheries

The Sustainable Livelihood Framework (SLF) is a holistic approach for understanding a targeted group of people´s livelihood particularly the methods and the livelihood capitals used in their livelihood strategies (Ellis 2000). The livelihood strategies include reducing the risk of vulnerability, poverty and understanding the impact and causes of vulnerability (Ferrol-Schulte et al. 2013: 254). Sustainable Livelihood programs in fisheries were introduced to 25 countries in Western Africa in 1999 to over 7 millions of people for seven years through the Food and Agriculture Organization (FAO) of the United Nation and the Department for International Development (DFID) of the United Kingdom (Allison & Horemans 2006).

The Sustainable Fisheries Livelihood (SFL) approach aims to alleviate poverty among the fishers while ensuring that the marine ecosystem is not compromised (Allison & Ellis 2001; Allison & Horemans 2006). Proper analysis of livelihoods can contribute to sustainable management in fisheries by strengthening and developing the social and human capitals for fishers through appropriate policy and institution (Allison & Horemans 2006). Studies show that policy makers emphasize "equilibrium" fish resources, aiming to maximize fishing capacity in order to meet the targeted fish product. These policies have neglected the well-being of the fishers (Allison & Ellis 2001). It is important to support the fishers' livelihoods as they provide fish protein for the local community especially in poor countries.

The notable studies on fishers in the developing countries such as the "fishing as last resort " (Allison 2011) and "poorest of the poor" (Salayo et al. 2008) have had a significant influence on policy development. The former suggests various factors causing the fishers to live in poverty and claims that substitution of different types of livelihood are needed to prevent overexploitation of fish resources (Martin et al.

2013). The latter suggests that the focus in policy making mainly should be to improve the social economy of the fishers while conserving the coastal environment (Allison & Ellis 2001).

Although the linkage between poverty and deprivation in fisheries had long been reported, Béné (2003:968) argued that to link deprivation in fisheries and poverty is considered too simplistic, and that there is a shift of paradigm that poverty is "a complex phenomenon which encompasses, alongside low income, other concepts such as illness and lack of education, social exclusion, entitlement failure, vulnerability to shocks and political powerlessness". This is not to ignore the existing scarcity or limitation of natural resources but also to assess the role of politics, which provide legitimacy for the access, control, and redistribution of the resource (Béné 2003).

The Malaysia government has observed the importance of providing basic amenities such as clean water supply, electricity, and roads to the people. PEMANDU (2012) stated that the basic amenities in rural areas especially in Sabah and Sarawak in 2012 had increased 30% compared to year 2009. However, a recent study of 2816 fishers in Malaysia shows that the number of fishers living in rural and urban areas that lack insurance, income, education and health were relatively high. Women fishers and unregistered fishers appeared to be more vulnerable than registered fishers, as registered fishers received subsidies from the government (Solaymani & Kari 2014).

There are limited studies about SLF for fishers in Malaysia, however there are studies of fishers in Malaysia that related to the subsets of the SLF. The subsets include existing studies on the fishers' demography backgrounds and impacts of social and environment changes towards fishers´ livelihood. The focus was mainly on fishers´ social economy and environmental degradation. There are also some studies that focus on fishers´ livelihood capitals.

3.2 Issues in Malaysia Fisheries

3.2.1 Overfishing

Today, poverty in Malaysia is relatively low compared to 1970, however, Biusing (2001) pointed out that the fishers in Banggi, Sabah were the poorest in Malaysia. They lived below the poverty line with an average household income of RM300 per day. The inshore fishers were living in improper house conditions, such as small wooden huts built on the sands. Most of the fishers were locals and but there are some illegal immigrants fishers occupants in Banggi. Both groups of fisher depend on the fish resources to sustain their livelihoods. The fishers´ livelihood were badly impacted by overfishing issues, numerous destructive fishing gears (blast fishing, cyanide fishing and trawling) used at the coral reefs coupled with commercial fishers intruding inshore fishers´ zones (Biusing 2001; Teh & Sumaila 2007). In addition, law enforcement and security problems in the east coast of Sabah have been an issue for the inshore fishers. The inefficiency of the fisheries authorities and marine police enforcement in the fishing areas had exacerbated the conflicts between the inshore fishers and the commercial fishers (Teh 2006).

In 1964, fights between commercial fishers and inshore fishers resulted in trawlers being banned, however the ban was lifted in October 1964 due to high demand for fish protein needed to support the increasing population (Ahmad et al. 2003). This high demand was an important source for national economic development. However, new sanctions in fisheries including setting zones for different fishing vessels based on the GRT, were imposed in 1981 to prevent conflicts amongst the inshore fishers and commercial fishers (Ahmad et al. 2003; Majid 1985) .

According to Ahmad et al. (2003), marine fish capture in Peninsular Malaysia has reached maximum yield, and some fish resources have been over-exploited. Since the introduction of modern fishing technology in the 1960s, fishing efforts have increased. As the coastal areas are open, inshore fishing is unrestrained and unmanageable. Hence, commercial trawlers have become inshore fishers´ rivals as they trawl into inshore fishers´ fishing areas which results in fish stock depletion. This is due to weak law enforcement and regulatory regimes with regards to the use of the fish resources.

3.2.2 Natural Hazard

Apart from conflicts, a major natural hazard also affected the fishers´ and aquaculturists' livelihoods in Malaysia. The death toll for Malaysia was 52 people, compared to the two hundred and fifty thousand people who were killed in Andaman Tsunami catastrophe of 2004 (Teh et al. 2009). Many fishers agreed that the mangroves had buffered the big waves and saved their lives from the Tsunami's impact. Studies show that mangrove forests are able to dissipate the wave energy, length and velocity depending wave and on the width of the mangrove forest (Teh et al. 2009).

3.2.3 Coastal Pollution

Table 1: Lesson learnt from Fishers in Kuala Juru Penang 1968-1977

Year	Description	Results/impacts
1968	1. New bridge was built: Tun Abdul Razak Bridge in Juru 2.Juru Dam	1.Prevented fishers to move upstream to sell their fishes to fish mongers in town. 1.Changes the natural flow of the Juru rivers, causing siltation and sediment accumulations in the riverbanks. • The amplitude of tides is 7.62m to 2.23m • Loss of fishes and hindered fishers' work
1971	1. New Industrial zone in Perai (1 mile away from Juru)	1.Mass chemical wastes from the industrial zone were dumped into the river that drains into Juru River. • Harmful heavy metals above international safety level were found in the river • Pollutants contaminated fishes. 2. Local markets refused to buy fishes from Juru
1971-1976	1. Fish resources had dwindled	1. 30 types of fish, shrimp and cuttlefish extinct 2.In April 1976, fishers loss 75% of their income (RM80) compare to before 1968 (RM320).

		3. Impacted fishers´ livelihoods • Children stopped schooling and worked in the sea with their parents. • Could not afford health services • Could not afford nutritious food for the family.
	2. Actions taken by the government officials	1. Slow in response, and had been ignored by the state and federal government. 2. Very little aid received from government.
Mid- July 1976	1. Natural cockles growth in Juru estuaries	1. Fishers started to collect and sell juvenile cockles to FDAM. 2. Dual occupations, fishing and cockle farming. 3.Fishers started cockle-farming project by leasing the coastal areas from the state government. 4. Improvement of livelihood: -Fishers were able to earn income above sustenance and were able to provide proper education and food for their children. 5. Although cockles are more resilient than fishes, unregulated pollution was still an issue affecting cockle farming in Juru Village.

Source: Jomo, 1977

In the 1960´s, the Juru River was rich in natural resources; there were many mangroves and a variety of fishes. Crabs, lobsters, prawns, cockles, fishes and firewood from the mangroves were plentiful. The coastal ecosystem provided nutritious food and economic safety for fishers and local people. The coastal ecosystem services from the river and mangroves were sufficient for the fishers to sustain their livelihoods, including basic needs and school fees for their children. However, unsustainable development in the late 1960´s, such as the construction of

the Tun Abdul Razak Bridge and the industrial zone built in Juru caused the fishers in Kuala Juru village to suffer. The bridge blocked the fishers' boats from traveling to the town to trade their fishes. Consequently, the traveling costs for fish trade had became higher (CAP 1976).

The Juru River became polluted and the ecosystem of the river had undergone drastic transformation. Pollution such as toxic wastes, siltation and sediments from industries and domestic sewage reduced the resilience and changed the ecosystem of the river. According to Berkes and Folke (2000), once a system has reached its threshold to recover from any disturbances and shocks, it will flip into another undesirable state of equilibrium. In this case of Juru River; the pollution caused the river to be uninhabitable for 30 types of fishes, prawns and cuttlefish. Many fishmongers had refused to buy fishes caught in Juru River as the fishes smelled of oil (CAP 1976).

This consequently impacted the livelihoods of the fishers in Juru, as their income became unviable and the living resources became scarce. Fishers could not afford to pay their medical expenses or send their children to school. Many children dropped out of the school in order to help out their families in daily fishing activities. Written letters to the authorities were ignored and assistance given to the fishers was limited. The fishers' standard of living deteriorated and their basic necessities were diminished compared to before 1968.

In 1976, there was a turning point in the fishers' conditions, when cockles had started to grow and spawn on the mudflats in Juru. Most fishers began to spread their risk by taking up a dual occupation, combining fishing and cockle farming. Hundreds of baby cockles found in other parts of the coast were collected in tins by the fishers and were sold to FDAM. Fishers in Juru then started to establish cockle farming projects through a cooperative. The cooperative has a board coordinating the cockle farming projects in a collective manner, and sharing the profits among the cockle aquaculturists. Juru Village's economy revived after the cockle-farming project started. Fishers were again able to meet their basic needs, that included fixing their old broken houses and sending their children to school (CAP 1976).

In spite of the lessons learn from the past, many mangroves in Malaysia were still being exploited for aquaculture, fisheries, agriculture, forestry products, settlement, urban development, industrial development and ecotourism (Chong 2006). The increase in shrimp cultivation has increased the level of pollution. Effluents from the shrimp cultivation polluted the river and cause siltation at the riverbanks (CAP, 2012). However, poor fish and shrimp farming management caused fish diseases and low production (Shariff and Subasinghe, 1993 in FAO 2013a). Thus, unsustainable developments continued to jeopardize livelihoods of fishers and cockle aquaculturists and to degrade the coastal environment.

3.2.4 Land reclamation

Land reclamation, such as the forming of new land or islands through land-fills, changes of the landscape and coastlines, impacted the environment within a short period of time. Due to land shortage and population growth, Penang State started to adopt these methods to expand their lands. However, land reclamation projects can change and degrade the social and environmental systems when impact assessments were not carried out in a proper manner (Yuet Ling 2000).

4.0 Methods

This section involves the methods used during the fieldwork in Penang.

4.1 The Study Area

Figure 6: Satellite image of Penang

Source: Google Earth, 2015

The data collection for this study was carried out from 17th – 28th of November 2014 in Penang. Penang is situated in the northern of West Peninsular Malaysia, and was under the British colonial rule until 1957 when Malaysia declared independence.

The island of Penang has an area of 293 square kilometers, while the mainland part of Penang State (Seberang Perai) is about 760 square kilometers (Sanusi et al. 2008).

This study investigates aquaculture and fisheries in Penang State. Persons from CAP and Penang State assemblymen provided help to introduce me to local fishers and aquaculturists. Meetings were arranged beforehand, prior to the face-to-face interviews.

The eighteen interview of respondents from the fisheries and aquaculture sectors, NGO, and governmental bodies, were conducted in various locations in Penang as indicated by the yellow pins in Figure 6 above.

Primary data from the interviews were coded to provide empirical primary data for this thesis. Due to time constraints, I have also used secondary data for from the government bodies and relevant publications to support this study.

4.2 Data collection methods

A qualitative method is applied in this study to achieve an in-depth understanding of the fishers´ and aquaculturists´ livelihoods and their coping strategies in Penang. According to Sullivan and Brockington (2004), a qualitative method is an empathetic study that enables the researcher to code the respondent´s behavior and speech in a logical manner. It requires the researcher to grasp and interpret the respondent´s social actions (Bryman 2008).

This method allows an outsider, who has little contact with the research subjects, to understand what lies beneath their social reality. Findings are based on the lens of the people, in this case, regarding how the fishers and aquaculturists respond to certain interview questions with their own words, terms and points of view. According Ritchie et al. (2013:33) the advantages using of this method as:

> "…. qualitative methods are particularly adept at looking at the dynamics of how things operate. They can contribute to an understanding of outcomes by identifying the different types of effects and consequences that can arise from a policy, practice system and the ways in which they occur."

4.2.1 Semi–structured interviews

In order to ensure that my interview questions for my study did not deflect from the objectives of the study, I prepared a few sets of semi-structured interview questions catered for respondents from different groups. Bernard (1988 in Cohen & Crabtree 2006) stated that this is to ensure that the researcher has the information needed in his/her studies as he/she would not have a chance to revisit them for a second interview. The state assemblymen and CAP had requested the interview questions in

advanced before the interviews took place. Therefore, I provided them sets of questions two weeks ahead in order to provide them with brief information about the interview.

Clear sets of guided interview questions strengthen the reliability and provide comparable qualitative data (Cohen & Crabtree 2006). A set of semi-structured questions were used in the beginning of the interview with the respondents where respondents provided their demographic information and then other information related to the study.

During data collection, a tape recorder was used for every interview with the consent and agreement of the respondents. While the tape recorder was recording, I was able to jot down some information about their gesture and facial expressions when they were answering the interview questions. Face-to-face interviews with semi-structured questions were carried out for all the respondents. Semi-structured interviews are informal conversations and allows respondents to express their point of views rather than a "yes" and "no" type of answer (Longhurst 2003).

