

Doctoral Thesis

Integrated Sustainable Livelihood Approach toward the Strengthening of Social Resilience: A Case Study on Recovery of Fisheries Livelihood after the Tsunami in Krueng Raya Bay, Aceh-Indonesia

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Hiroshima University**

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The Author

Zulhamsyah Imran

ABSTRACT

Integrated Sustainable Livelihood Approach toward the Strengthening of Social Resilience: A Case Study on Recovery of Fisheries Livelihood after the Tsunami in Krueng Raya Bay, Aceh-Indonesia

(社会回復力の強化に向けた統合的かつ持続的な生計アプローチ：インドネシア・アチェ州、クルングラヤ湾における津波後の水産業復興に関する事例研究)

Purpose and Objective

Integrated sustainable livelihood approach toward recovery of fisheries livelihood was implemented, in order to relief fishing communities and restore fish resource in tsunami-affected areas, Aceh-Indonesia. This approach gave a direction for the fishing communities how to make a balance between exploitation of fish resources and its conservation, on the recover process. This research purpose was to identify the strategies of integrated sustainable livelihood approach toward the strengthening social resilience in fisheries communities. It was conducted to focus on recovery process of the disaster in Krueng Raya Bay, Aceh Besar.

This research has five specifics objective: 1) to examine factors affecting on changes of fisheries livelihood pattern in fishing communities; 2) to examine factors that cause decrease of anchovy resources and coastal ecosystems degradation; 3) to assess effectiveness of integrated and participatory sustainable livelihood approach by using indicative figures such as poverty and income, and by referring to fishing communities's involvement in recovery activities; 4) to investigate the recovery process of fisheries livelihoods and roles of indigenous institution toward the strengthening of social resilience in fishing communities; and 5) to provide recommendation for adaptive framework on recovery of fisheries livelihood.

Methodology

A series studies were carried out in Krueng Raya Bay-Aceh, Indonesia. Four villages; Ruyung, Meunasah Keudee, Meunasah Kulam, and Meunasah Mon; were selected as case study area. While referring to secondary data, survey, sampling, focus group discussion, and in-depth interview were conducted in March 2012 and September-October 2012 in Krueng Raya Bay, Aceh Besar-Indonesia. Semi structured and open questionnaires were delivered to 120 respondents and key informant persons, with references to fishing communities, fisheries livelihood, fish resources, and social capital. The target respondents were fishermen, fish processing, financial trader, head of villages, sea commander, and local institutions. This research adopted the following analysis tools: (1) damage and loss analysis, (2) descriptive statistics analysis, (3) inferential statistics analysis, (4) stock classification analysis, (5) Social Vulnerability Index (SoVI) and Social Resilience Index (SRI), (6) Likert type scale analysis, (7) Aid Dependency Index

(ADI), (8) stakeholders analysis, (9) comparative analysis, and (10) quantitative contents analysis. The most important analysis is inferential statistics analysis, followed by social vulnerability index, and stakeholders' analysis.

Factors Affecting Changes of Fisheries Livelihood

Fishing communities are exposed on unpredictable disasters. In 2004, the tsunami had directly affected on fisheries livelihood in Krueng Raya Bay. Definitely, it severely impacted on both tangible and intangible assets of fishing communities. The impact of the tsunami on fisheries livelihood asset could be measured using damage and loss analysis. As a result, USD 2.7 million fisheries livelihood assets was damage and loss. This amount approached 0.4% of total fisheries assets damaged and lost in Aceh Province. Moreover, the pattern of fisheries livelihood was changed by the tsunami struck. It led a number of fishermen increasing from 10.6% of total population in 2003 to 15% in 2011. It also caused a number of fishing boat decreasing sharply, and operational cost and re-investment of asset production increasing significantly. And the most interesting impact of the tsunami was to increase the percentage of fisheries household dependency on fisheries resources from 40% in 2003 to 60% in 2005. The changing of fisheries livelihood pattern might be led by direct and indirect factors. A declining of fish production in both volume and value could be identified as direct factor which shifted the income of fishing communities. An upward of food, fuel, wood, and equipment price; a change of workforce and livelihood; and an increasing immigration were contributed as indirect factor on change of fisheries livelihood. To sum up that the tsunami impact and the recovery process have become the opportunities and challenges on development of fisheries livelihood in sustainable way.

Assessment Factor Contributing on the Anchovy Fisheries Decline

Fish resources, in particular anchovy in Krueng Raya Bay faced a depletion state aftermath the tsunami. Some crucial factors contributing to the declining of anchovy which was identified as *Stolephorus commersonii* due to characteristics identification. According to the results of focus group discussion and fishermen interviewed, fish resources shown a downward trend and anchovy could be categorized into a depletion state aftermath the tsunami. Anchovy growth could be subjected to a negative allometric growth, meaning length growth is faster than weight growth. A downward trend of anchovy production could be revealed by less of catch during west monsoon season of 2012, amounted 7.8 tons or 52% of the total catch with the operation of 7-29 units of lift net boats. The result of surplus model calculation showed that maximum sustainable yield (MSY) of anchovy after the tsunami disaster was less than 20 times of MSY before the tsunami. Simple regression analysis resulted two different models of MSY either before or after the tsunami in 2004 which were shown as $y = 0.8696 - 0.00008x$ and $y = 0.1138 - 0.00002x$, respectively. Model 1 recommended to reduce the number of lift net boat to 43 units for optimization of yield. On the other hand, Model 2 suggested that only 23

units could be operated for optimal effort each year. Average recent catch in MSY showed 53.9% (less abundant) before the tsunami and 5.5% of Average recent catch in MSY (depletion) after the tsunami. These conditions were led by increasing catch effort, destructive fishing gears, and degradation of coral reef and mangrove. Such a tragedy of resource depletion was accelerated by anthropogenic factors and compounded by the tsunami factor (natural environment). The tsunami's environmental impact on anchovy fishery depletion may be lesser than the combined effects of destructive fishing and anthropogenic factors.

Incorporate Sustainable Livelihood Strategy on Recovery of Fisheries Livelihood

Strategy on recovery of livelihood should be promoted by community participation and their shelf-lesson learnt. Poverty alleviation through income increasing is a main target of sustainable livelihood. Increase of poor population was caused by a drop of income, a depletion of fish resource, assets production damage, and ecosystem degradation. In Krueng Raya Bay, high dependency on fisheries resources, ranging between 0.61 and 0.81, brought poverty condition in fishing communities. It can be seen that 65.9% of total population was lived within coastal area and 69.2% (or 9 villages) of the 13 villages were coastal villages before the tsunami disaster (Statistics Indonesia Agency, 2005). The recovery program of fisheries livelihood successfully reduced a number of poverty population to 56.58% on 2009 from 97.70% in 2005. The strong internal characteristics of fishing communities were regarded to cope fisheries livelihood recovery. But, their capacity of recovery process and financial capital were insufficient to restore fisheries livelihood without any aid delivered from Government of Indonesia and other donor agencies. Lesson learnt from engagement in reconstruction process, people in fishing communities recommended to integrate alternative livelihood development and social-ecological approach into development of fisheries livelihood. These comprehensive strategies were supported by external institutions and their aids, which amounted to around USD 76.5 million.