4.2.2 Focus group interview

A focus group interview was carried out with a group of respondents who were both fishers and cockle aquaculturists in Kuala Juru. The setting for this interview was important, as this ensured that respondents felt secure and comfortable when the interview was conducted. Hence, the focus group interview was conducted at the their normal coffee stall on 9th November 2014.

Ogunbameru (2003) points out that a focus group interview is able to reveal the attitude, perception and manner in which the respondents influence each other's opinions in discussion. As a facilitator of the focus group interview, I allowed some respondents to lead the discussion as and when it was appropriate. At times I needed to steer the group discussion back to the track, and observed the group dynamics in the interview. I encouraged some respondents who remained silent to respond to the interview questions. This is to stimulate a group of people in common to feel comfortable to express themselves when talking to each another (Longhurst 2003). This method enabled me to come closer to the goals of my research. The rich data

also helped me to understand the interviewees' backgrounds, livelihood strategies and the social and environmental changes that impacted them in an in-depth manner.

4.3 Sampling

Inshore fishers and both marine fish and cockle aquaculturists were selected as the targeted group for this study because they operate their daily activities in the downstream sections of the rivers, which are often exposed to pollution and other environment stressors. All the respondents in this study were male, except for one female officer from CAP. A snowball sampling method was used in this study, since local inshore fishers and aquaculturists were more inclined to participate in the interview when it was referred by their familiar friends or institution.

According to Berg (1988), snowball sampling is a chain of referral for a circle of group of people who know each other. Respondents felt less skeptical and more willing to share views on certain private and sensitive issues regarding the case study (Biernacki & Waldorf 1981). During my fieldwork, this method turned out to be the most efficient and convenient method for me. Snowball sampling is recommended for qualitative study as it enables researchers to establish contacts with a group of relevant respondents and then with others (Bryman 2008:184).

4.4 Secondary data

I used several secondary sources of data for information that I was not able to obtain directly myself. The secondary data used are from scientific publications, reports and newspapers. CAP also provided me with numerous brochures, books and reports.In additional, online interviews of fishermen were used.

4.5 Limitations

The time available for this study was one the limitations. The fieldwork lasted for less than two weeks. Data collection for this study was intense, with back-to-back interview meetings, and revisiting interviews was not possible. Moreover, the sample size for the data collection is small due to time constraints. Therefore, if this study were conducted for a longer period, the data would be richer in content thereby increase the reliability of the study.

According to Bryman (2008:391), it is not possible to replicate qualitative studies and generalize to other settings. Unlike the quantitative method, the qualitative method is not able to represent the population of the studied group in the area, but rather to support the contextual understanding of the studied group (Bryman 2008).

The limited availability of previously published information about the livelihoods of the fishers and aquaculturists in Penang has made this study challenging. Literatures from the past studies can only support the subset of the livelihood studies.

4.6 Trustworthiness & Ethical consideration in studies

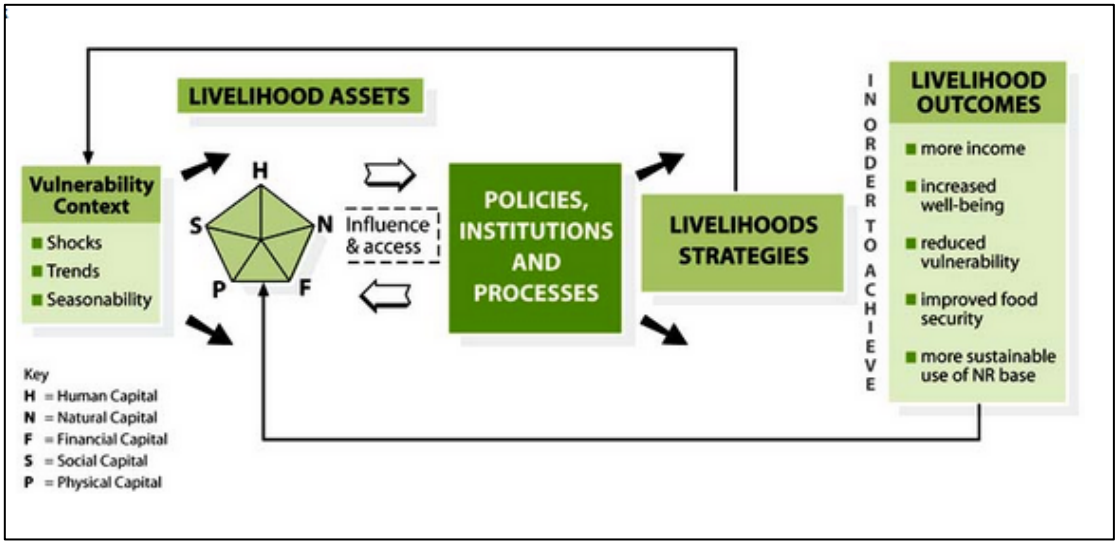
For this study many respondents had requested to remain anonymous, as some information that was recorded were sensitive and confidential. I respected their decision; their names have remained anonymous in this thesis. This is to protect them from any harm or any invasion of privacy (Bryman 2008). Some answers might provoke the sensitivity towards environmental issues in relation to aquaculture practices and institution change in sanctions and decision-making. Respondents were worried that what had been reported might jeopardize their livelihood. Hence, I ensure that there is complete respect for privacy and integrity in my study. I explained the objectives of my research to respondents, and assured them of the safety of the confidential information they provided me.

As student of environmental studies, the knowledge, values, theory, concepts in social sciences could possibly influence this thesis, especially when interviewing the respondents. However, I tried my utmost not ask leading questions that could influence the outcome of of my study, as this could create biases and thereby decrease the validity of my study.

5.0 Theoretical framework

5.1 Sustainable Livelihood Framework (SLF)

Figure 7: Sustainable Livelihood Framework



Source: DFID in Marsh (2003)

SLF in Figure 7 was conceptualised in the 1990s by the British Department for International Development (DFID). SLF aims to contribute to the elimination of poverty by analyzing the causes and relationships between the different aspects of people´s livelihood (Chambers & Conway 1992; FAO 2013c). SLF has contributed to a deeper understanding of people´s capacity, such as their assets and their coping strategies. Although the framework focuses on people´s livelihood capitals, aspects of the environmental sustainability and the impacts of the environment on livelihood are included in order to provide a more holistic understanding of people´s livelihoods (Carney 1998). Chambers and Conway (1992) explained that "A livelihood is environmentally sustainable when one is able to maintains or enhances the local and global assets on which livelihoods depend, and has net beneficial effect on other livelihoods".

5.1.1 Livelihood assets

The livelihood approach derives from literature that seeks to understand how rural people cope with crises through their assets (Allison & Ellis 2001). The core of livelihood assessment framework lies within the pentagon is explained below (FAO 2009:119) :

- Human capital, e.g. household size, skill levels, leadership potential, health status,

- Natural capital e.g. natural resources such as farming and grazing land, forests and non timber products, wildlife, and water;

- Physical capital e.g. shelter, infrastructure such as roads and transport, buildings, irrigation systems, and productive assets such as seed, tools, livestock, fishing gear and other farm and processing equipment;

- Financial capital e.g. cash income and remittances, credit, savings in kind and cash; Social capital e.g. formal and informal institutions (including markets), associations (e.g. water users and savings and credit associations), extended families, and local mutual support mechanisms.

The pentagon in the framework aims to understand the inter-linked relationships within the different types of assets. Various types of external vulnerability such as shocks, trends and season ability can affect these assets.

5.1.2 Policies, Institutions & processes

Policy and institution responses and influences may deter or improve the livelihood assets of an individual. For instance, policy and social relations in the community may prohibit fishers' to access to fishing areas.Therefore, understanding the five livelihood assets enables policy makers and other institutions to provide the right decisions in policy making for alleviating poverty amongst the fishers (Allison & Ellis 2001).

5.1.3 Livelihood Strategies and outcomes

The SLF aims to pursue desirable outcomes: more income, increased well being, reduced vulnerability, improved food security and more sustainable resource use. The outcome depends on fishers´ and aquaculturists´ livelihood strategies in managing their livelihood capitals. However, the strategies are also influenced by institutions such as the government, local fisheries associations and NGOs. Land rights are bound to property right systems; fishery goods are controlled by the supply and demand in

the market and sanctions from the government. These social structures and sanctions may increase or decrease the resilience of the fishers´ and aquaculturists´ livelihood strategies. In a wider context, if the policies are meant to lift up the vulnerable groups of fishers and aquaculturists with a bottom-up approach, then the chances for them to cope with various perturbations would be more effective (Krantz 2001). Understanding the challenges and rights of the access to resources increases the opportunity for achieving a better outcome for their livelihoods (De Haan 2012).

5.1.4 Vulnerability

Miller et al. (2010) stated that vulnerability studies were introduced through the research related to hazards and disasters. It is commonly practiced in fields like anthropology, economics and engineering studies (Adger 2006). What these fields of research have in common is the study of linkages between humans and the environment.

This study aims to examine the elements in the vulnerability context, on how environmental changes affect both the fishers´ and aquaculturists´ livelihoods in Penang. Vulnerabilities elements can be conceptualized when they have susceptible effects towards the capitals assets and causes an individual not to be able to sustain his or her livelihood (Adger 2006). Liverman (1990) study shows that vulnerability can exist in two main elements, which are the biophysical and the political economic. The biophysical includes people living in geographically unsafe areas where they are exposed to hazards and environmental pollutions, while the political economic is related to how power influences the entitlements in the social structure, and how social institutions permit or restrain the rights of the entitlement for the people.

The vulnerability context in sustainable livelihood focuses on personal responsibilities of an individual (De Haan 2012). Personal responsibilities can be viewed as how a person copes and manages challenges based on his or her priorities and preferences in livelihood asset building. Challenges are the vulnerabilities from various stressors from shocks, trends, seasonality, as shown in Figure 7. Shocks include natural hazards; typhoons, climate change, increased fuel prices, low market prices for fishes and fish diseases that decrease the output of fishes beyond fishers´ control. Trends

encompass decline of catch in the area, and other non-fisheries impact, such as household´s health, rising food prices and access to medication (Allison & Horemans 2006). Seasonality is shift of prices, production, health employment opportunities that affected the livelihoods of the group of people negatively (DFID 1999).

5.2 Resilience Theory

Resilience theory coined by Holling (1973:14) defined resilience as " a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variable". However, the concept of resilience has evolved through many other researchers who had adopted this theory in their studies. Berkes and Folke (2000) broaden the resilience theory in social ecological system (SES). SES emphasize linkages and feedback between human in nature. It provides a holistic understanding of the dynamic interconnections of the environmental thresholds and the feedback between social and environment. This is due to the social and environment systems are complex, non-linear, multi-equilibrium and are bound to uncertainties and discontinuities (Berkes & Folke 2000).

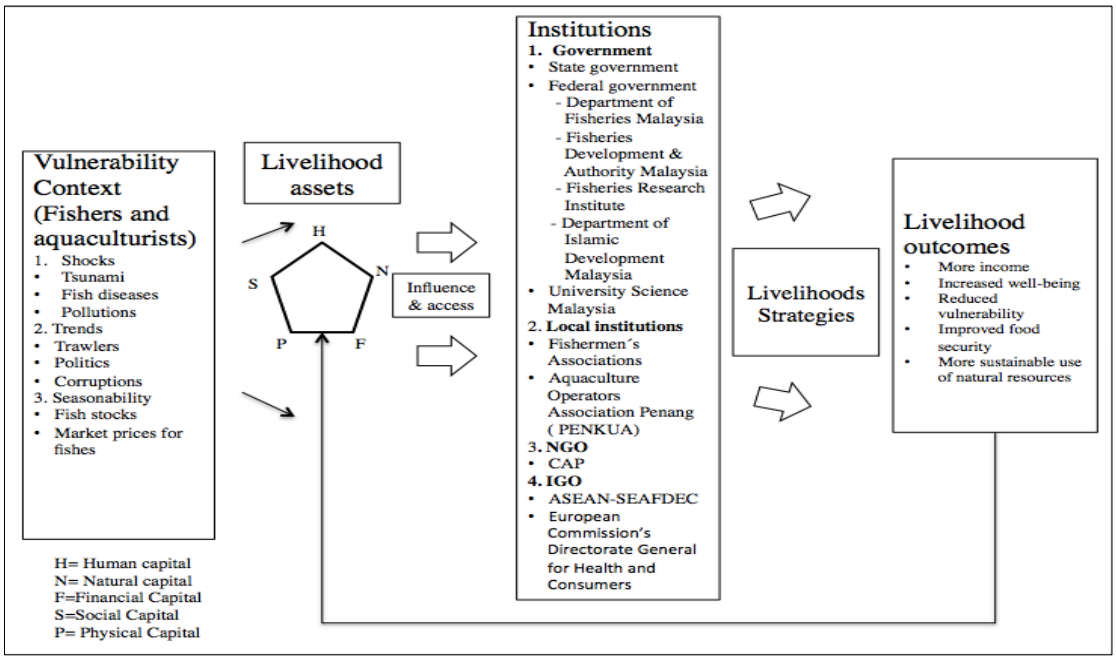
Adger (2000:347) defines resilience as the "…ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change". Allison and Ellis (2001:347) further define resilience in the context of ecological or livelihood system by pointing out the ability of the systems to 'bounce back' from stress and shock. The capability of a livelihood system to absorb the magnitude of stress and shock and retain its initial stage in short period of time indicates the robustness the system has high resilience and low sensitivity to perturbations (Allison & Ellis 2001:378). This theory is important for this study to examine whether the fishers and aquaculturists community in Penang are able to cope with the social and environment changes by understanding their level of resiliency and their level of sensitivity to changes.