Toward Strengthening Social Resilience through Fisheries Livelihood Recovery

Social resilience has a role to govern the local communities and coastal fisheries resources toward sustainable fisheries development in tsunami affected area. The tsunami was impacted on social capital through destructed social facilities (housing, fishermen meeting hall, etc.), erupted intangible of social capital (such as trust, network, relationship, indigenous institution, rule and norm), and increased shock and stress of fishing communities. The four villages selected, i.e. Ruyung, Meunasah Keudee, Meunasah Kulam, Ruyung, Meunasah Mon showed high social vulnerability index, which were in range 0.7850 – 0.8460 (low social resilience index), because these villages are located nearby sea and flat area. Indigenous institution had a contribution and adaptable to rebound social resilience. The Panglima Laot Lhok (sea commander) had determined and adapted role on recovery of the fishing communities, particularly facilitated aid delivery

for fishermen, as shown in anchovy fisheries relief case in Krueng Raya Bay. Toke Bangku (financial trader) had stimulated for reinforcement of advance payment and market channel link. The other institutions supported upon linking and bridging connectivity among stakeholders. Collaborative governance can avoid conflict, reduce donor dependency and strengthen social resilience within fishing communities. Toward the strengthening social resilience of fishing communities could be gained through: (1) revitalization of rule, norm, trust, network, and relationship using the social value and religious; (2) engagement of indigenous institution and local government unit on recovery process in designing program planning, decision making, monitoring and surveillance; (3) adoption of the sustainable livelihood approach by using fishing communities participation; (4) integration of management adaptive strategies for implementing fisheries livelihood program and activities; (5) collaboration action among the stakeholders and local institution capacity building in coping shock and crisis circumstance aftermath tsunami, (6) arranging exit strategies for fisheries and alternative livelihood development.

Conclusion and Recommendation

It is clear that anthropogenic factors contribute to depletion of fish resources and degradation of coastal ecosystem. The tsunami brings out fish resource and its ecosystems to the worse condition and resulted a huge negative affect on fisheries livelihood. It has caused a decreasing of income, increasing of poverty people, rising of social vulnerability, declining of social resilience within fishing communities. One of strategies that adopt and imply on recovery of fisheries livelihood is the sustainable livelihood strategy toward the strengthening social resilience of fishing communities. In addition, sustainable livelihood strategy implementation need to consider on communities' participation to achieve self-social resilient of fishing communities and cope fish resources depletion and ecosystem degradation.

ABBREVIATIONS

ADI	: aid dependency index
BAPPENAS	: Badan Perencanaan Pembangunan National/The National Development Planning Agency of Indonesia
BRR NAD-Nias	: Rehabilitation and Reconstruction Agency for Nanggroe Aceh Darussalam and Nias
CCMRS	: Center for Coastal and Marine Resources Studies
CBM	: communities based management
CFW	: cash for work
CPR	: common pool resources
CPUE	: catch per unit effort
DaLA	: damage and lost analysis
DFID	: Department for International Development
ECLAC	: the Economic Commission for Latin America and the Caribbean
EDC	: export development center
ETESP	: Earthquake and Tsunami Emergency Support Project Asian Development Bank
FAO	: Food and Agricultural Organization
FB	: fishing boats
FGD	: focus group discussion
FH	: fisheries household
FMA	: fisheries management area
FPU	: fish processing unit
FLRP	: Fisheries Livelihood Recovery Program
GDP	: gross domestic product
GOAP	: Government of Aceh Province
GOI	: Government of Indonesia
IOO	: investor outreach office
JRS	: Jesuit Refugee Service
KKM	: packaging and branding center
KSHB	: Koperasi Syariah Hidup Baru/syariah system of cooperative
LGU	: local government unit
MCF	: marine capture fisheries
MMAF	: Ministry of Marine Affair and Fisheries
MSY	: maximum sustainable yield
NGO	: non-government organization
OC	: operational cost
PLL	: Panglima Laot Lhok/sea commander
RDC	: Regional Development Committee
SFLA	: sustainable fisheries livelihood approach
SLFD	: sustainable fisheries livelihood development

SLA	: sustainable livelihood approach
SLF	: sustainable livelihood framework
SoVI	: social vulnerability index
SMEs	: small-medium enterprise
SRI	: social resilience index
SRA	: simple regression analysis
TB	: Toke Bangku/Financial Trader
UNDP	: United Nation Development Program
WLR	: weight-length relationship
VLS	: village level system

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CHAPTER 1. INTRODUCTION

1.1. Background

1.1.1. Socioeconomic Indicator and Impact by Tsunami

Aceh Province, which is located at the top of Sumatera Island-Indonesia, is one of strategic region in Indonesia (Statistics Agency of Aceh Province, 2013). It is situated between Indian Ocean and Malacca Strait. Geographically, it is positioned between 01° 58'37.2" – 06°04'33.6" North Latitude and 94° 57'57." - 98°17'13.2" East Longitude with average altitude 125 meter above sea level. Approximately 4.6 million population lived within this province, in 2011, with average density of 77.7 people/km². Total area of Aceh Province is 56.770,81 km² in 2011, which is encompassed to 5 cities and 18 districts, 284 sub districts and 6,450 villages. This autonomous province has challenged economic development, although it has exposed from various natural disaster.

Earthquake and tsunami of 26 December 2004, which was measured 9.1 on the Richter scale event off the West Coast of Northern Sumatra and followed by tsunami. These disaster were led significantly in shifting of economic structure, in particular reducing 97% of Gross Domestic Product (GDP) of Aceh Province. These huge disaster had also severely impacted for human and other aspects. Rehabilitation and Reconstruction Agency for Nanggroe Aceh Darussalam and Nias (BRR NAD-Nias) (2009b) reported that the disaster caused 127,720 people killed; 635,384 people displaced; 93,285 people missing; 500,000 survivors lost their homes; 750,000 people lost their livelihood; and 600,000 people lost job. It also destroyed 2,618 km road; 139,195 houses; 3,415 schools; 22 ports, 113 bridges; and 104,500 small scale enterprises. The total of estimation damages and losses from this matter was IDR 41.4 trillion or USD 4.45 billion - equivalent to about 80 percent of Aceh's GDP (The Consultative Group on Indonesia, 2005).

Inevitably, the impact of earthquake and tsunami were massively influenced on social indicator of population in Aceh Province. The simple indicators were a number of poverty people and unemployment increasing. Prior to the disaster the number of poverty population and unemployment accounted for 28.5% and 9.9% of the total population

(Statistics Agency of Aceh Province, 2005), and increased to 28.7% and 14% respectively (Statistics Agency of Aceh Province, 2006). Recovery program during 2005-2009 could reduce a number of poverty and unemployment to 23.5% and 9% respectively (Statistics Agency of Aceh Province, 2010; World Bank, 2008). Nowadays, a number of poor people sharply declined to 11.5%, but unemployment considerably increased to 10% (Statistics Agency of Aceh Province, 2013). Simultaneously, the fluctuation of economic and social indicator would be affected on social vulnerability¹ and resilience² of communities in both directly and indirectly.

1.1.2. Marine Capture Fisheries and Impact by Tsunami

Aceh Province has a great potency of marine capture fisheries (MCF) as a part of fisheries resources³. This province has 17 districts located within coastal area, 119 small island (Aceh Province of Marine Affair and Fisheries, 2008), 1,660 km coastline, and 57,365.6 km². The National Development Planning Agency of Indonesia (BAPPENAS) (2005) reported that more than 292,876 ha coral reef and 346,838 ha mangrove ecosystem in 2002 were distributed in coastal zone and small islands of Aceh Province. Therefore, Aceh Province has an important role in developing of fisheries livelihood after the tsunami disaster as well as before that.

With 102,824 ton/year of maximum sustainable yield (MSY), marine capture fisheries production fluctuated within 15 years before tsunami in Aceh Province. Total production was approximately 17,351.7 ton in 1989 and rose 3.8%/year in the period 1989-1997; however, it considerably dropped -6.5%/year in the period 1998-2002 (Indrawan et al., 2003; Data Analysis, 2014). It increased again to 134,077 ton from 92,181.1 ton in 2002 and sharply went down to 102,555 ton in 2004 (Aceh Province of Marine Affair and Fisheries, 2005). In contrary, a number of fishing boats (FB) showed a downward trend in period 1989-2003. A number of FB was around 14,584 unit in 1989, it's reducing -

¹ Social vulnerability is the exposure of groups or individuals to stress as a result of social and environmental change, where stress refers to unexpected changes and disruption to livelihoods (Adger, 1999).

² Social resilience is the social system ability to respond and recover from disasters through adaptive processes (Cutter et al., 2008).

³ Fisheries resources term adoption in this thesis is composed as system of three interacting components, which are the aquatic biota, the aquatic habitat and human user of these renewable resource (Lackey, 2005). Meanwhile fish resources term using in this thesis refer to such as fish, for example anchovy.

0.2%/year in the period 1989-1997 (Aceh Province of Marine Affair and Fisheries, 2003), continued declining -4.4%/year in the period 1998-2002, and sharply climbed to 16,070 unit in 2003 from 10,768 unit in 2002 (Aceh Province of Marine Affair and Fisheries, 2012).

The tsunami had been the greatest impacted on MCF. The Consultative Group on Indonesia (2005) reported that the total production value and asset loss of MCF were about USD 422.2 million and USD 522 million, respectively. It also mentioned that 20% of 80,000 fishermen was death and 14,936 fishermen was missing. Indeed, 7,700 unit boats were also damaged and the destruction of 800 X 1-6 km² beach area; 6,775 ha mangrove and 9,175 ha coral reef ecosystem were brought out MCF to become in the worst condition (BRR NAD-Nias, 2009a). As consequence, total production of MCF dramatically went down to 81,163.4 ton in 2005 from 102,721.1 ton in 2004 (Aceh Province of Marine Affair and Fisheries, 2012), and the income of fishermen failed to 0.3-3 million/month from 0.5-6 million/month.

Livelihood capital of MCF were severely damaged and lost. In fishing communities, poor people sharply rose in number and their vulnerability increased. It was expected that, at the end of the worst scenario, the resilience of fishing communities would be dropped indirectly as causality cause by vulnerability context increasing.

1.1.3. Recovery Program for Communities Relief and Fisheries Sector

Rehabilitation and reconstruction programs were needed for community's relief aftermath tsunami. Government of Indonesia (GOI) declared 26 December 2004 of tsunami as national disaster in 27 December 2004. GOI and other agencies (local, national, and international) took place for quick respond in emergency phase until the end of March 2005 due to the President of Indonesia declaration.

The President of Indonesia ordered line departments and ministries to mobilize available national resource, assigned the emergency mechanism inherent with the National Coordinating Board for Disaster Management, and coordinated international agencies, for helping Aceh. The mainly task of emergency phase was to provide immediate assistance for tsunami survivors (Masyrafah and Mckeen, 2008). For emergency respond,

international assistance was a vital play role for providing relief to tsunami's victim and helping to prevent a far higher death toll.

GOI divided recovery program to relief, reconstruction and development phase after establishment BRR NAD-Nias in 16 April 2005 for coordinating and jointly implementing a community-driven recovery program for Aceh and Nias. The purpose of this program was to recover communities' living and all sectors which were impacted by the tsunami and integrate into the concept of "build back better" as the main mission, including poverty eradication and human development. The recovery program encompassed immediate action (community and spatial planning, land titling, and housing) until the end of 2007 and long term development (infrastructure and other facilities, education and health, religion-culture-social affair, economic and business empowerment, and institution development) until the middle of 2009 (BRR NAD-Nias, 2007). BRR NAD-Nias (2009b) reported that spending budget was about USD 5.64 billion for all rehabilitation and reconstruction.

BRR NAD-Nias (2009a) recorded that GOI expend around IDR 809 billion through on budget scheme and donor agencies also provided appropriate fisheries aid through off budget scheme for implementation of fisheries program until the end of April 2009. These budget were disbursement for: (1) provision and building 7,109 boats, (2) rehabilitation 17,444 ha fish pond, (3) provision 17,748 fishing tools and 19,527 agro input, (4) building 197 unit fish aggregate devise and 532 fish processing unit, (5) reconstruction 10 unit fish market, and (6) provision and building other fisheries facilities.

The most interesting effect of recovery program was shifted oil and gas determination to agriculture sector (agriculture, livestock and fisheries). The evidences shown that agriculture could grew in range 1.5-4.5% during recovery process in the period 2005-2009.

1.1.4. National Strategies on Recovery of Economic Sector and Livelihood

GOI through BRR NAD-Nias formulated two mission on recovery of economic sector (BRR NAD-Nias, 2009a). The first mission was to recover productive and public assets, which were the rehabilitation of rice fields, plantations, fish and shrimp farms, boats,

fishing ports, fish breeding facilities, markets and abattoirs. The second one was to strengthen a sustainable economic foundation through re-building of the vital facilities for economic growth. The “blue print of economic action plan” was implemented through: (1) the development of marine capture fisheries in offshore area, livestock farming zone, the industrial center park; the establishment of skills training centers; (2) the construction wholesale market; and (3) the establishment of an investor outreach office (IOO), export development center (EDC), and packaging and branding center (KKM).

Implementation of economic recovery was supported by five main policies (BRR NAD-Nias, 2009a). These policies were: (1) empowerment of a community-based economy through mainstreaming direct community involvement in activities of economic recovery and providing immediate benefit for beneficiaries; (2) increasing value added of small-medium enterprise (SMEs) products through building and strengthening SMEs’ productivity and their products value added; (3) recovery and development of trading through repairing infrastructure of goods circulation, market, trading and services facilities; (4) capacity building for economic and business players through training and internships; and (5) promoting and facilitating investment growth through establishment of investment outreach office, provision of investment information, partnerships with local entrepreneurs, assistance in legal requirements and authorization, and giving input to the local government on investment matters.

Integration five policies above into several strategies was arranged within the sequent year (BRR NAD-Nias, 2009a). In 2005-2006 period, the strategies were focused for economic revitalization community improvement and empowering local wisdom, which were supported by the provision of economic and business facilities, infrastructure and efforts to improve the quality of human resources. In 2007, the strategy was aimed at the integrated development of economic and business activities through raising production, institutional capacity building and stimulating the growth of SMEs and economic centers. And in 2008-2009 period, the strategies were determined on creating a sustainable economy and strengthening the local market in order to gain entry for the international market. The framework of economic recovery can be seen in Figure 1.

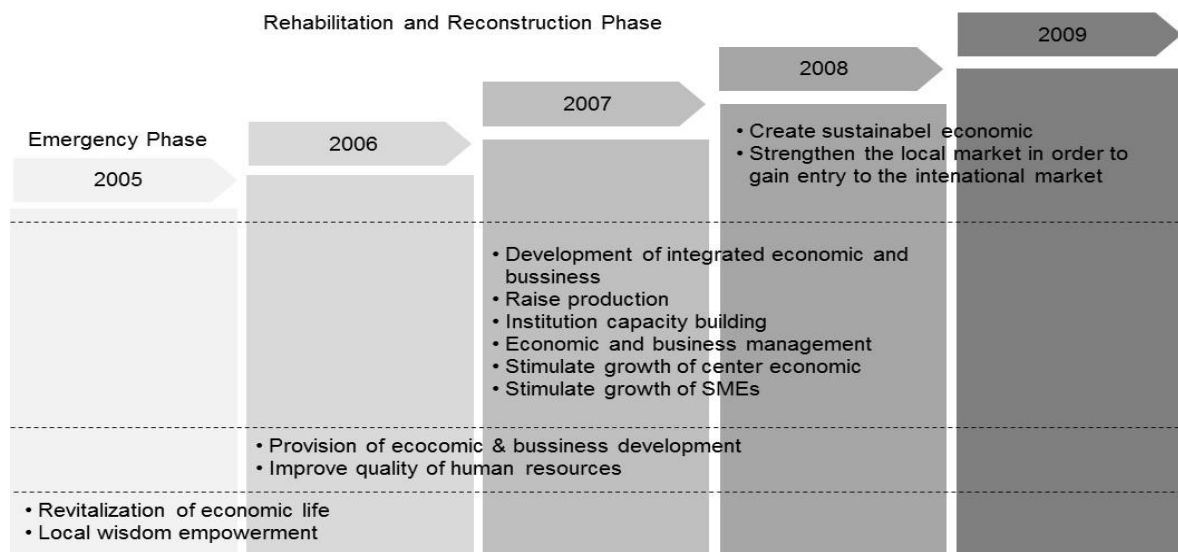


Figure 1. Economic sector recovery strategies (BRR NAD-Nias, 2009a)

The recovery of community livelihood itself was incorporated into economic recovery strategy. It was inherent into national strategies on economic sector recovery. Those national strategies embedded the recovery of community livelihood as main target for strengthening and developing sustainable economic. Some of national strategies on economic recovery have direct linkage with the sustainable livelihood strategy. In term of fisheries livelihood recovery, the strategies were designed to address the reconstruction assets production and fisheries infrastructure, the promotion of fishing fleet modernization, and provision the good standard of fish product for strengthening of fisheries livelihood.