6.0 Results

All the respondents are anonymous in this thesis since some information from the them is private and confidential. Hence, the respondents will be referred to as:

- Respondent A, B, C, D, E, F – dual occupation (inshore fisher and cockle aquaculturist)
- Fisher G – inshore fisher
- Fisher H – inshore fisher
- Aquaculturist 1 – Medium scale shrimp farmer
- Aquaculturist 2 – Medium scale fish farmer (and offshore marine fish culture)
- Aquaculturist 3 – Large scale fish farmer (in addition to offshore marine fish culture and inland pond culture)

Figure 8: Modified SLF for fishers and aquaculturists in Penang



Source: Carney 2003

SLF in Figure 8 is modified according to the transcribed interviews from fishers, aquaculturists, governmental institutions and non-governmental institutions in Penang. The following part is the analysis of the fishers´ and aquaculturists' livelihoods in Penang.

6.1 Inshore Fishers´ Demographic Data

This section represents the demographic data for eight interviewed fishers and secondary data from Fishermen's Social and Economic Census surveyed by FDAM in the year 2007. The secondary data in year the 2007 is from the latest census, which is available in FDAM at the moment.

a) Human Capital

The demographic data that was collected for the eight interviewed male fishers in Penang ranges from the ages 38 years old to 65 years old.

Figure 9: Inshore Fisher´s Age in Penang

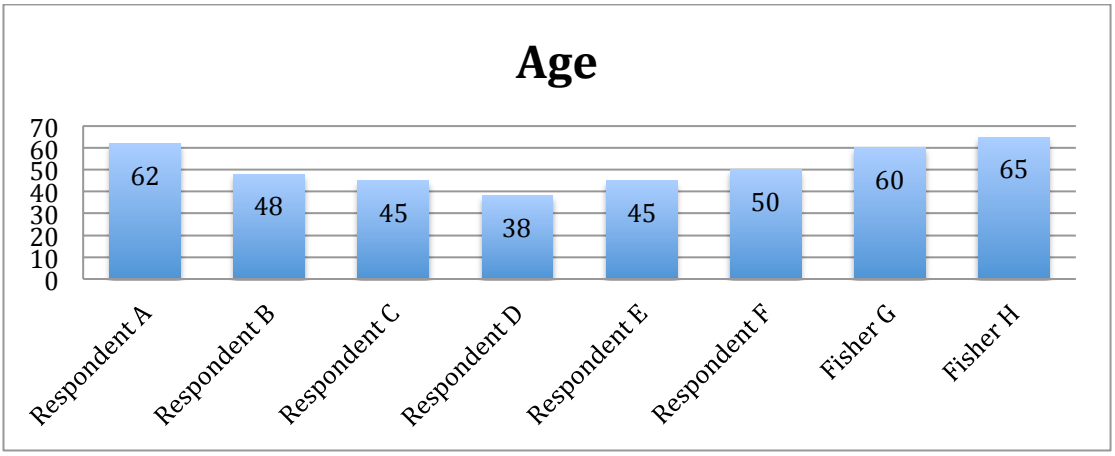
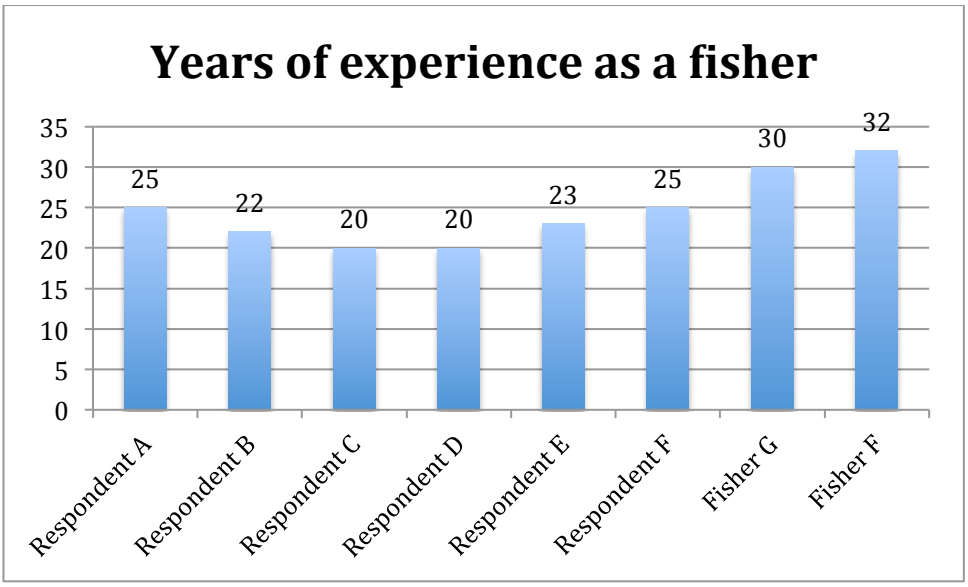


Table 2: Inshore fisher´s education level

Variable	Number of fisher
Number of respondents n=8	
Attended Primary school	7
Did not attend school	1

Amongst the eight interviewed fishers, seven of them attended primary school; only one fisher did not attend school. According to the fishermen´s social and economy census from 2007, only 82 fishers (5.59%) in Penang out of a total 1466 fishers in Penang did not attend school and majority of fishers attended primary school (FDAM 2007).

Figure 10: Fisher´s years of work experience



Good traditional fishing skills and local knowledge in their daily fishing experiences have sustained their livelihoods. Figure 10 shows that most of the fishers have been fishing for 20 years or more. Respondents A, B, C, D, E and F have dual occupations, they fish and farm cockles. Fisher G and Fisher H solely depend on marine fish capture.

None of the fishers experienced serious illnesses, and they have access to public and private healthcare. Nevertheless, Fisher G bears a crooked index finger and stated that he injured his finger years back after pulling his fish traps up from the sea. According to FDAM (2007), about 20% of fishers in Penang face various health problems such as skin, eye, ear, nose or throat illnesses, cardiac hypertension, asthma, nephrology, diabetes, or arthritis.

b) Natural Capital

Coastal areas in Penang provide vital ecosystem services for the inshore fishers and aquaculturists. Figure 11 shows the riverbanks in Juru, which are the landing areas for the fishers to moor their boats, and a working area to fix their fishnets.

Figure 11: Juru River with the Mangroves Swamp along the Riverbanks

The mangroves are the habitat and nursing ground for many different marine and brackish water species, and also contain valuable resources such as fuel wood (Latiff 2012). The fish resources provide the main income for the fishers to sustain their livelihoods (Jusoff 2009). In addition, mangroves protected the fishing community in Pulau Betong, Penang, from the tsunami in 2004 (Filmer 2009).

c) Physical capital

The interviewed fishers were well equipped with fishing gear and have access to infrastructure. Infrastructure includes the paved roads from the main street to the jetty. All the interviewed fishers had access to both clean water supplies and electricity. The roads, canals, jetties enable produce (production/seafood) from the fishers to be transported to other places regionally as well as internationally. Semi-traditional fishing methods are still in practice in their daily activities. The fishers owned different types of nets, traps, and boats. Fisher G uses his self-designed fish traps together with other fishing equipment for his daily fishing activities.

d) Financial capital

Most of the interviewed fishers said that they do not have many savings since they do not have a fixed income. This is because marine catches are unpredictable and vary

from day to day. Nevertheless, some fishers have grown-up children who work in other sectors and are able to support and contribute to the family´s finances. This increases the family income and contributes to the fisher family´s financial capital.

Financial support is only available from a few government financial institutions; this is due to most of financial institution requiring assets such as land grants to process loan applications. Most of the fishers are not entitled to land grants since they build their houses on state owned land. Nevertheless, government institutions such as FDAM and Agro bank are able to provide loans for the fishers to purchase the equipment needed for fishing. Fisher G mentioned that governmental banks loan for fishers can reach RM250, 000 depending on the fishery business setting, and monthly installments are required for the approved loans. In addition, registered inshore fishers are entitled to petrol subsidies at RM1.65 per liter and RM200 monthly allowances from the federal government (MCDM 2008).

e) Social capital

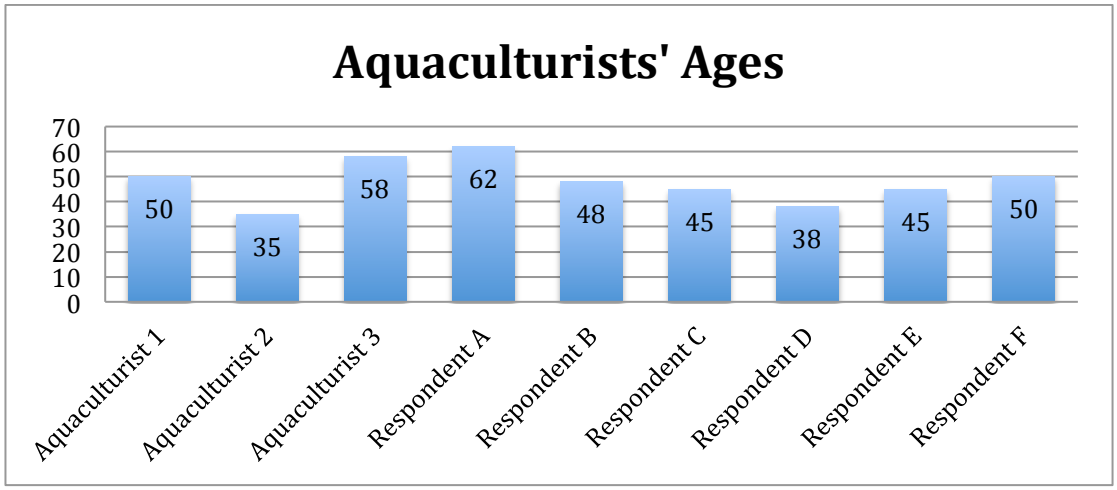
All the respondents were members of the Fishermen Association. According to FDAM (2007) , 82% of the fishers in Penang had a membership in the Fishermen´s Association. Every Fishermen´s Association branch has a chairman and committees who are mostly fishers. Fishermen´s associations serve as a medium between the fishers, local authorities and NGOs. The association enables fishers to voice their views and concerns about fishing and to communicate information to internal and external institutions (CAP 1997). Meanwhile, governmental institutions and NGOs use the association to channel trainings, workshops, capital subsidy entitlement and information about new laws (Othman & Gestsson 2004). All the fishers agreed that the Fishermen´s Association builds solidarity among the fishers to stand as one and fight for their human rights and access to natural resources.

6.2 Aquaculturists´ Demographic Data

This section provides background information about the interviewed aquaculturists in Penang.

a) Human Capital

Figure 12: Aquaculturist´s Age



The interviewed aquaculturists were between 35 to 62 years of age. Aquaculturists 1, 2, and 3 attended secondary school. The cockle aquaculturists´ (Respondent A, B, C, D, E, and F) educational levels are similar to those of the fishers. As Table 3 shows, all the five cockle aquaculturists attended primary school, except for one, who did not have any formal educational background. Low education levels amongst the cockle aquaculturists had affected their ability to qualify for other formal jobs.

Table 3: Aquaculturist´s Years of Education

Variable	Value
Number of respondents n=9	Number of aquaculturist
Attended Primary school	5
Attended Secondary school	3
Did not attend school	1

Table 4 below shows that aquaculturists have a mean of 17.8 years of working experience in aquaculture production. Cockle aquaculturists had more years of

experience compared to fish and shrimp aquaculturists. This is because cockle aquaculturists had been engaged in cockle farming at younger ages when they helped their parents in cockle farming activities.

Table 4: Aquaculturists' years of working experience in aquaculture

Variable	Years of experience in aquaculture
Number of respondent n=9	Mean=17.8
Aquaculturist 1	15
Aquaculturist 2	2
Aquaculturist 3	8
Respondent A	25
Respondent B	22
Respondent C	20
Respondent D	20
Respondent E	23
Respondent F	25

My findings show that shrimp and fish aquaculturists have better access to private and governmental consultations in relation to aquaculture farming compared to cockle aquaculturists. Aquaculturist 1 explained that his feed pellet supplier in Bangkok had provided aquaculture farming management information regarding the layout of the farm and consultation for aquatic disease. In addition, Aquaculturist 3 had collaboration with government and overseas fish consultants for pellet production and fish disease consultations. However, most fish and shrimp aquaculturists prefered to seek private consultants rather than governmental institutions.

The cockle aquaculturists have dual occupations; they farm cockles and also fish in the coastal waters while waiting for the cockles to grow. The cockle farming project is run by a cooperative under the Fishermen´s Association. This collective project has elected committees that manage cockle-farming activities. The Board of the association is able to represent the members in any trading and communications related to cockle farming.

Local and scientific knowledge in Juru village had improved ever since a cooperative for the cockle farmers had been established. In addition, the government and CAP provide workshops and training. CAP is one of the most long-standing NGOs that has

been providing assistance for local aquaculturists. CAP often communicates with the cockle aquaculturists on the current issues happening in fishery and cockle farming.

b) Natural Capital

Waters of the coastal areas, including rivers are shared among different users, especially users from other agricultural sectors. Access to brackish water is vital, as many of the aquaculturists farm marine shrimps. Marine fishes and shrimps have higher value and demand in the market compared to freshwater fishes. Trash fish was still used as feed. Aquaculturist 2 used both pellets and trash fish feed while Aquaculturist 1 and 3 only used pellets for fish feed. Trash fish was an important natural resource for aquaculturist 2 to sustain his aquaculture business. For the cockle aquaculturists, the mudflats at the mouths of the river constituted an important form of natural capital as grounds for the cockles to grow as natural filters feeders. They only feed on nutrients in the muds. Full-grown cockles are able to spawn and reproduce as they grow. Thus, the cockle aquaculturists are highly dependent upon the suitability of the mudflats. Natural spawned cockle seeds can be found in Juru areas and are collected by cockle aquaculturists. This has reduced the seeding cost for cockle farming. Nevertheless, findings show that the natural capital in the coastal areas are deteriorating due to various stressors, which will be further discussed in the following section in the vulnerability context.

c) Physical Capital

All the interviewed aquaculturists had access to infrastructure and facilities such as jetties, highways, and the airport for fish trade. The strategic geographical location of Penang is convenient for both national and international trade.