There are several advantages integration of SLA into fisheries livelihood recovery. Theoretically, integration of SLF into recovery of fisheries livelihood might reduce poverty and vulnerability, and increase fishing communities income (Salagrama, 2006). Other advantages are integrated coastal ecosystem rehabilitation, revitalized local institution, incorporated community base approach, and increased the resilience of fishing communities. However, it is hard to ensure whether fishing communities can restore their livelihood for long term after disaster struck. Chambers and Conway (1991) argued that a livelihood will be sustainable if its recovery can cope and improve from stress and shock, maintain and enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; meanwhile, it has not weaken the natural resources base (Scoones, 1998).

1.1.5. General Information of Research Site

Krueng Raya Bay, which is located in Aceh Besar District-Aceh Province, belongs to Kemukiman⁴ Krueng Raya administratively. This Sub Sub District compress 8 villages and 75% of the total can be categories into the coastal village type (Table 1). A number of population inhabit in this area was 5,575 people in 2003, increased to 5,891 people in 2005, and climbed to 7,920 people in 2011.

Table 1. General information of geography, population, main income and tsunami impact

No.	Villages	Type of Village	Sea Level (m)	Population (people)			Main Income			Tsunami Impact
				2003	2005	2011	2003	2005	2011	
1.	Ruyung	Non Coastal	8	551	556	765	C	F	A	Moderate
2.	Paya Kameng	Coastal	7	332	318	431	F	F	F	Moderate
3.	Beurandeh	Coastal	7	336	520	580	F	F	F	Moderate
4.	Meunasah Kulam	Coastal	8	695	534	695	F	F	F	Moderate
5.	Meunasah Keudee	Coastal	5	1,262	1,012	1,334	F	F	F	Heavy
6.	Meunasah Mon	Coastal	8	887	1,085	1,368	F	F	F	Heavy
7.	Ie Seu Um	Non Coastal	13	361	449	527	A	A	A	No Impact
8.	Lam Reh	Coastal	7	1,151	1,417	2,220	F	A	A	Moderate
	Total (people)			5,575	5,891	7,920				

Sources: Indonesia Statistics Agency; Note: F=Capture Fisheries; C=Aquaculture; A=Agriculture

The majority of people in Kemukiman Krueng Raya were involved in capture fisheries, aquaculture and agriculture livelihood to support their household income. Statistics Indonesia Agency (2005) figured out that 66% of 2,294 household earned their income from agriculture and 34% from non-agriculture livelihood in 2003. In fact that 77% of agriculture livelihood was determined by capture fisheries; followed by aquaculture (7.8%), agricultural crops (7.6%) and horticulture (7.7%). This area has developed as “capture fisheries center” for supporting fisheries livelihood with consider to the potency of fish resource.

⁴ Kemukiman is the unity of indigenous communities, which compose several villages, has regional boundaries, and pointed under sub district or it can be called sub sub district

Kemukiman Krueng Raya has strategic position⁵ for fisheries sector development. It is located between 3° 37'20.86" - 5°36'43.34" North Latitude and 95 ° 27'43.36" - 95 ° 32'17.81" East Longitude (Field Survey 2012) and lying within Malacca Strait and North Sea water of Indonesia. According to Ministry of Marine Affair and Fisheries number 1/2009, Krueng Raya Bay can be included into fisheries management area (FMA) number 571 which is compressed to Malacca Strait and Andaman Sea.

Krueng Raya Bay is consist of several ecosystems. The main ecosystems are mangrove (19.18 ha) and coral reef (9.58 km) ecosystem which have the function for fish feeding, nursery, migration, and spawning ground. In fact, this region also supported by other ecosystems such as river, coastal vegetation (such as *Pandanus* sp and *Ipomoea Pes Caprei*), cliff beach (3.5 km), sand beach (4.39 km), white sand beach (8.12 km), brackish water shrimp pond (66 ha), casuarina forest (1.26 ha), coconut tree, and lagoon (14.69 ha). One of the horizontal zoning ecosystem and its characteristic can be taken example in a block of Aron Meudawa-Mouth of Krueng Raya River (Figure 2). This block shows that the formation of ecosystem were composed by mangrove, lagoon and sand beach.

Since 19 century, Krueng Raya Region had been used for harbor (Malahayati Harbor), bunkers, natural resources utilization, and accessibility. In the same period, the agriculture, livestock, and fisheries were also developed by the local communities. The emperor of Aceh also build Iskandar Muda and Inoung Balee Battle to defend the sovereignty when the colonialist want to occupy the land of Aceh. Entering 20 century, fishermen from Pidie and Banda Aceh, initiated this coastal zone for a fishing ground target, temporary settle, upload logistic, and fish market purpose. Nowadays, this region is designed for multiuse zone by Government of Aceh Besar District.

⁵ The distance of this fisheries center from Banda Aceh (the capital city of Aceh Province and Jantho (the capital city of Aceh Besar District) is around 30 km (35-45 minutes) and 70 km (1.5 hours) respectively. It can be accessed by public or private transportation from both of the capital city. With the rainfall 41-461 mm/year and temperature 26-28° Celsius, Krueng Raya Bay are suitable for the center of fisheries development. It is situated at 5-13 meters above sea level (DFID, 1999).

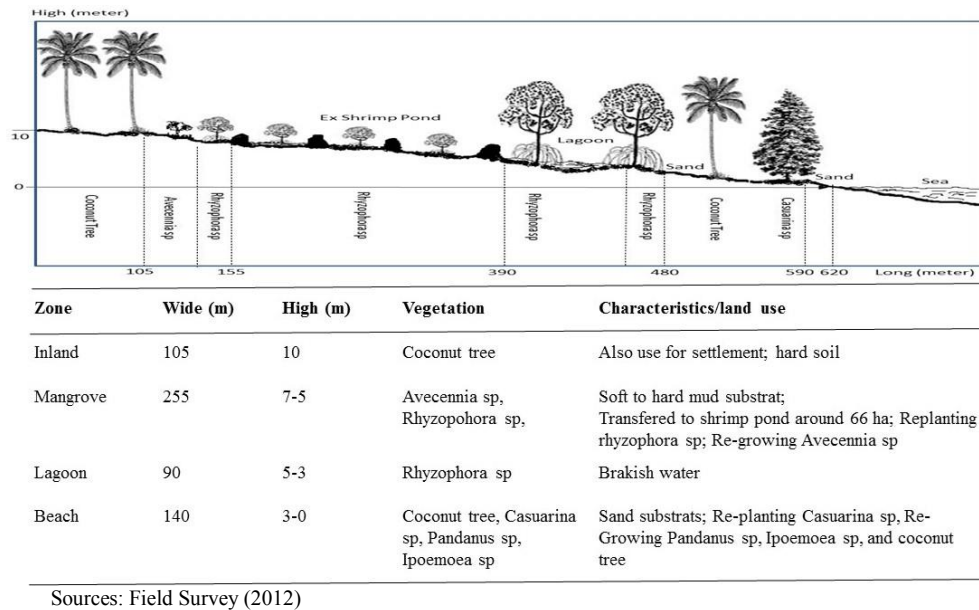


Figure 2. Formation and characteristics of ecosystem in Aron Meudawa-Mouth of Krueng Raya River block

MCF activities have operated in coastal waters of Krueng Raya since the 1970s (Panglima Laot Lhok Krueng Raya, 2012). In the beginning, fishermen used the traditional boats without engine and hand line fishing gear. Since 1970s, beach seine boats without engine had been introduced to this area and then they were equipped with engines in the 1980s when Government of Indonesia implied the motorization policy. In the same period, the lift net boat adopting simple technology was initiated by fishermen and it was evolved more modern fishing boats equipped with outboard engine and diesel generator before the tsunami disaster.

1.2. The Statement of Problems

Issues and topics

Many issues appear for integrating the sustainable livelihood approach on recovery of fisheries livelihood within fishing communities soon after the tsunami. The central issues were destruction of fisheries livelihood capital, followed by increasing vulnerability and decreasing resilience of fishing communities. Declining income and increasing poverty population are common indicators which are used to evaluate the high level pressure on fishing communities.

A number of population in coastal area of Aceh Province might be equal level of Indonesia's coastal area, around 95.7% in 2003 (United Nation Development Program (UNDP), 2005) and increase to 96.1% in 2012 (UNDP, 2013). Due to the percentage of UNDP estimation, it can be estimate that 4 million people of total population inhabit in coastal area in 2003 (Statistics Agency of Aceh Province, 2004) and it increased to 4.3 million in 2012 (Statistics Agency of Aceh Province, 2013).

The percentage of poverty population is high in Aceh Province. It was estimated that 32% of total population living in coastal zone is poverty population (Kusnadi et al., 2006); 1.3 and 1.4 million poverty population were distributed in 16 coastal districts in 2003 and 2012 respectively.

Increase of poverty and decline of income

Increase of poverty population has been determined by a declining income of fishing communities. Before the tsunami disaster, the average income of fishing communities in Aceh Province was in range 0.6-6 million. The tsunami disaster change their income to in range 0.5-3 million. People in Krueng Raya Bay earned almost the same amount of income. Therefore, they were always in trap of poverty condition. Based on sampling data in four villages of the research, poverty population accounted for 45.3% of total before the tsunami, aftermath which they sharply increased to 97.7%. And it gradually declined to 56.7% in 2009. This percentage was extremely less than the that in Aceh Besar District, accounting for 29.4% in 2005 and 20.09% in 2009 (Statistics Agency of Aceh Province, 2012). Increasing of poverty population also might has relationship with fish production indirectly.

Fish and anchovy production declining

Fish and anchovy production dropped in Krueng Raya Bay. There was no exactly data fish landing record annually in this region. But, fish production in Aceh Besar District was indicated a downward trend in the period 1989-2004. Statistics Agency of Aceh Province recorded that the average growth of fish production was 2.9% in the period 1989-1998 and declined to 0.9% in the period 1999-2004. The tsunami brought out the average growth of fish production to -65.4% in 2005.

In the same condition was occurred for anchovy which was produced from Krueng Raya Bay. As regards anchovy, its production was 3,675.6 ton in 1999, and it sharply declined to 787 ton (-78.6%) in 2004. The tsunami caused extremely reduction of anchovy production to 285.2 ton in 2005. Destruction of coastal ecosystem such as coral reef and mangrove ecosystem might influence on a change of anchovy production in this study area. Naturally, those who highly depended on fish resource suffered from vulnerability on environment changing. Pomeroy et al. (2006) described that the communities, which highly dependency on severely depleted of natural resources base and badly degraded ecosystem, can be categories to the fragile communities.

Fragile communities

Fragile fishing communities are exposed to natural disaster. In fact, the tsunami had affected fishing communities and their livelihood in Krueng Raya Bay. Statistics Indonesia Agency (2005) reported that 84.8% of total fisheries household were affected by the tsunami. In Krueng Raya Bay, this disaster killed 44 fishermen, increased fishing communities' stress, and led the fishermen income loss around USD 150/month. It had also heavily affected fishermen's settlement, fisheries capital, production assets, fisheries infrastructure, and social facilities. Gibbs (2009) remarked that fishing communities as a part of coastal community was heavily impacted from natural disaster.

Social vulnerability and resilience of fishing communities

There was no previous research on social vulnerability in the study area, with exceptions of studies on economic diversity of fishermen's wife (Miftachuddin, 2003), marketing efficiency (Lisna and Sofyan, 2011), and fisheries subsidy non-fuel fisheries (Muchlisin et al., 2012). Social vulnerability is a significant issue on both sustainable livelihood approach and fish resource management. DFID (1999) mentioned that if social vulnerability changes, it will affect to sustainability of livelihood.

Meanwhile, Adger (2000) argued that aspect of social resilience is depended on livelihoods stability (in particular income sources), assets distribution, social stability (i.e., population change, mobility and migration), and environment variability. It is generally understood that the tsunami eradicate social resilience in fishing communities through

destruction of coastal ecosystem directly, local institution's function, and stakeholder's interaction in reconstruction process.

Recovery of fisheries livelihood

A series of actions had been completed to recover fisheries livelihood in Krueng Raya Bay. As a part of economic sector, the recovery of fisheries livelihood was integrated with others sectors such as infrastructure and housing, social, education, and health. The total budget amounted to USD 76.6 million, provided by GOI and donor agencies. Economic sectors including fisheries sector were only allocated 8.8% of total budget, being USD 84.4 million. The highest priority of budget disbursement was given to short term effect, such as cash payment for work program, by adopting un-sustainable approach. Generally speaking, Pomeroy et al., (2006) revealed that the quick response and recovery program around the world post disaster has usually focused on physical reconstruction and less paid attention on individual or community rebuild livelihood for long term sustainability.

Successful recovery programs supported by local institutions

The recovery process was dominated by the external institutions of Krueng Raya Bay. In reality, 53 donor agencies (national and international level) were engaged in recovery programs, 28.3% of them were directly concerned on economic sectors, and less than 10% of the total was directly focused on recovery of fisheries livelihood. They were involved in reconstruction of fisheries livelihood capital⁶.

However, the successful of fisheries livelihood recovery programs was supported by local or indigenous institution participation. Shortly after the tsunami disaster, Panglima Laot Lhok (sea commander, hereafter it is called PLL), local government unit (LGU), and fishing communities rebuilt temporary shelter and their fishing boats to relief their livelihood. During relief, reconstruction and development phase, PLL and LGU acted not only as self-organizer for relief of fishing communities, but also as center role on fisheries aid delivery. Pomeroy et al., (2006) warned that although the disaster often

⁶ Fisheries livelihood capital are assets production (boat, fisheries infrastructure, fish processing unit building, and fish pond rehabilitation), capacity building (training for fishermen, fish processor, and fish farmer), and strengthening local or indigenous institution (technical assistance of institution and fisheries management).

weekend the structure of fishing communities' organization, reconstruction process had to re-enforce existing social structure (such as PLL and LGU) and involved them in decision making on this process because they are essential for institutional sustainability.

Role of indigenous institution

In many case including in Krueng Raya Bay, an indigenous institution such as PLL strengthened social resilience for coastal fishing communities and managing fish resources for sustainable of fisheries livelihood. Ostrom (2008) mentioned that fish resources as a part of common pool resource may be governed and managed by wide variety of institutional arrangements, one of which can be community ownership. Noorwijk et al., (2006) remarked that social capital such as indigenous institution in fishing communities of Aceh has been an important rule base on resilience, especially the family and religious networks that absorbed survivor.