Aquaculturist 1, 2 and 3 had higher amounts of capital than the cockle aquaculturists. They had business partners ranging from four to six people in the aquaculture enterprise, and they possessed private lands and some state-leased land for their fish or shrimp farming business. Aquaculturist 1 and 3 had at least three aquaculture farms operating in different sites in Malaysia.

Aquaculturist 3 cultured live feeds, produced feed pellets, and owned fish processing factories, transports vehicles, lands, cultured fish, hatchery farms and marine cage fish farms. Aquaculturists 1 and 2 possessed facilities like tractors, water pumps and water treatment ponds. Private lands and farmed fish stocks were physical assets for the aquaculturists. Aquaculturists agreed that these physical assets could be converted into monetary assets if their business ever came into a crisis situation.

The physical capitals for cockle aquaculturists included small boat vessels with 40-horse power engines that mobilize their travel to the river mouth the in the Kuala Juru vicinity. Traditional cockle farming methods require machinery such as cockle sorting machines and cockle washing machines. Individual cockle aquaculturists owned less physical capitals that could be converted into monetary terms. According to Respondent A, each cockle aquaculturist rakes about five gunnysacks of cockles per day to produce for the demand. The market price for one sack of cockles is about RM140-150, but each cockle aquaculturist is able to get RM60 for every gunny sack they have raked.

c) Financial capital

Shrimp and fish aquaculturists had more stable financial capital compared to the cockle aquaculturists. Fishes and shrimps are farmed in controlled systems, and their harvest and profits are consistent as long as there are no serious diseases affecting the shrimps and fishes. Aquaculturist 1, who owned six shrimp ponds, claimed that his company earned at least RM1.0 million for one season (a three to four month period) for each pond. The interviewed fish and shrimp aquaculturists had higher incomes and savings as each company consisted of at least four to six business partners, which strengthens their capital and businesses.

Cockle aquaculturists had limited savings and less physical capital that could be converted into monetary capital. Moreover, they received little financial support from the banks because they did not own much physical capital that could be mortgaged. The land on which their houses were built belongs to the state government. Hence, they did not have land grants, which was one of the requirements needed for loan

applications. The lack of collateral and financial capital has limited their options to cope with various stressors.

e) Social Capital

CAP had been aiding the cockle aquaculturists in Kuala Juru ever since the fishers protested against pollution in the mid-1970s. CAP had placed their officers to monitor and provide assistance for the cockle aquaculturists.

Cockle aquaculturists in Juru were members of the Fishermen Association branch, which acted as a cooperative body and functioned as a representative for the cockle farmers, as well as a medium for communication with other institutions. The Fishermen Association also participated in the management of cockle-farming activities.

The Aquaculture Operators Association of Penang (PENKUA) was established with the goals of forming collectivity among the aquaculturists. Many aquaculturists in Penang were members of PENKUA, as it provides assistance to the local marine aquaculturists in relation to farming issues, such as combating fish diseases and resolving conflicts with other institutions. It connected the local aquaculturists to governmental organizations, NGOs and International Non-governmental Organization (IGOs). Training and workshops were given to equip the local aquaculturists with the latest fish farming technology and to improve their welfare. The association trained new and young marine aquaculturists, and assisted them in the start-up of their fish farming businesses.

Aquaculturist 3 stated that governmental departments such as DOFM held dialogue with his company every three months, wherein they discussed current issues in marine aquaculture. A collaboration project with University Science Malaysia (USM), such as fish and shrimp diseases research, strengthened Aquaculturist 3´s social capital.

6.3 Vulnerability Context

Based on the interviews, this section highlights the factors that increase the fishers´ and aquaculturists' vulnerability in their livelihoods. In addition, statistical data regarding the 2004 Tsunami and secondary literature sources are used in the section below.

6.3.1 Impacts of water pollution on inshore fishers and aquaculturists

The livelihoods of fishers and aquaculturists was under threat due to the water pollution in Penang. The interviewed aquaculturists and fishers pointed to water pollution as being one of the issues they faced. Aquaculturists often found dead fishes or shrimps in their farms because most of their farms are located at the lower end of streams or at the mouth of the river where pollutants have flowed from the upper parts of streams down to their farms.

Pollution from factories in Juru, Mak Mandin and the Free Industrial Zone in Bayan Lepas has impeded development in aquaculture and fisheries in Penang. Since the industrial development in the 1970s, cockle aquaculturists and fishers in Juru coastal have been experiencing environmental degradation (Sanusi et al. 2008). Toxic pollutants discharged from industrial areas into Juru River were still occurring. Some factory owners still tried to avoid paying pollution abatement costs and continued to release toxic effluents into the river illegally. The smell of toxins made the local people feel nauseated, especially during low tide. Fisher G, who lives beside the Juru River said he had seen many dead fishes floating in the river, especially during the end of the year when most companies start cleaning their factories. He also shared one of his personal experiences of his grandson who accidentally fell into the river, gulped a few mouths of water from the river and fell ill. His grandson was affected by contaminated water and was admitted to the hospital for treatment for a few weeks.

Fisher G has noticed that the catch has plunged to a stage where it cannot meet the demand in the market. Often, when he heaved up his fish traps, he inadvertently pulled up solid wastes such as plastic bags from the seabed instead of fishes. He then added, "the sight of the sea from the Penang bridge may be pleasant but do not be

deceived by the beauty of the surface, as the unsightly lies beneath with a layers of filthy plastics smothering the seabed".

During rainy seasons, canals from the Penang Free Industrial Zone (FIZ) gushed pollutants from factories, domestic garbage and many other effluents into the sea. Fisher H said the river mouth is the most polluted area. He had to avoid fishing near the FIZ area, and travelled further to Gertak Sanggul and Rimau Island to fish. As a result, more time and more money on fuels were spent in order to maintain the time required for fishing.

Cockle aquaculturists in Juru mentioned that pollution of the river had been a problem for over 40 years. In periods when pollutions were particularly intense, cockles on the mudflats died before the harvest, and fish resources dwindled. In 2014, cockle aquaculturists in Kuala Juru were shocked when they hauled up their harvest from mudflat areas and found mostly empty shells, dead cockles or under-sized cockles. They had targeted harvesting 12,000 sacks of cockles but the total harvest was only 4,500 sacks. The reduced harvest of cockles resulted in monetary loss of approximately RM1.1 million. The 2014 harvest was 25% less than in 2013. According to the cockle aquaculturists, their best yield was in 2007, when they managed to earn RM2.0 million (about 14,000 sacks of cockles). At that time, bonuses and profits from the cockle farming were shared among the cockle aquaculturists.

Poor harvests caused large loss of profits amongst the Juru cockle aquaculturists. Even the surviving cockles were too small to be harvested. The 2014 growth rates for the cockles was slow compared to the year 2007. The cockle aquaculturists claimed that the condition of mudflats has deteriorated. They had observed changes in the cockle sizes during the sorting process. Many were too small and unsuitable for commercial trade.

Marine fish aquaculturists´ farming zones were situated near the mouth of the river, where most of the pollutants are affecting the fishes in the cages. Aquaculturist 2 said he was not able to control the cleanliness of the water and could only rely on the pollutants to dissolve themselves through the assimilation in the sea. Fishes are prone

to disease when they are exposed to the effluents from the river mouth. In some circumstances, waste from the fishes sinking to the seabed in the same area can also lead to self-pollution.

Aquaculturist 2 mentioned that relocating his fish farm to a new spot in the coastal area is a lengthy process. Red tape amongst the FDAM officials has caused delays for fish farm relocation application to be processed. This was due to FDAM needing to ensure that the new zone in the sea is free from construction and development, and that it should not be a marine protected area. Hence, many offshore fish aquaculturists were reluctant to have their farm relocated.

Figure 13: Trash Fish Feeds in Offshore Fish Farm

Aquaculturist 2, who owns an offshore fish farm in Penang, had around nine foreign workers, fifteen dogs and a farm manager managing 600 fish cages. The farm hygiene was a concern as dog feces and dead fishes are discarded into the sea. The dogs are unleashed and dog feces and urine can be seen all around the farm. Dogs are kept for the purpose of preventing thieves at nighttime.

Many local aquaculturists still practiced trash fish feeding, as most farmed fishes are marine fishes. According to Aquaculturist 2, both pellets and trash fish in fishmeal were used in his fish farm as trash fish feed was cheaper than pellets feed. One kilogram of trash fish costed around RM1.00-RM1.50 while one kilogram of pellets costed about RM3.50 to RM4.00. Aquaculturist 2 assumed that waste from his farm that went into the sea can be cleaned through the natural processes and that proper management for the waste is not needed.

On the contrary, both Aquaculturists 1 and 3 had banned the use trash fish feed in their fish farms. This was because of problems of self-pollution and the fact that it increased the risk for fish and shrimp to acquire diseases. In addition, in order to maintain MyGAP certification they were obligated to comply with the rules for not using trash fish in their feeds.

In addition to pollution of the sea, fish and shrimp aquaculturists were also victims of river pollution. Aquaculturist 3 said that since his farm was situated in the downstream part of the river, so pollutants from agricultural activities such as pig farms and palm oil plantations in the upper river had affected the water quality in his farm. Aquaculturists 3 pointed out that "polluter pays" concept was not possible as pollution was caused by different groups of people. Hence, there was no compensation for the fishers and aquaculturists for any financial losses caused by pollution.

6.3.2 Impacts of Fish and Shrimp Diseases in Aquaculture

The aquaculture sector in Penang had been expanding due to high profit in aquaculture and strong demand for aquaculture products in the market. However, the limiting factor to high profitability was acute epizootic diseases that hit the fish and shrimp farms. Shrimp disease was among the factors that lead to aquaculturists facing great losses in their aquaculture businesses. Poor harvest usually coincides with sick shrimps or death of the fry. Aquaculturist 1 mentioned that shrimp farming is a high-risk business; his friends who farmed shrimp had lost millions of ringgit due to EMS (Early Mortality Syndrome).

Water pollution remained one of the main issues faced by the aquaculturists. Aquaculturist 3´s laboratory assistant stated "Our filtering machines are not able to filter the eggs of parasites when water from the shared river is pumped into our farm". Apparently, the parasites grew together with the fingerlings till the fishes reach adulthood; thereafter fishes suffered malnutrition, diseases and mortality. The losses in fish farming has eroded aquaculturist´s financial capital, natural capital and physical capital.

In an interview with a member of Penang state's executive council (EXCO), it became clear that prior to the new government coming into power in 2008, aquaculturalists were not practicing sustainable aquaculture production. For example, water treatment ponds for the shrimp and fish farming were not enforced by the previous government. Because of this unsustainable production and lack of enforcement, water pollution was not taken seriously which resulted in high water treatment costs in Penang. These costs have been increasing with additional pollution from agriculture, household waste and factories (Mak 2014b; Star 2014).(Mak 2014b; Star 2014).

The Penang state executive council (EXCO) for environment and welfare stated that many of the aquaculturists had mindset with a focus on profit. When government officials visited their farms, they would claim to portray good aquaculture management practices. After the visitation, however, their fish farm management proved to be contrary; including cost cutting on effluent treatment, resulting in unsustainable aquaculture management. This is due to the fact that many aquaculturists are still lacking civic consciousness; a change of attitude and mindset amongst the aquaculturists was still an ongoing challenge.

6.3.3 Impacts of Horse Mussels Invasions in Cockle Farming

Figure 14: Horse mussel invasion in Star newspapers 2012

In 2012, cockle aquaculturists in Juru River and Sungai Sembilang had battled with horse mussel invasion. This pest resulted in slow growth and death for most of the cockles due to a lack of oxygen and food. Cockle aquaculturists in Juru were able to salvage only 50% of the cockles they had sown, and had suffered huge financial losses. Large amounts of dead cockles were piling up the shore of Kuala Juru Jetty and were considered unsightly by the cockle aquaculturists. Appeals were made to the Department of Fisheries, but authorities did not take immediate action to investigate the issue until CAP highlighted it in the press (*Fishermen in despair* 2012).

6.3.4 Impacts of Tsunami

Table 5:Tsunami impacts in Penang

Deaths	Missing	Injured	Damage
52	5	205	521 houses 1430 boats

(b) Deaths by district

District	Site of casualties	Deaths
Northeast	Batu Feringgi/Tanjung Tokong	23
Southwest	Telok Bahang/Pulau Betong	27
Sungai Prai (Central)	Bukit Mertajam Hospital	0
Sungai Prai (North)	Jalan Padang Benggali/Teluk Air Tawar	2
	Overall Total	52

Source: Horton et al. 2008:315

The Andaman Tsunami that happened on Boxing Day 2004 was a rude awakening for Malaysia; it was a least expected disaster since Malaysia is not located in an earthquake zone (Koh et al. 2009). Table 5 above is a summary of the tsunami impacts in Penang. Penang was one of the worst affected states in Malaysia. Many victims were shocked by the event and did not evacuate from the beach when they

saw the big waves approaching the shores. There was neither alarm nor notification broadcasted to warn the picnickers and fishers about the disaster. Consequently, there was a death toll of 52 people while 205 people were wounded and five had gone missing. The highest number of death was in the Teluk Bahang and Pulau Betong areas, with 27 dead. Batu Ferringhi and Tanjung Tokong followed with 23 fatalities. The only places that had put up a red flag to warn tourists were the hotel officials at Batu Ferringhi after they received information regarding tsunami impacting Pulau Langkawi and Thailand (Horton et al. 2008).