Sustainable livelihood approach

The sustainable livelihood approach contributed on recovery of fisheries livelihood in Krueng Raya Bay. A few donor and implementing agencies, such as United Nation Development Program (UNDP) and Center for Coastal and Marine Resources Studies (CCMRS), agreed to adopt SLA into fisheries livelihood recovery due to previous lesson learned on empowerment of fishing communities. The fishing communities including indigenous institution (such as PLL, LGU, and others) in the planning, implementing, monitoring, and hand over of fisheries livelihood recovery program.

1.3. Research Questions

The problems mentioned above have relationship with sustainable livelihood approach. However, these conventional problems still remain in the fishing communities of Krueng Raya Bay after 7 years of the tsunami. Because it has impact on fisheries livelihood capital definitely in both directly and indirectly. However, the recovery process of fisheries livelihood, which internal and external institutions were involved, also emerged some problems within the fishing communities. Therefore, shelf resilience and capacity of fishing communities were needed to cope the negative impact of tsunami and seasonal change of environment.

This research focused on the following questions in order to build back better of fisheries livelihood:

- 1) What were the tsunami disaster impact on fisheries livelihood? And what were factors affected on the change of fisheries livelihood in tsunami influenced fishing communities?
- 2) What were factors affected on fish resource decline and coastal ecosystem degradation?
- 3) How did poverty increase and income decrease in the fishing communities? And what strategies did those affected people propose on recovery of fisheries livelihood?
- 4) How did the affected people suffer from social vulnerability? Did they recover social resilience?
- 5) How has sustainable livelihood approach been effective in the strengthening social resilience of fishing communities?

1.4. Purpose and Objectives of Research

The purpose of this research is to identify the strategies of sustainable livelihood approach toward the strengthening of social resilience in the tsunami-affected fishing communities. To approach the purpose, this research has five particular objectives, as follows:

- 1) To examine factors affecting on changes of fisheries livelihood in the fishing communities.
- 2) To examine factors affecting on anchovy resources decline and coastal ecosystem degradation.
- 3) To assess the sustainable livelihood strategies into the restoration of fisheries livelihood.
- 4) To identify the role of indigenous institution in building and strengthening social resilience.
- 5) To propose recommendations for further development of the affected fisheries livelihood.

1.5. Conceptual Framework of Research

Sustainable livelihood framework (SLF) was adopted and modified on recovery of fisheries livelihood. The SLF is defined to bring together the five principal components (vulnerability context, livelihood capital, access and recovery, livelihood strategies, and livelihood outcome). These components are referred to livelihoods definition⁷ and demonstrated the interactions among them. In the recovery of fisheries livelihood⁸, this research put additional components such as resilience context, factors affecting (disaster and anthropogenic), strategies and program of SLF. Here, the framework of the research is called sustainable fisheries livelihood approach (SFLA) toward the strengthening social resilience, shown in Figure 3.

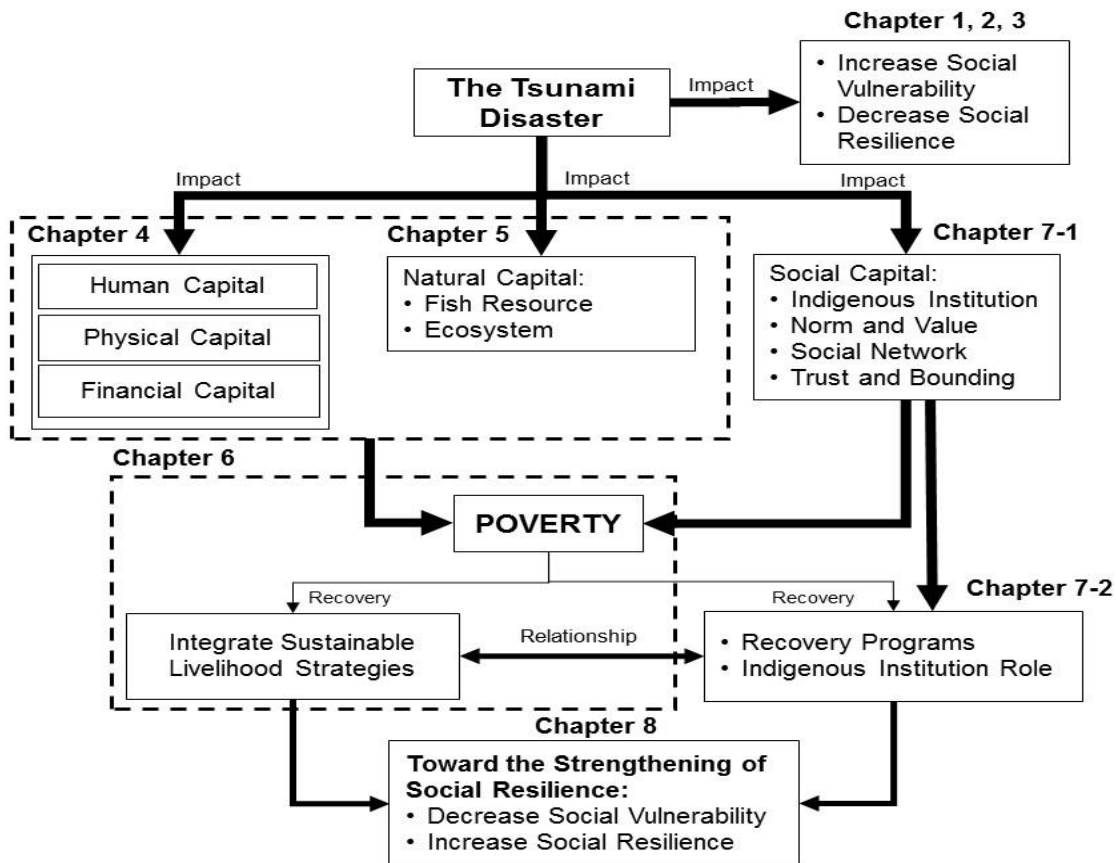


Figure 3. Research framework

⁷ Livelihood is comprises the capability, assets and activities required for a means of living (Chamber and Conway, 1991)

⁸ Fisheries livelihood is the capabilities and activities of fishing communities, and fisheries livelihood capital required on recovery process for a mean of living (Imran and Yamao, 2012)

Tsunami factors have impacted on livelihood capital, vulnerability and resilience context. The starting point of SFLA is how the tsunami and anthropogenic factors⁹ can impact on vulnerability and resilience context, and livelihood capital. Commonly, these factors can cause the increasing of poverty through changing livelihood capital, increasing vulnerability, and decreasing resilience. As modification of SLF, the SFLA also recognizes five main capitals (pentagon capital) which are composed by human capital (people in fishing communities), physical capital (asset production and fisheries infrastructure), financial capital (asset production cost, operational cost, fisheries aid), natural capital (fish resource and coastal ecosystem), and social capital (indigenous institution, norm, network and relationship). Vulnerability and resilience would be focused on social vulnerability and resilience of fishing communities.

Fishing communities has two access on recovery of fisheries livelihood. The first access is how fishing communities to integrate sustainable livelihood strategies into fisheries livelihood recovery. The second one is how they can participate and arrange the fisheries livelihood recovery program and put indigenous institution role to be representative on recovery process. The interaction of these two access and recovery can achieve social vulnerability decrease and social resilience increase toward the strengthening social resilience of fishing communities and to improve fisheries livelihood capital.

To elaborate the SFLA into this research, this thesis consists of eight chapters.

Chapter 1 consists of the introduction, background, problem statements, research questions, objective and conceptual framework. **Chapter 2** concentrates on theoretical reviews that are constructed for factors affecting on vulnerability context and fisheries livelihood capital, sustainable livelihood, integration of SLA approach into the recovery and resilience of fisheries livelihood. This chapter also concerns linkage between fish resources management and social resilience in fishing communities.