Table 6: Estimated Losses for Fisherfolk in Penang

Status	Number of Fisherfolk Involved	Estimated Losses (RM)
Licensed	934	8,881,516
Unlicensed	610	
Crew	1189	
Total	**2733**	

Source: FDAM Penang 2005 in Hung Teik and Lim 2005

Following the catastrophic incident, the fisheries and tourist sector were the most impacted sectors. According to the FDAM 2005 in Hung Teik 2005, the Fishermen´s Association reported that 2733 fishers (both licensed and unlicensed fishers) had lost about a total of RM8.9 million as a result of the tsunami. However, FDAM later verified that only 2486 fishers were entitled to compensation from the government. The compensation included boats, motors, nets and other fishing tools (Hung Teik & Lim 2005). However, fishers said the compensation was insufficient to cover the full cost of their loss. Many fishers still needed to obtain loans from the government, local institutions and NGOs, or use their personal savings to recover their losses (Horton et al. 2008).

Table 7: Number of damaged Jetties in post Tsunami in Penang from Fisheries Development Authority Board (LKIM) Penang

	PNK	No. Of Jetties Damaged	Value (RM)
1	**Pulau Pinang Selatan**	2	150,000
2	**Seberang Perai**	37	1,260,000
3	**Teluk Bahang**	2	150,000
	Total	**41**	**1,560,000**

Source: FDAM 2008 in Hung Teik and Lim 2005

Table 7 shows there were a total of 41 jetties destroyed after the tsunami incident. The estimated total value was around RM1.6 million. Many fishing boats, which were moored near the jetty, were badly damaged. According to the head of the Fishermens´ Association in Balik Pulau, interviewed by Hung Teik & Lim (2005), fishers were still in the recovery stage a year after the incident. Only seven of 42 fishers in that area were able to continue with their daily fishing activities, while four of the fishers waited for their engines from Japan and nets from Thailand. But since Thailand was also hit by the tsunami, the demand for the nets had spiked, resulting in a longer time for fish nets to be supplied. Fishers´ livelihoods were badly impacted, as they were not able to generate any income for their family during the waiting period. Some had waited for four months to get their fishing equipment and boats ready for fishing (Horton et al. 2008). Aquaculturists had more significant financial losses in the post tsunami period. Their losses include boats, cages, raft platforms, fishes, oysters, jetties and other equipment. Referring to the table below, the estimated total losses for the aquaculturists was RM13.8 million.

Table 8: Edited version for the Estimated losses for aquaculturists in different locations during Tsunami

Location	Marine Cage culture	Brackish water Culture	Freshwater Culture	Cockles/Oysters	Total	Losses (RM millions)
Pulau Betong	3	4	1	1	9	3.06
Teluk Bahang	10	-	-	1	11	4.48
Sungai Udang	54	-	-	-	54	5.85
Bukit Tambun	0	-	-	5	5	0.41
Total	67	4	1	7	79	13.80

Source: DOFM 2005 in Colbourne 2005.

Table 8 shows the most impacted areas were located in Sungai Udang and Teluk Bahang. Sungai Udang suffered the most serious losses in marine cage culture, with 54 cages; Pulau Betong lost three marine cage cultures. Marine culture of red snappers, groupers, barramundi and golden snappers were valuable fishes and when the fish farms in Penang were hit by Tsunami, the fish stock died of suffocation due to changes in the water such as suspended muds and lack of oxygen. A total of 79 farms in these areas experienced an estimated lost of RM13.8million (Hung Teik & Lim 2005). According to Horton et al. (2008), one of the oyster aquaculturists had to bear the loss of 20 000 oysters which he had planned to supply to his customer. With all his jetties and facilities destroyed, his customer needed to wait for 3 months until the delivery of batch of new oysters.

All the interviewed fishers said they discouraged their children from following in their footsteps to become fishers. This concurs with Siwar et al. (2006), whose findings showed that a majority of the fishers did not want their children´s occupation to become fishers because it is an unsafe occupation that pose risk to their lives and might not provide a stable income. Most fishers´ daily income was uncertain and most of them had very little pension fund. Fishers preferred their children to work in the white-collar sector, with fishing as the last resort if other jobs are not available.

6.3.5 Impacts of Siltation and Erosion in The Coastal Areas

Figure 15: Shallow Coastlines in Seri Jerejak

Fisher H has observed coastal changes after the Jelutong land reclamation project had been carried out. Crabs and clams had disappeared, as the sand was muddy and inhabitable for them . The muddy sand from sedimentation and erosion had also changed the tidal and current flows of the area.

6.3.6 Impacts of Commercial Trawlers

For the past 40 years, the commercial trawlers operating in Penang have threatened the livelihoods of inshore fishers. Fisher G mentioned that fish stocks were decreasing. Nevertheless, as long as the trawlers were not operating within their fishing zones, they considered that there was still hope for the fish resources to replenish. Trawlers had experienced decreased catches beyond eight nautical miles because the trawling technology is destructive to the seabed and fish stocks. Hence, trawlers were keen to encroach into the inshore fishers' fishing grounds, which are within the eight nautical miles from the shore.

Pernicious conflicts between the commercial trawlers and inshore fishers over the fish resources were still intense in Pulau Betong. Commercial trawlers were accusing inshore fishers for encroaching on their fishing grounds and vice versa. In addition, the inshore fishers complained that the commercial fishers are vulgar and wanted to

pick a fight whenever the inshore fishers informed them that the trawlers had encroached into their fishing grounds. Commercial trawlers had also destroyed inshore fishers' nets when these became entangled with the trawls (Beng Hock 2010).

Commercial trawlers had been operating their daily fishing activities dangerously. They operated in the early morning and at nighttime without lights and had caused boat accidents between inshore fishers and commercial trawlers. Instead of compensating the inshore fishers for their broken boats and nets, commercial trawlers had put the blame on inshore fishers and refused to pay full compensation for the damage. Such incidents have made the inshore fishers infuriated, as they have been forced to pay extra money from their savings to fix the damaged nets and boats (Beng Hock 2010).

Inshore fishers felt intimidated because small-scale fishers´ livelihoods are often ignored. Inshore fishers in Pulau Betong experienced hardship in sustaining their livelihoods. At times, they returned home with just a few fishes or empty handed.

Reports of the conflicts had been made to the FDAM and Marine Police, but to no avail, trawlers were still operating rampantly, encroaching on inshore fishers´ areas. The inshore fishers have been compiling evidence of the commercial fishers' offences by taking videos, pictures and recording respective trawlers´ number plate as they encroached their areas. They had informed the marine police and handed over the evidence of the offences by to the marine police. Yet, most of the time the commercial trawlers were able to escape from any marine police raids (Beng Hock 2010).

Fishers claimed that marine police were slow in their response. They arrived after the trawlers had left and then the inshore fishers were accused of giving false alarms. Inshore fishers suspected there are some syndicates between the corrupted officials with commercial trawlers, providing information about raids to the trawlers. Marine police officers defended themselves by claiming that they did not have sufficient boats or manpower to patrol the coastal areas, leaving the inshore fishers in Penang vulnerable. Inshore fishers mentioned that the enforcement of law remains weak even

if the commercial trawlers were caught red-handed. They were worried that it will come to a point where inshore fishers no longer tolerate the problems anymore and will start to fight (Beng Hock 2010).

6.3.7 Impacts of Fish Resource Overexploitation

Most of interviewed fishers stated that the use of efficient high technology fishing gears such as trawl nets, purse seines, GPS and lights to attract fishes have caused overexploitation of fish resources and destruction of the marine ecosystem. For instance, intensive bottom trawling indiscriminately captured non-target organisms on the seabed. Thus, seagrasses and corals, which provide food and shelter for fishes, were destroyed, and organisms caught unintentionally were either dead or dying when thrown overboard. Fisher D quoted "one is able to spot the differences between the fishes caught by trawlers and inshore fishers by looking at the body of the fish, as most of the fishes caught by trawlers have bruises and are missing scales". This implied that big and small fishes were caught and squashed together when the trawl net was being pulled up.

All the interviewed inshore fishers also stated that there was a lack of enforcement of fisheries regulations regarding the allowable net mesh size, as some of the trawlers use meshes smaller than the approved 38mm mesh size; these are known as crocodile nets `pukat buaya´ and were used illegally by some commercial trawlers. Another reason for the fish stock depletion was considered by the inshore fishers in Pulau Betong was the rivalry between commercial trawlers and inshore fishers for the same fish stock (Beng Hock 2010). The inshore fishers in Pulau Betong considered the rivalry between them and commercial trawlers to be main reason for fish depletion of the same species. In addition, in the recent years, the government had provided subsidies to all fishers. All registered fishers are entitled to the fuel subsidy; the inshore fishers mentioned that they were entitled to RM1.65 per liters of petrol.

Fisher G mentioned that about 15 years ago, he used to place 10 to 15 traps to fish for groupers, snappers, and other crustaceans. At the time of this research, he needed to place 60 to 65 traps, in order to catch the same amount or sometimes even smaller catch. In most of the first quarter of the year, especially February and March, Fisher H explained that he struggled to obtain any decent catch at Seri Jerejak. At times he did

not catch a single fish, even when he had spent extra on fuel to travel further out to sea. This had resulted in financial setbacks in his savings.

6.3.8 Impacts of Fish Prices Fluctuation

In 2012, the aquaculture production for brackish water decreased by 15.6% and lost about 7.92% of its value compared to 2011. This was due to the disease EMS in shrimp farming and horse mussels invasion in the cockle farming (DOF 2012). Aquaculturist 3 stated that many shrimp aquaculturists' businesses were badly affected by EMS. Millions of ringgit were lost, as the mortality rate for the disease exceeded 70%.

In order to minimize their losses, many aquaculturists had switched from shrimp farming to fish farming. In Penang, fish farming has increased and many aquaculturists had started to farm fishes like barramundi, grouper and pomfret in order to spread their risk. However, the rise of production of the farmed fishes had lowered the prices of the fishes. According to Aquaculturist 3, the market price of 1 kg of barramundi fish used to be RM 8.00-9.00 but due to the increased supply, the price has fallen to RM7.00 per kilogram. The net profit is little as many of the aquaculturists have switched from trash fishes to fish pellets for feed. Aquaculturist 3´s lab assistant shared the Feed Conversion ratio (FCR) for the barramundi, which is about 4:1. This implies four kilograms of fishmeal is needed to produce one kilogram of fish. The high consumption of fishmeal and other costs of fish farming leaves only small profits.

During the post tsunami period in Penang, many local people were skeptical towards consuming marine fishes because of seawater contamination and water borne diseases when the marine fishes had perhaps fed upon retrieved corpses. These concerns influenced fish sales locally as well as overseas. One of the fish wholesalers said his sales for Penang marine fishes to Kuala Lumpur had dwindled to 50% from the actual demand in the market (Hung Teik & Lim 2005). Many consumers refused to purchase fishes from Penang during the post tsunami even during festive seasons such as the Chinese Lunar Year when seafood like promfret, shrimps and groupers are usually in highest demand (Hung Teik & Lim 2005).

6.3.9 Impacts of Corruption

Corrupted officials had stunted and weakened the enforcement of law in fisheries, according to the interviewed fishers and officers from DOFM, and both groups mentioned that commercial fishers often had their ways to settle offences against them. Even if commercial trawlers were caught for a fishing offence, they had politicians or well-known people, who were conferred by the state with honorary entitlements like "Dato" to bail them out while paying a sum of money for their summons. They could be caught on one day and then released the next. Fisher G mentioned that the commercial trawlers were able to operate their daily activities within inshore zones without fear. The weak governance system and corruption have benefited the wealthy and powerful people in the society. While the weak and poor, such as the inshore fishers, continued to be marginalized.

Aquaculturists 1 and 3 mentioned that corruption was still ongoing in Penang. They reported that some officials that came to their farms for inspections had other intentions. They abused their powers in the hope that the aquaculturists would bribe them. One of the aquaculturists stated, "Corruption is way too much in all stages of this aquaculture business set up". Corruption is rampant throughout the whole process, from the point when one is starting a farming business until the end product.

Corruption had also hindered aquaculturists from seeking aid from the government. Aquaculturist 1 mentioned that he refused to obtain aid from the authorities whenever problems occurred in his farm. At times, in order to be able to run their business smoothly, aquaculturists were pressured by the authorities to pay bribes.

6.4 Fishers´ and Aquaculturists´ Livelihood Strategies

The previous section presented the factors that increase the inshore fishers and aquaculturists´ vulnerabilities in their livelihoods. The next section focuses on their livelihood strategies in coping with various stressors such as water pollution, fish diseases, overexploitation of fish resources, corruption, natural disaster and the volatile market for fish prices.

6.4.1 Aquaculturists coping with water pollutions

Aquaculturist 1 who had been farming fish and shrimp for more than 15 years said farm hygiene is one of the ways to prevent fish and shrimp diseases. Firstly, it was important that aquaculturists did not self-pollute their own fish or shrimp farms. Shrimp farming requires optimal care and cleanliness, hence the natural assets such as the water condition in the farm needs to be tested and controlled daily as shrimps in all stages (from juveniles to adult shrimps), can only thrive in clean water and a hazardous free environment. He also mentioned that he disagreed with some aquaculturists that use dogs to guard their farms as dogs might be carrying diseases from outside or inside the farm to the ponds.

Aquaculturists 1 and 3 who possessed MyGap certification mentioned that in order to maintain the certification, they were committed to good practices in aquaculture. Water treatment for the ponds was one such prerequisite; waters that were pumped out from and into the farm needed to be treated. The outflowing effluent water was filtered and treated with chlorine before being released into the river, while the incoming water was filtered and then adjusted to the right salinity for fish or shrimp farming. Not all biological contaminants (parasites, coliform and E-coli) or pollutants (debris, toxic chemicals or heavy metals) from the river can be filtered, but the chances of having a good harvest and yield from the shrimp farm would be more promising when these basic farm hygiene requirements were met.