Chapter 3 is to explain the methodology adopted, which includes study area, survey procedure, data collection and data analysis. **Chapter 4** focuses on factors affecting on

⁹ Anthropogenic factor is the externality or impact of the human activities on nature resources or environment. This factor refer to the human activities to produce some product using in both natural and non-natural capital or utilization of natural capital such as fish use destruction fishing gear.

fisheries livelihood capital exclude fish resources and coastal ecosystems. **Chapter 5** mainly analyzes the factors contributing to the decline of fish resource including anchovy.

Chapter 6 explores how the changing factors of fisheries livelihood affected income and poverty. This chapter also assesses how fishing communities collaborate with external institutions in the recovery process of fisheries livelihood and the integration of sustainable livelihood strategies. **Chapter 7** is assessment on tsunami impact to social capital of fishing communities and analysis on how indigenous institutions has played an important role on the recovery of fisheries livelihood. **Chapter 8** consists of conclusion and recommendation.

1.6. Summary of Thesis

The summary of thesis will be described in follow paragraph:

Chapter 1 describes the comparison of some socioeconomic both before and after the tsunami in Aceh Province. The earthquake and tsunami have contributed on changing of structure economic and influenced on social indicator. The population was in poverty trap and high unemployment before the tsunami. Those affected people were under worst condition after it, and gradually got better in the recovery process. This chapter also explains the potency of marine capture fisheries (MCF) for fisheries sector and fisheries livelihood. This huge disaster had also severely impacted for fisheries livelihood capital. The series of fisheries livelihood recovery, which are supported by national policy, was elaborated in this chapter. Finally, this chapter will convey the general information of the study area, the statement of problems, research questions, the purpose and research objectives, the conceptual research framework, and summary of thesis.

Chapter 2 concerns about the theoretical review to lead the study and survey to the challenge and success. The sustainable livelihood approach (SLA) will be main focal point in this chapter and it will be explored the important principles of the SLA (such as vulnerability context, livelihood capital, livelihood strategies and outcome). The integration among these principles is analyzed how they are adopted in fisheries livelihood recovery. Social resilience is discussed in this chapter. Other theoretical reviews focused on management of fish resource as common pool resources, considering

the fact that a success or failure would effect on fisheries livelihood capital. This chapter also shows the link with fish resources management and social resilience in fishing communities. Therefore, those references reviewed in this chapter would be useful for studying on link between fisheries livelihood recovery strategies and fish resource management, in Aceh Province, in particular Krueng Raya Bay.

Chapter 3 conveys the detail information of the research site on geographical, socioeconomic and ecological aspects. Primary data collected are firstly described and methodology adopted will be discussed in depth, referring to secondary data of this research area. Survey, sampling, focus group discussion, and in-depth interview were used to collect primary data in March 2012 and September-October 2012 in Krueng Raya Bay, Aceh Besar-Indonesia. This chapter also presents objective analysis on primary and secondary data. This research adopted the following analysis tools: (1) damage and loss analysis, (2) descriptive statistics analysis, (3) inferential statistics analysis, (4) stock classification analysis, (5) Social Vulnerability Index (SoVI) and Social Resilience Index (SRI), (6) Likert type scale analysis, (7) Aid Dependency Index (ADI), (8) stakeholders analysis, (9) comparative analysis, and (10) quantitative contents analysis. The most important analysis is inferential statistics analysis, followed by social vulnerability index, and stakeholders' analysis.

Chapter 4 analyzes the factors affecting a change of fisheries livelihood between before and after the tsunami. In the beginning of this chapter, the impact of the tsunami disaster on tangible and intangible assets of fisheries livelihood is assessed by adopting damage and loss analysis. Furthermore, the changing conditions of fishermen, fishing boat, and operational cost, asset production cost are compared between before and after tsunami.

Chapter 5 compares the state of fish resources in both before and after the tsunami, in particular anchovy. The state of anchovy stock was estimated by using surplus production model. The result show that maximum sustainable yield (MSY) of anchovy after the tsunami disaster was less than 20 times of MSY before that. The anchovy stock had been less abundant before the tsunami disaster and became depleted after that. The characteristics of anchovy and long-weight relationship were also discussed to support the state of anchovy stock change. Moreover, certain factors contributing to the decrease of anchovy were also identified and referred to the anthropogenic and disaster impacts.

Chapter 6 discusses the integration of sustainable livelihood strategies into fisheries livelihood recovery in fishing communities. Poverty alleviation with increase of income is a main target of sustainable livelihood. Several factors affecting on fisheries livelihood capital (such as asset production damage, value of fish production declining, and change of fishing boat composition) will be elaborated for in-depth discussion about why poverty and income change occurred in fishing communities. This chapter also presents aids and external institution role on recovery of fisheries livelihood and over-dependency of fishers and fishing communities. The main and supporting strategies toward the development of fisheries livelihood post recovery process will be discussed.

Chapter 7 describes the outcomes of this research, while focusing mainly on the impact of the tsunami disaster on the improvement of social capital which would be toward the strengthening of social resilience. How the disaster destroyed and damaged intangible assets such as social capital including people's networks will be analyzed in depth. Two indexes are calculated to show up how high or low social vulnerability and resilience in fishing communities before tsunami. Finally, the role of indigenous institutions are also identified to strengthening social resilience in Chapter 7.

Chapter 8 provides a summary of conclusions, and recommendations for improving the management of fisheries livelihood and its strategies toward the strengthening social resilience in fishing communities post the disaster.

CHAPTER 2. THEORETICAL REVIEW

Implementation of sustainable livelihood approach (hereafter is called SLA) into small scale fisheries is an effective tool to reduce poverty reduction and improve people's life. SLA might solve the problem of vulnerability and enhance the resilience of fishing communities. Aftermath the tsunami, there have been many programs planned and implemented by GOI and other donor agencies. However, there were not many researches how SLA incorporated into the recovery of fisheries livelihood and the strengthening of social resilience. This chapter will discuss factors contributing on capital accumulation of fisheries livelihood, sustainable use of fish resource, institutional development for the recovery of fisheries livelihood, and so on. In order to create a theoretical framework, this thesis will analyze some selected issues and topics concerned.

2.1. Promoting Factors on Fisheries Livelihood Changing

The Sustainability¹⁰ of fisheries¹¹ resources as natural capital has contributed for fishing communities. FAO (2014) estimated that 58.3 million people were involved in the sector of capture fisheries and aquaculture in 2012. A number of full time workers were 37% of those who were engaged in this sector, following by 23% part time, the rest of them were either opportunities fishermen or of unspecified status. Stobutzki et al. (2006) emphasized that fish resource is an important source of income and means of livelihood in developing countries, in particularly for rural areas.

The majority of people employed in fisheries sector were inhabitant in coastal area. Thirty percent (30%) of 1.2 billion population in the world lived nearby the coast in 1990 (Small and Nicholls, 2003) and this percentage rose to 41% (2.5 billion) in 2002 (UNDP, 2005). In Indonesia, 204.5 million of total population were lived in coastal zone (UNDP, 2005) in 2003 and rose to 234.7 million in 2012 (UNDP, 2013). There is no exactly record in Aceh Province; at least, 16 districts have coastal zone and they depend on fish resources in developing of communities' livelihood.

¹⁰ Sustainability is defined as the ability of a system to maintain productivity in spite of a major disturbance, such as is caused by intensive stress or a large perturbation (Krippendorff, 2004)

¹¹ Fisheries term meaning in this context also involve aquaculture activities.

Unfortunately, fishing communities are also high vulnerability. Allison and Ellis (2001) and Pomeroy *et al.* (2006) used the fragile term to describe how high the vulnerability of fishing communities in developing countries. They argued that fishing communities are rely high dependent on severely overfished natural resources and badly degraded coastal ecosystems; instead, few have sustainable way out of poverty and make them vulnerable to change in resource condition. Fishing communities may also high vulnerability to the hazard because coastal zone is potential affected by disaster (Duxbury and Dickinson, 2007).