However, the adverse effects of the increasing industrialization and urbanization have affected aquaculture development. Aquaculturist 1 mentioned that he used to have a fish farm in Sungai Udang, but because of the heavy river pollution, his shrimp harvest had plunged to an unacceptable degree. Therefore, he had sold off his farm to cope with his losses and had started a new shrimp farm in Kuala Sungai Pinang. Many aquaculturists were able to offset debts and acquire new lands by converting their physical assets such as farms and the existing fishes and shrimps into cash.

The ability for aquaculturists to have mixed livelihood strategies with access to financial capital enables them to cope and build greater adaptive capacity when confronting unpredicted stressors in fish farming. Thus, shrimp and fish aquaculturists

were mobile, as long as they had sufficient physical and financial assets, they were able to relocate their farms to other areas. However, fish and shrimp aquaculturists were prone to risk if they failed to analyze and make the right decisions in their farming management and thus run into deeper debts. Aquaculturist 2 said the loss of fishes due to pollution was still bearable as long as the strong currents in the sea are able to clean the pollutants and enable the farm to recover from stresses. The amount of dead marine cage cultured fishes was tolerable because the profit from the fishes is high enough to offset the losses.

The cockle aquaculturists are those worst affected by the massive pollution at the river mouth. One of their coping strategies is having a dual occupation; cockle aquaculturists are often also fishers. They fished while waiting for the cockles to grow or in the case of a bad cockle harvest season. In order to sustain their livelihoods, they needed to diversify their jobs and catch. Different types of fishes and crustaceans that were in high demand were targeted. Social capital remained the main support for the fishers during the time of need in their livelihoods. The kinship amongst the fishers in the local fishermen´s association had provided aid to the poor and needy fishers. The local fishermen´s association had supported the poor fishers financially through voluntary contributions and governmental aid. In addition, they also shared information amongst fishers about the areas that are rich in fish resources (through messages and phone calls).

Although fishers had urged the government to take action towards the pollution, it has often landed on deaf ears. Fortunately, social institutions like CAP and PIFWA had been giving fishers support by providing workshops and training, creating awareness and uplifting their rights in fishing and cockle farming. PIFWA sets up programs and training for fishers to better understand pollution and resource exploitation issues in Penang. The support from social institutions like CAP and PIFWA had directly empowered the local cockle aquaculturists, who have been provided with knowledge to understand the issues in relation to pollution in Juru areas. Thus, the aid from CAP was preeminent to the cockle aquaculturists in Juru; most of the issues had been highlighted through press conferences and dialogue with authorities. However, actions and enforcement taken by the authorities remained weak and slow. For

instance, the authorities neglected the cockle aquaculturists in Juru when they requested for help to tackle invasion species issues.

6.4.2 Cockle aquaculturists coping with invasion species

The head of the Fishermen Association Kuala Juru said they had reported the clam invasion species to the FDAM and Fisheries Research Institute (FRI) and requested them to provide assistance. However, only little action was taken in the earlier stage. It was only after the issue had escalated to the press that the fisheries authorities started to aid the cockle aquaculturists. Together with the FDAM officers, Kuala Juru Fishermen unit held a clean- up activity on the mudflats. The cooperation between the FDAM officers and the cockle aquaculturists was a success as they managed to clean up in a short period of time.

6.4.3 Aquaculturists coping and preventing fish and shrimp diseases

Aquaculturist 1 mentioned that maintaining sustainable aquaculture management required extra effort, time and finances, but the return from the hard work and investment was worth it in the long run. The results of good harvests indicated the importance of practicing sustainable aquaculture management. Aquaculture management included daily recording of the shrimps, fishes and water conditions in the farm. Advanced technology such as an auto-feeder machine had made feed utilization and minimization of loss possible. The auto-feeder machine disperses pellets according to a preset timer that enabled aquaculturists to adjust fish and shrimp feeding accordingly. In addition, pellets that were less suspended in the water increase the chances of the shrimp and fish to be fed. This has prevented algae bloom pollution when excessive macronutrients sink to the bottom the shrimp ponds and beneath the fish cages that caused health problems to the shrimps and fishes.

Other methods to prevent shrimp diseases included rotation of different types of farm fishes. Shrimp aquaculturists swapped to fish farming when the shrimp harvest is bad. Fish such as barramundi were farmed to restore the ecosystem in their ponds while offsetting their loss from shrimp farming. Therefore, aquaculturists in Penang could be both shrimp and fish aquaculturists, depending on the results of the harvest.

Aquaculturist 1 and 3 had fish and shrimp experts from overseas for fish and shrimp diseases consultations. Aquaculturist 3 had additional support from DOFM fish disease consultation as part of his farm was connected to the government´s fish and shrimp disease research project. The farm had a fish laboratory for internal research and development. Experiments such as polyculture farming with small numbers of tilapia fishes to consume excess feeds in the shrimp pond were conducted in his farm. This had enabled his company to cope better in fish farming challenges. Future plans for applying fish vaccinations had been discussed in the company. Results from vaccinated fishes show a decrease in fish mortality fish and better immunity against diseases. Another method of preventing fish and shrimp diseases can be found in probiotic usage.

6.4.3.1 Probiotics usage in shrimp feed

Probiotics are living microorganisms that benefit the host by balancing the intestinal flora and improving the immune system of the host (Tseng et al. 2009). The aquaculturists stated that the usage of probiotics for fish and shrimp was less destructive than other types of chemicals. Aquaculturist 1 claimed that he had bad experiences when he used antibiotics and medication to treat sick fishes and shrimps. He mentioned that chemical usage is a short-term solution for treating shrimp diseases. In addition, the shrimps might not be safe for human consumption. Therefore, he used probiotic methods to increase digestion in shrimps and fishes and to treat shrimp diseases. The cost of probiotics usage was higher than antibiotics, but in the long-term, results showed it was less destructive to the environment. The natural probiotic bacteria help shrimp to grow better and healthier and thus increase the production. Aquaculturist 1 had used pineapple probiotics in his shrimp farm. The enzyme substances are mixed together with the pellets in a cement mix machine to ensure pellets are coated evenly with probiotic substances.

Figure 16: White bucket pail storing enzymes and cement mixed machine used by a shrimp aquaculturist to mix pellets and enzymes evenly in Penang.

6.4.4 Aquaculturists' Coping with Natural Hazard (post-Tsunami)

Aquaculturists affected by the tsunami had received little compensation from the government; hence, they had to use their personal savings to restart their business. In Horton et al. (2008), an oyster aquaculturist who had a total loss of approximately RM20,000, received only RM1,000 compensation from the government. The total amount of unaccounted and uncompensated lost by the aquaculturists in Penang was RM23.9mil (Colbourne 2005). Nevertheless, strong financial capital has made the aquaculturists more resilient than fishers. Many fish traders and aquaculturists had frozen and salted the valuable fishes, and some were made into fish meals for aquaculture due to the reduced demand for marine fishes during the post-tsunami period in Penang (Hung Teik & Lim 2005).

6.4.5 Inshore Fishers Coping with Trawling and Overexploitation of Fish Resources

The trawlers have caused most of the problems of fish exploitation in Penang (Noordin 2014b). The ban of trawl nets by the Malaysian Government will only be effective in 2016 (FRI 2014) hence, in the meantime it was tough for fishers in Penang to cope. Most of the fishers either looked for part time jobs or converted their physical assets into monetary terms to sustain their livelihoods.

Fisher 6 mentioned that the Seri Jerejak area was free of trawling issues, because the depth of the sea is shallower compared to areas in Balik Pulau. However, he mentioned that fish resources were depleting, and that he found it hard to cope financially since fishes were scarce in the sea. While waiting for the fish stock to recover, he looked for temporary jobs on land, such as a construction work, to generate income for living.

Fisher 5 had sold his lorry because it was no longer needed. The wild catch in the sea was too little to support the demand in the market. It was a financial loss for him, as the price of his lorry had depreciated. Fortunately, he was able to liquefy his assets. In order to make ends meet, some fishers had pawned some jewelry to pay their debts and sustain their livelihoods (CAP 2013). Money was needed the most during festive seasons and when schools reopened. Fishers needed to spend money on books and school uniforms for their children.

6.4.6 Inshore fishers cope with natural hazard (post-Tsunami)

After the tsunami incident, most of fishers' boats were badly damaged. The affected fishers were compensated by the FDAM in monetary terms ranging from RM 1000 to RM 3000 each. The compensations were received in a period of less than a month. However, the compensations were not sufficient to cover the total losses that included fishing equipment, and the waiting time for new boats and nets to arrive. Fortunately, most of the fishers had strong social support from relatives and a network of friends that enabled them to sustain their livelihoods during the post tsunami period (Horton et. al 2008:319).

6.5 The influence of local and international institutions towards inshore fishers and aquaculturists

This section presents the various institutions which influence and help to improve the livelihoods of the inshore fishers and the aquaculturists in Penang.

6.5.1 Inshore fishers in relation to Federal and State government in Penang

All Malaysians, including the fishers and aquaculturists, who earned below RM720 per month, were entitled to the national welfare support program and other subsidies. The support includes house repairs and restoration, and financial support. The federal government uses E-Kasih system, which tracked the poor and needy people in the country, while the state government operates through the local council and local district office to obtain the information about mid-core poor.

Officers from the state assembly office verified and identified the families who were in these categories before they received the state´s financial aid. None of the interviewed respondents in this study received any of this support since they earn more than RM720 per month. However, Fisher A said some fishers received support for house repairs from the DOFM. All interviewed inshore fishers received fuel and RM200 in monthly allowances subsidies. The fishers agreed that these subsidies have lessened their financial burden and contributed to covering their family expenses. Although the amount they received from the government is not very large, they were happy to receive it.

Unlike the fishers, the shrimp and fish aquaculturists in Malaysia were not entitled to any subsidies from the government. This was because they were considered business entrepreneurs. Shrimp and fish aquaculturists did not have much financial support from the government. Most of them ran their businesses privately and borrowed from the local banks if needed. Only when the aquaculturists had some collaboration projects with the government, they then partially supported by government subsidies.

6.5.2 Inshore Fishers´ with local NGO institutions

Local institutions that had been assisting the fishers are CAP and PIFWA. These two organizations played an important role for the fishers in supporting them in the daily challenges of the local fishery business. CAP had been providing assistance for the

local fishers in Juru since the 1970s when pollution was at its peak. From time to time, CAP released issues about events in Kuala Juru to the press in order to pressurise the authorities into taking action.

One of the significant accomplishments during the previous five years from CAP and PIFWA was when they had supported the inshore fishers against the government and achieved approval of the proposal to increase the inshore fishing zones from five nautical miles to eight nautical miles from the coastline. The expansion of inshore fishing zones was intended to prevent trawlers for encroaching into the inshore fishers´ fishing grounds. The new sanction was only applied for inshore fisheries in Penang; inshore fishers´ fishing zones in other states of Malaysia is still only for five nautical miles from the coast. In addition, CAP had also fought for the fishers in Malaysia to ban all trawl net operators in Malaysia. In November 2014, the federal government agreed to ban the use of trawl nets starting from year 2016.

6.5.3 Aquaculturists´ local NGO institutions

6.5.3.1 Aquaculture Operators Association of Penang (PENKUA)

Aquaculturists were backed by local and international institutions in fighting for their rights in fishery. Aquaculture Operators Association of Penang (PENKUA) provides workshops, training and knowledge sharing for the aquaculturists. Aquaculturists became more resilient and less marginalized after they learned about their rights in aquaculture. For instance, some cockle associations used to sublet the mudflat areas that they leased from the state to the individual cockle farmers at outrageous rental prices, charging the farmers about 30 times the price they leased from the state government. One of PENKUA committee stated that the state government use to charge RM5 for one hectare of land to all fishermen´s associations, but some fishermen´s association charged RM150 for one hectare of land to individual cockle aquaculturists. After PENKUA fought for the rights of the individual cockle aquaculturists, the state government applied new sanctions on the state leased land. The state government had abolished the Temporary Occupation License (TOL) application through the fishermen´s association. Individual cockle aquaculturists in Penang no longer go through the local Fishermen´s Association to obtain the TOL but through direct application to the state government.

Each year, PENKUA offered a range of workshops and training with the aim to empower the aquaculturists through educational sharing. Most of the aquaculturists were interested in being a member of this association as they were then able to share their good and bad experiences and discuss various fish farming issues with other aquaculturists. It encouraged the aquaculturists to practice sustainable aquaculture management in their businesses. Aquaculturist 1, who is a member of this association, said the association had provided important information with regard to local and international certifications. Certification is the gate to expanding the aquaculturist´s business locally and internationally. The association guides individual aquaculturists towards various certifications that are required.

6.5.3.2 Aquaculturist with international non governmental institutions

Figure 17: ASEAN Task Force team´s field trip to fish farm in Pulau Aman, Penang

ASEAN Public Private Partnership Dialogue Taskforce

In the ASEAN Public Private Partnership Dialogue Taskforce held in November 2014, Penang, various topics regarding aquaculture and fisheries were discussed.

Important topics included main issues in zoning, diseases, food security, sustainable aquaculture practices, and many more. Slyvie Doutriaux, a Senior Regional Food Security Advisor at USAID Bangkok, who is part of the ASEAN task force team, informed me that the task force program was an opportunity for aquaculturists to enhance their knowledge in aquaculture management. This task force enabled aquaculturists to build their networks with other aquaculturists and fisheries governmental bodies from ASEAN. The program also helped aquaculturists in ASEAN to work towards goals of sustainable aquaculture management and to better respond to climate change. The program had empowered aquaculturists to adopt good aquaculture practices and provided business opportunities for aquaculturists to meet standards, which are required by fish traders in different regions (ASEAN-SEAFDEC 2014).

7.0 Discussion

The following part discusses the main factors that increases vulnerabilities amongst the inshore fishers and aquaculturists. In addition, based on the results, this section will also discuss the coping strategies adopted by the inshore fishers and aquaculturists in sustaining their livelihoods.

7.1 Factors that increase vulnerabilities amongst the fishers and aquaculturists

Various anthropogenic and non-anthropogenic stressors have increased the vulnerability of the fishers, aquaculturists and environment in Penang. However, results in this study show that anthropogenic pollution have had more detrimental impacts on the social and environmental spheres compared to non-anthropogenic. Dr. Aileen Tan, a marine biologist in USM, said that anthropogenic impacts like pollution have more lasting impacts than the tsunami that hit Penang in 2004 (Mak 2014a). After the tsunami, the ecosystem was able to retain its environmental resilience through recovery from the disaster in a short period of time. Conversely, anthropogenic impacts have detrimental effects to the social and environmental spheres (Mak 2014a).

7.1.1 Natural Disaster

Perturbation and stressors from natural disasters like tsunamis had increased the vulnerability of the fishers and aquaculturists in Penang. This study shows that inshore fishers in Penang had low livelihood capitals and depend on natural capital for their living. Studies from Philip and Rayhan (2004) indicated that people with low livelihood assets had more difficulty in coping when they were exposed to anthropogenic stressors coupled with natural disaster .

Most of the boats, fish cages and fishing gears in some areas were destroyed or lost during the tsunami, and some of their houses were not livable after the incident. The post tsunami relief program from the government and NGOs provided them with basics such as temporary shelter, clothes and some compensation was given to the fishers. However, the compensation was insufficient to cover the full cost of their losses.

The financial shortfall was ameliorated by FDAM, approving 50% repayment loans to the fishers through the headman of the village. There were, however, some obstacles with the arrangement, as loans could only be obtained through personal relationships and connections and had to go through the headman of the village (Horton et al. 2008). These obstacles directly influenced the social capital of the fishers, as not all fishers of the post tsunami were entitled to the benefits provided by the FDAM. The fishers who did not have connections with the headman of the village did not have access to the financial support. Philip and Rayhan (2004:8) state that the lack of access undermined the capability of the victims to cope and recover from the hazard. However, this had elicited the victims to seek other coping strategies in their recovery stages. Studies showed that the impacted fishers in Penang mostly received aid in terms of monetary support and accommodation from family members and friends (Horton et al. 2008).

7.1.2 Land Reclamation

Figure 18: Residents of Penang protesting against land reclamation in Penang

Source: Bhatt 2014 in Fz.com

Rapid development can bring both positive and negative impacts to the social, economic and environmental sphere. Peet and Hartwick (2009) explained that sustainable development was not only about social and economics growth. To achieve sustainable development, environmental aspects need to be taken into account. The concept of labeling a price on the environment is much accepted and applied today.

However, Amartya Sen (cited in Raven et al 2010:34) criticized the method of valuing the environment as a commodity in economic terms and recognized the complexities of nature and its contributions to people´s livelihoods.

Prior to the land reclamation project start-up, the Department of Environment Malaysia (DOEM) carried out a DEIA at Tanjong Tokong. The assessment gave the developer a green light to start the project on the reclaimed land for housing development. However, the ongoing housing project had caught the attention of the public and of many NGOs, who considered that the land reclamation project for housing and commercial properties in Tanjong Tokong have had significant social and environmental impacts on the coastline.

According to Ramly (2008:47),

> "The land reclamation project caused changed wave conditions at the shoreline by enlarging the land area towards the sea, influencing the wave transformation behaviour. The wave transformation is influenced by diffraction, refraction, and shoaling processes."

The incoming waves are stronger from the west side compared to the northeast and it was expected that waves coming in from the west were going to cause erosion and changes to the sediment transportation (Ramly 2008). Siltation caused by the effect of sediment transportation, could be seen in areas close to land reclamation projects, such as coastal areas at Gurney Drive and Tanjung City Marina. This finding is consistent and supported by one of the interviewed government officials from the Department of Irrigation and Drainage (DID) Penang. He mentioned that dredging activities had increased the siltation and sediments at Tanjong Tokong areas. In addition, the coast in Gurney Drive areas has become shallow and muddy. According to Berkes et al. (2000), when a system has reached a threshold it can flip to another stage into an undesirable equilibrium. Therefore, land reclamation can lead to the loss of ecosystem resilience as the sediments and siltation from the dredging activities continue to pollute the coastal area. Subsequently, this increased the vulnerabilities of the marine life and the fishers in Tanjong Tokong Penang. Fishers would be impacted as their livelihoods depend on the fish resources in the coastal areas.

There had been a dispute between the Detailed Environment Impact Assessment (DEIA) reports and the findings from scientists from the Environmental Law Alliance Worldwide (ELAW) for the land reclamation project. Chernaik and Weiskel (2014), criticized the DEIA report from government institutions for the lack of several important assessments. They stated that environmental impact of the area was not thoroughly assessed. The assessment has undervalued the environmental services at the reclaimed area, such as mudflats and marine food chains. Additionally, the assessment lacked "what-if" scenarios, especially regarding the contingency plans in case the land reclamation project would be abandoned by the developers (Chernaik & Weiskel 2014).

The state government argued that stopping the reclamation project would require millions of ringgits worth of compensation as there was a contract agreement signed between the previous state government and the developer; which meant that there would be a question of who should bear the cost for the compensation (Mok 2014). Although the international panels and local civil society groups revealed several flaws in the DEIA report, the housing project would still continue its operations.

The weak assessment from the DEIA had made the public and NGOs question the reliability and integrity of the evaluation. In this case, the project´s negative externalities had been condoned, and the polluters´ accountability for their illicit acts towards the coastal ecosystem remained unclear. Inshore fishers remained vulnerable as they were losing their natural capital as a result of the weak DEIA. Because inshore fishers lack livelihood capital, they may not be able to cope well through their livelihood strategies in the long run.

According to Nadzir et al. (2014), the effect of land reclamation in Penang had degraded the coastal environment and livelihoods of the local people. He states that this was due to the fact that policy makers were willing to trade off the fisheries sector in favor of industrial development. In most development projects, minority groups such as inshore fishers, are often neglected. Thus, fishers that depend on coastal ecosystems to sustain their livelihoods continued to suffer the consequences.

7.1.3 Intensive Aquaculture Production

The state government had allocated 242 hectares of land in Penaga (northern mainland Penang) for intensive aquaculture production. The project, named Zone Industry Aquaculture (ZIA), was intended to be developed for intensive fish and shrimp farming. It was the first aquaculture project that had a DEIA assessment. The design of the farms is stated to have proper treatment ponds and zero discharges of waste. Effluents from the shrimp and fish farming are intended to be recycled. At the time of this study, there were nineteen aquaculturists involved in this project, most of whom are local persons.

Although the project perhaps looked promising for the local aquaculturists, the fishers in the area had started to express some concerns regarding the projects' long-term impacts on the area. The project involved the clearing mangroves in that area. The loss of mangroves can be devastating to the livelihoods of the fishers, as they provide crucial ecosystem services, income and protection from natural hazards. Based on FAO (2006) findings, large scale and intensive aquaculture practices can bring negative impacts to the people socially and environmentally.

A case study from the Chao Phraya Delta in Thailand offers a good illustration of the boom and bust cycle effects that came about as a consequence of high-intensive aquaculture farming. The shrimp production boom in the lower delta in the 1980s ended in a production collapse, which was a result of self-pollution, shrimp diseases and environmental degradation (Szuster 2003). Farms that had been set up during the "boom" had exceeded the delta´s carrying capacity. Carrying capacity is a method used to measure conditions of an ecosystem and understands the limit of a production in a particular zone. Brummett (2013) illustrated that the risk of pollution and environmental degradation for high-intensity aquaculture is higher since it also requires clearing of coastal estuaries such as mangrove forests. Many shrimp aquaculturists in Thailand had suffered high monetary losses, bad harvests and the accumulation of debts which have forced them to look for jobs outside the shrimp farming business (Szuster 2003).

In addition, farming marine fishes requires fishmeal and fish oil in feed. Intensification of marine fish culture will increase the demands for fishmeal and fish oil sourcing throughout the world. In some poor countries, small pelagic fishes are important and affordable food for the poor. This has caused competition between fish as food for the poor and fish for feed in aquaculture. In Peru, for example, small pelagic fishes like anchovies are used for fishmeal export. For people in the rural area of Peru who are living on the poverty line with less than USD 1 per day, small fishes like anchovies serve as an important food protein. Nevertheless, fishmeal enterprises in Peru have continued to compete with the poor people by fishing for small fishes needed in fishmeal production. Hence, aquaculture production is encouraging small fishes in the world to be fished for aquacultural business purposes (Metian 2009).

7.1.4 Coastal Pollutions

The use of trash fish feed in marine fish farming needs to be discontinued. Findings show that excessive trash fish and pellets that were uneaten, combined with slower current movements, caused eutrophication (Azmat et al. 2008). Excessive growth of phytoplankton and harmful algae blooms on the seabed increase anoxic activity (Allsopp et al. 2008; Wong 1995); the bacteria then take up most of the dissolved oxygen and release macronutrients into the water (Azmat et al.2008:228). Macronutrients combined with other pollution (from agriculture, industrial waste, domestic waste and ships) could possibly cause the loss of resilience in the marine ecosystem in Penang.

The cockle aquaculturists´ and inshore fishers´ livelihoods remained vulnerable, as the water pollution in the rivers and coastal areas were considerable. Cockle aquaculturists and inshore fishers in Juru estuary are threatened by anthropogenic pollution from industries, sewage, agriculture and domestic wastes (Sabullah et al. 2014). The impacts include high Biochemical Oxygen Demand (BOD) resulting in death or contamination of benthic communities in that area (Ramachandran 1997). Cockles are natural filter feeders in the estuary, and pollutants, especially heavy metals accumulated in the blood cockles (Idriss & Ahmad 2012; Yap & Tan 2008) which meant they were no longer be safe for human consumption. This posed serious

implications to the cockle aquaculturists socially and economically as these cockles were an important source of income (Yap & Tan 2008).

7.1.5 Dependency on natural capital and jobs

The coastal areas remained the provider of natural capital for the cockle aquaculturists and fishers. Results of this study show that Juru cockle aquaculturists have little job diversification. One of the cockle aquaculturists emphasized that the only thing they knew how to do for a living, was fishing and cockle farming. These two activities are vital to the sustenance of their livelihoods. Most of the fishers and cockle aquaculturists had low human capital. For example, literacy rates among fishers and cockle aquaculturist were low, which meant that job opportunities outside the fishing and cockle farming business were limited.

7.1.6 Misuse of rights and power

Based on the findings in my interviews, there appeared to be some contradictions between the authorities and cockle aquaculturists. For example, local Fishermen´s Association used to be given the rights over the mudflats. Hence, before cockle aquaculturists could start their business, they needed to register themselves in a fishermen´s association in order to obtain the leased land from the state government. However, some fishermen´s associations abused the power given by the state and acted as a middleman by monopolizing the aquaculture sites, thus hindering individual cockle aquaculturists from starting their farming business.

The state government used to own cockle-farming projects previously, however this arrangement has failed due to the fact that some cockle aquaculturists had started to abuse the system. Cockle aquaculturists refused to declare the sites, which had natural cockle seeds and continued taking cockle seeds from the government so that they could harvest more cockles and gain more profits. The state government had undergone a great monetary loss by aiding the cockle aquaculturists. This had resulted a broken trust between the government and cockle aquaculturists. Thus, the state government had set up new regulations by diverting cockle farming ownership from the state government to cockle aquaculturists. Cockle aquaculturists operated their farming project by leasing mudflat areas from the state government.

7.1.7 Weak law enforcement and corruption

Many inshore fishers were threatened by the profound overfishing problems in Penang especially in Pulau Betong areas. The failure to maintain sustainable fishery management is due to various factors, including the abuse of power, corruption and violations of human rights.

The enforcement of the law in Penang was a challenge. Referring to Ratner et al (2014), one of the reasons for fish resources overexploitation was the weak institutions that failed to regulate illegal fishing activities. In Pulau Betong, there was the issue of trawlers encroaching inshore fishers' fishing ground, and destroying fish resources and violating their rights as small-scale fishers. The dispute between the commercial trawlers and inshore fishers was so intense that it threatened to cause violence among them. To illustrate, a similar conflict between commercial trawlers and inshore fishers in Senegal, Africa had led to fights with weapons like guns, rocks and knives. The inshore fishers felt that the government sided with the commercial trawlers and neglected small-scale fishers' rights (DuBois & Zografos 2012).

Most of the interviewed inshore fishers suspected that some of the government officials are corrupt, and that they had some deals with the commercial trawlers, because illegal commercial trawlers were frequently able to escape from marine police raids. In addition, the misconduct of some politicians and Dato honorable officials enabled trawlers to evade the law if they paid a monetary penalty. This had deleterious impacts on the fish resources in Penang. The misconduct by the politicians not only hindered the commercial fishers from learning any lessons from offences, but also encouraged the offenders to lean on powerful people while marginalizing the weak, in this case the inshore fishers. These unequal power relations eroded the social capital and increased the inequalities between the commercial trawlers and inshore fishers for upholding their rights in their fishing ground (Ratner et al. 2014). Although the problem with pernicious fishing operations has been going on since the 1970s in Malaysia, actions taken by the government to address the issue have been limited. However, the government intended to phase out the destructive trawling activities in 2016.

7.1.8 Fish and Shrimp Diseases

Cleanliness in aquaculture farms is vital as it determines the survival rates of the shrimp and fish. Water pollution from the rivers and self-pollutions in the farm increased the risk of fatalities. Trash fish may be cheap, but when it came to the fishes´ health, the use of trash fish increased the mortality rates. Evidence shows that marine fishes are prone to infections if they are fed with trash fish (Gomez et al. 2010).

Shrimp diseases can be even more contagious and may spread rapidly when the aquaculturists practice high stocking densities in their farms. Common diseases for white shrimps and black tiger shrimps include white tail disease, taura syndrome, yellow head disease, crayfish plague, necrosis and necrotizing hepatopancreatities (Kautsky et al. 2000).

An FAO report (2013) states that shrimp are highly susceptible to EMS and other shrimp diseases in poor water quality condition. EMS often kills 90% of the shrimps, (FAO 2013b). Shrimp aquaculturists´ loss may have reached millions of ringgit due to this disease. In one year, a shrimp aquaculturist had about three to four seasons for harvest. A medium scale aquaculturist in Penang can earn about RM 1 million in a season. Hence, with shrimp mortality rates at 90%, a shrimp aquaculturist may lose more than 3.6 million ringgit in a year. If the problem persists, it will affect the aquaculturist´s financial and physical assets and increase the vulnerability of the aquaculturist when coping with the loss.

7.2 Coping strategies that increases resiliency

This section below presents the coping strategies used by inshore fishers and aquaculturists in sustaining their livelihoods in Penang.

7.2.1 Local Knowledge

Most of the inshore fishers in Penang learn from fishing, they do not possess high education backgrounds but their experiences in fishing in everyday life have provided them richness and deep learning in fishing knowledge. Fishers spend most of their time in the sea, and they learn from experience, which has made fishers more resilient

to stressors such as impoverishment, because they are able to self-sustain through their fishing. Fishers depended on local fishing knowledge to survive, and they strived to ensure that the catch are sufficient to sustain their livelihoods.

Fisher 7 had encountered many failures before he managed to design the right size for the fish trap. Most of the inshore fishers have low financial capital and they could not afford a GPS to locate their traps. Hence they ensured their fish traps are retrievable from the sea. Fisher 7 learned to estimate and coordinate the location of the traps by looking at an L shape angle setting points at some landmarks like bridges, houses and many more. However, local and traditional knowledge passed down from generation to generation are less popular and lack of legitimacy in the western system that is based on scientific findings (Berkes & Folke 2000).

With globalization many institutions encourage modernization, like science and technology; traditional knowledge is usually set aside and some traditional knowledge which originates from religion beliefs is not accepted by modern scientists (Berkes & Folke 2000). Nevertheless, the methods used by inshore fishers were less deleterious than modern technologies. Although trawl nets and other modern fishing equipment may increase fishing efficiency, the impacts of the usage are deleterious to the marine ecosystem. Consequently, this affected the inshore fishers´ livelihoods. On the other hand, shrimp aquaculturists used local knowledge and also fish farming knowledge from abroad, such as probiotic shrimp farming, to reduce risk.

7.2.2 Probiotic usage in Aquaculture

Probiotics helped to prevent shrimp and fish diseases and decreased mortality rates in aquaculture. Aquaculturist 1 had adopted probiotics in shrimp farming for seven years. He claimed that shrimp mortality in his farms was lower compared to without probiotic usage. Studies from Zhou et al. (2009) show that the usage of probiotics in ponds increases the survival rate of the shrimps. The survival rate with probiotic feed is about 20%, compared to the survival rate without probiotic usage, which is around 13% (Tseng et al. 2009).

According to Davis et al. (1998), one of the methods to reduce organic waste in fish

feed is to increase the feed utilization. Feed utilization requires feed that is consumed by the fishes and shrimp to be highly digestible. Highly digestible feed infers less fecal waste contributing to the release of nitrogen, phosphorus, and other organic wastes. Hence, the usage of probiotic supplement increases digestibility in fish and shrimp which is able to reduce environmental pollution and costs of production.

However, using probiotics in aquaculture remains a challenge. Aquaculturists need to know the right amount of probiotics for treatment and the right type of probiotic enzymes to increase the efficiency in shrimp farming (Verschuere et al. 2000). Furthermore, in one of the interviews, an FRI officer said probiotic usage in aquaculture can be costly if it is implemented in large-scale farming. Also, improper culturing methods such as home culturing probiotic may reduce the effectiveness of the microorganisms when treating shrimps and fishes.

Provided that the right feed technologies and strategies are used, probiotics may reduce pollution and decrease feed costs. For example, as illustrated in Davis et al. 1998 enzymes like phytase are able to increase the FCR of the shrimps. Aquaculturists who practice probiotic feed in their farms increased the resistance of shrimps and fishes from disease outbreaks compared to those who use other chemicals for treatment. Probiotic usage had strengthened the aquaculturists' financial and physical capital as it increased the survival rate of the shrimps and reduced pollution. Fish and shrimp diseases were prevented which led to lower consultation and medication costs. This enabled the aquaculturists to optimize the profit margins in their production.

7.2.3 Financial and social capital from various institution

According to Adger (2006), social institutions may contribute to increasing the resiliency of a social group. Social institutions include family, friends, government and NGOs. Tsunami victims in Penang were able to cope and recover from the hazard a couple months after they had received short-term relief from social institutions, and avoided becoming dependent on social welfare. Apart from financial capital, fishers and aquaculturists had social capital from international and local networks. These networks have aided and enhanced fishers´ and aquaculturists´ coping strategies.

8.0 Conclusion

This thesis has studied the fishers´ and aquaculturists´ livelihoods through SLF by analyzing their livelihood capitals, vulnerabilities and coping strategies in the face of various social and environment changes. The inshore fishers and aquaculturists were exposed to stressors such as marine coastal pollution, corruption and fish resource overexploitation. It is evident that there had been a deterioration in the resilience of the coastal environment as well as the livelihoods of the fishers and the cockle aquaculturists.

Coping strategies among the inshore fishers and cockle aquaculturists remained weak compared to fish and shrimp aquaculturists. Job diversification options amongst the fishers and cockle aquaculturists were limited, as they did not possess professional skills other than fishing. In addition, most of the fishers depended on subsidies (monthly allowances and fuel subsidies) from the government, and working extra hours fishing for various types of fishes and crustaceans in order to sustain their livelihoods.

In contrast to the inshore fishers, the shrimp and fish aquaculturists' livelihood strategies were more stable as they had stronger livelihood capital. Fish and shrimp aquaculturists have better coping strategies compared to cockle aquaculturists and fishers. They had greater access to self-owned facilities, private fish consultants from overseas, cheap foreign labor and aid from the government. This enabled them to spread risk in their fish farming activities. Fish and shrimp aquaculturists were mobile; they were able to move their farms to other areas if their farming area was badly polluted. In addition, professional consultants from overseas were the key for aquaculturists to strategize their fish farming business and cope with fish and shrimp diseases. Apart from fish farming strategies, fishers´ and aquaculturists´ livelihoods and environment depended on how the government evaluated DEIA and perceives development.

The government perceived development as an opportunity to improve the living standard of the local people, and the new infrastructure as an important means to support economic growth and population growth. Despite reviewing the contradictory

findings from the civil society on a certain development project, the government was only willing to comply with the DEIA evaluation. Hence, any development projects are likely to be carried out as long as DEIA approves the project. Nevertheless, it important that DOEM and developers continue to reevaluate the DEIA for any ongoing development projects from time to time since the environment is dynamic and may change over time. Although, it may require more time in order to get evaluation in place, it is crucial that the government manages to come up with long-term solutions that will benefit the population of Penang as a whole.

My findings show that Malaysia had enacted effective sanctions applicable to fishery and environmental conservation. There was however, a lack of law enforcement and uniformity in the government bodies in fisheries management. The disjuncture between government bodies and a lack of manpower had delayed actions and decisions to be taken for issues in fisheries. To illustrate, the conflict regarding trawlers who encroached on inshore fisheries' fishing grounds, has been an ongoing issue for the past five decades, and yet commercial trawlers were still able to operate their illegal activities in the unpermitted fishing zones. Nonetheless, the official ban for commercial trawling is intended to be enforced in 2016.

Bribery and corruption in fisheries were experienced to lead to social erosion and failures in marine coastal ecosystem management in the community. Therefore, it is important for government officials to identify the root cause and the ways to eliminate corruption. The abuse of power amongst the government officials and Dato had allowed commercial trawlers to practice illegal unreported and unregulated (IUU) fishing and oppression of the inshore fishers. Nevertheless, the enforcement of laws against corruptions in the waters remains a challenge as it difficult to locate the offenders in the open-access coastal waters of Penang (Sumaila & Jacquet 2008).

Urban and agricultural wastes and pollution from aquaculture remained among the core issues in Penang. Enforcement of the law by applying the polluter pays principle is vital, but putting the principle into practice remains a challenge. The permissible amount of pollutants in Penang waters had yet to be determined as there are still gaps in analyzing the threshold of the contaminant levels (Omar 2003). Nevertheless, the prevalence of water pollution in the coastal areas had affected other resource users

and biodiversity of the areas. Inadequate regulations in managing water pollution had caused resource users to neglect the importance of sustaining the coastal environment.

Although SLF is not a "blue print" that can solve all conflicts and issues faced by the fishers and aquaculturists in Penang, it is a concept that helps to broaden and deepen the understanding of the fishers´ and aquaculturists´ livelihoods. SLF has identified the vulnerabilities and the resilience aspects of the fishers and aquaculturists. Anthropogenic impacts and social policies that prioritize economic development over social development and environmental protection in the fisheries sector had led to a deterioration in the resilience of the coastal ecosystems and a subsequent increase in vulnerability amongst the local people who depend on these ecosystems. The government had failed to protect the livelihoods of fishers and aquaculturists by continuing to devalue the environmental costs and the impacts towards these communities. Therefore, emerging issues such as pollution, corruption and overexploitation of fish resources still remained urgent.

Bottom-up approach studies incorporating SLF amongst the local fishers and aquaculturists are still needed to further identify effective policies for development that prevents the deterioration of the coastal environment and resource users´ livelihoods. Follow-up studies on the impacts of the upcoming social and environmental changes, such as the ban on trawling in 2016, land reclamation projects and establishment of intensive aquaculture ZIAs will have a crucial role in assuring further protection and development of fishers' and aquaculturists' livelihoods in Penang. Nevertheless, this thesis has attempted to contribute an in depth understanding of the fishers´ and aquaculturists´ capitals, resilience, vulnerability and coping strategies.

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Appendices

Appendix 1

Table 9: Water quality classification based on Water Quality Index Malaysia

Parameter	Indeks *Index*		
	Bersih (B) *Clean (C)*	**Sederhana Tercemar (ST)** *Slightly Polluted (SP)*	**Tercemar (T)** *Polluted (P)*
Indeks Kualiti Air (IKA) *Water Quality Index (WQI)*	81 – 100	60 – 80	0 – 59
Keperluan Oksigen Biokimia (BOD_5) *Biochemical Oxygen Demand*	91 – 100	80 – 90	0 – 79
Ammoniakal Nitrogen (NH_3-N) *Ammoniacal Nitrogen*	92 – 100	71 – 91	0 – 70
Pepejal Terampai (SS) *Suspended Solids*	76 – 100	70 – 75	0 – 69

Source: DOE in Compendium of Environment Statistic Malaysia, 2013:196

Table 10:Water classes and uses in Malaysia

Kelas *Class*	**Kegunaan** *Uses*
Kelas I *Class I*	Pemuliharaan alam semula jadi *Conservation of natural environment*
	Bekalan Air I – Hampir tiada rawatan diperlukan *Water Supply I – Practically no treatment necessary*
	Perikanan I – Spesis akuatik yang sangat sensitif *Fishery I – Very sensitive aquatic species*
Kelas IIA *Class IIA*	Bekalan Air II – Memerlukan rawatan secara konvensional sahaja *Water Supply II – Conventional treatment required*
	Perikanan II – Spesis akuatik yang sensitif *Fishery II – Sensitive aquatic species*
Kelas IIB *Class IIB*	Kegunaan rekreasi yang melibatkan persentuhan badan dengan air *Recreational use with body contact*
Kelas III *Class III*	Bekalan Air III – Memerlukan rawatan yang ekstensif *Water Supply III – Extensive treatment required*
	Perikanan III – Spesis tertentu yang mempunyai nilai ekonomi biasa Bekalan air minum haiwan ternakan *Fishery III – Common, of economic value and tolerant species* *Livestock drinking*
Kelas IV *Class IV*	Pengairan *Irrigation*
Kelas V *Class V*	Tiada seperti di atas. *None of the above*

Source: DOE in Compendium of Environment Statistic Malaysia, 2013:196

Table 11:Water quality status within Polluted river basins monitored, Malaysia, 2011 and 2012

NEGERI *STATE*	LEMBANGAN SUNGAI *RIVER BASIN*	SUNGAI *RIVER*	BILANGAN STESEN *NO.OF STATIONS*	IKA *WQI*		SUNGAI (2012) *RIVER*	
				2011	2012	KELAS *CLASS*	KATEGORI *CATEGORY*
KEDAH	MERBOK	PETANI	1	59	58	III	T/P
Penang/ P.PINANG	PINANG	AIR ITAM	5	57	59	III	T/P
		PINANG	1	44	56	III	T/P
		JELUTONG	1	43	36	IV	T/P
	PERAI	PERTAMA	1	50	47	IV	T/P
		KEREH	2	45	50	IV	T/P
	JURU	JURU	2	54	47	IV	T/P
		RAMBAI	1	52	53	III	T/P
	JAWI	JAWI	1	42	44	IV	T/P

Source: DOE in Compendium of Environment Statistic Malaysia, 2013:211

Appendix 2

Organization Chart for Fisheries in Malaysia

Websites:

MOABI (2015)

http://www.moa.gov.my/image/image_gallery?uuid=ce93cbf3-688d-41bb-bf08-52f64f81d27c&groupId=2270178&t=1438745170385

FDAM (2015)

http://www.lkim.gov.my/image/image_gallery?uuid=55a0b2e5-8464-4d0d-a112-0a0ad770eb89&groupId=10124&t=1435803406188

DOFM (2015)

http://www.dof.gov.my/en/organization-chart2;jsessionid=98C85A3E936C00CE4AD5BF41D1DC3158