There are various definition of vulnerability. The UK Department for International Development (DFID) (1999) mentioned that vulnerability can be defined as external factors in which people exist. Adger (1999) stated that vulnerability is the exposure of communities to livelihood stress as an impact result of the environmental change. Meanwhile, Wisner *et al.* (2004) noted that vulnerability is how the characteristics and situation of group that influence their capacity to anticipate, cope with, resist, and recover from the impact of natural risk. Within SLA, vulnerability context is included the issues of seasonality, trend and shock (Chambers and Conway, 1992; Scoones, 1998). In the disaster literature, vulnerability is a potential losses from hazard event or disaster (Cutter, 1996) and it is needed to focus on assets and resources to reduce the impact of a stressor (Birkman *et al.*, 2009). In this thesis, the definition of vulnerability is related to internal characteristics of fishing communities in building their capacity to cope and recover from the disaster impact.

There are many variables can be classified into the formation factors of vulnerability context. It is widely acknowledged that the formation factor of vulnerability encompasses the shock, trend and seasonal factors (DFID, 1999; Chambers & Conway, 1992; Scoones, 1998). DFID (1999) described that such as of composition of vulnerability context comprise to; (1) shock can be expressed by human, natural, and economic, livestock, fisheries, and conflict; (2) trend is represented by population, resources, economic, governance, and technology trend; and (3) seasonal is shown by seasonality of price, production, health and employment opportunities. In fisheries livelihood, Allison and Horemans (2006) clearly explained that shocks, including storm damage, toxic alga bloom, fuel price increase, and currency devaluation, can affect to fishing input and market price for fishery product. They added that trends, such as decreasing catch rates,

increasing fish prices, and factors unrelated to fisheries, might impact on fisheries households (i.e.: rising costs of food staples or medicines). Availability of fish stock, income-generating opportunities, and fish demand and services may fluctuate seasonally.

Changing of vulnerability can be affected on livelihood. DFID (1999) mentioned that vulnerability changing can direct impact upon livelihood capital through shock, trends, and seasonal shift in economic factor and food availability for poverty people. Messer and Townsley (2003) warned that the composition of shock, trend and seasonal factors may become, more or less, vulnerable to poverty. Natural disaster can affect to the changing vulnerability and it would be impact to human live, household, productive asset (Pomeroy et al., 2006; Westlund et al., 2007), fish stock, fish global supply, fish price, goods cost, services (WorldFish Center, 2007), transform assets into a living (WorldFish Center, 2007), and poverty increasing (UNDP, 2010); FAO and ILO, 2009).

According to some definitions and concepts above, this study more concerned on social vulnerability context. Here, social vulnerability is the exposure of groups or individuals to stress as a result of social and environmental change, where stress refers to unexpected changes and disruption to livelihoods (Adger, 1999). Cutter et al. (2003) mentioned that social vulnerability is a multidimensional concept and it help to identify those characteristics and experiences of the communities that enable them to respond to and recover from environmental hazard. They suggested several indicators to analyze social vulnerability such as socioeconomic status (income), gender, age, employment loss, education, family, social dependence, and population growth.

Lee (2014) promoted that social vulnerability indicators can be identified using the capital approach based on the result of review from many literature which related to social vulnerability indicators. He defined three group of social vulnerability indicators which are human capital, social capital, and public resources provision and public security (Table 2).

Table 2. Integrated factors of social vulnerability

Type of capital	Description of factors	Indicators	Relation to social vulnerability
Human Capital	Demographic characteristics	<ul style="list-style-type: none"> • Female population • Age • Population density • Birth rate • Infant mortality rate • Household with disable members 	Positive Positive Positive Positive Negative Positive
	Social and economics characteristics	<ul style="list-style-type: none"> • Social and economic status • Poor population • Income • Percentage of population 25 years or older with lower than high school diploma • Rates of unemployment • Working population in primary sector 	Negative Positive Negative Positive Positive Positive
Social capital	Community development	<ul style="list-style-type: none"> • Strength of social network • Percentage of houses rented or seasonal houses 	Negative Positive
Public resource provision and public security	Public infrastructure and resources that belong to inhabitants and its safety	<ul style="list-style-type: none"> • Public infrastructure and resources that belong to inhabitants • Quality and price of house • Percentage of old house 	Negative Negative Negative

Sources: Lee (2014)

This thesis defined that the formation factors of social vulnerability both before and after the tsunami disaster may have direct and indirect effect on input, process, and output of fisheries livelihood. Initially, this research classified human capital (such as fishermen), financial capital (operational cost and production cost of fishing fleet), physical capital (fishing vessel and fishing gear), natural capital (fish resources and its ecosystem), as input factor of fisheries livelihood. Meanwhile, institutions including local wisdom, fisheries management and fishing communities interaction are regarded as social capital, which are the process how the input factor work in production fish. In this context, the series of strategies of local and national level have an important role to regulate input factors in avoiding tragedy of commons such as fish resources overfishing or depletion. It put fish production as a result of input and process factors and it will be a determinant factor to meet the level of welfare in fishing communities. This is dependent on income and poverty of people. Finally, it is estimated that fisheries livelihood capital shifting either by anthropogenic factor or natural disaster will be influenced to fisheries livelihood

and fish resources in short and long term effect. Regarding this interaction, it has the tentative hypothetic as can be seen in Figure 4.

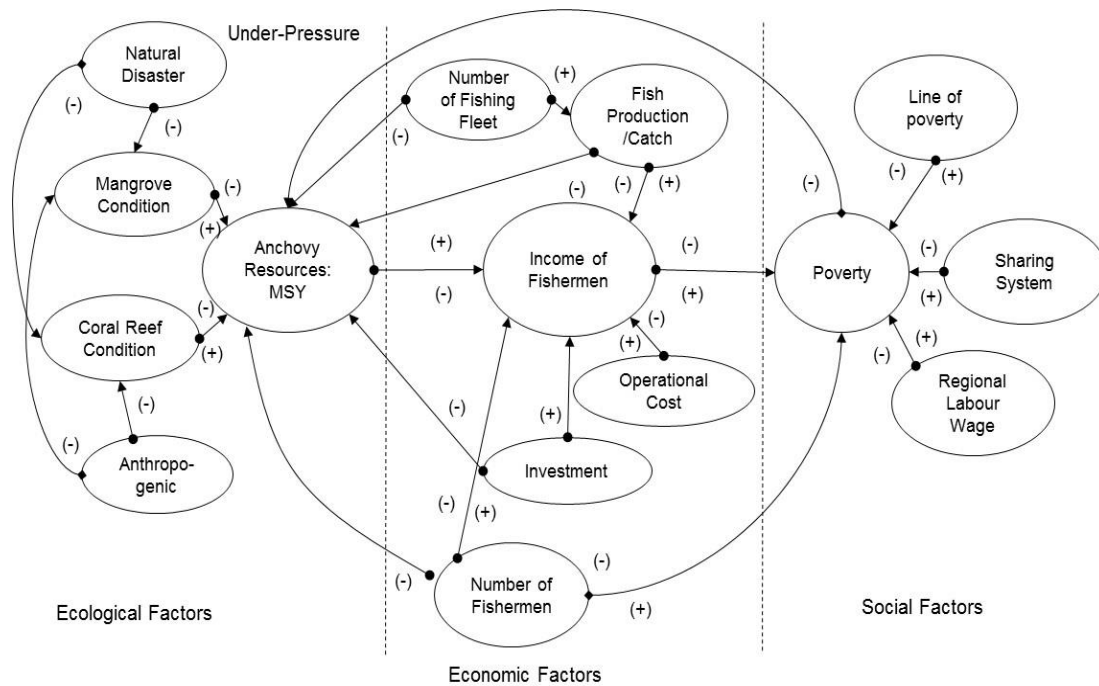


Figure 4. Inter-correlation factors in fisheries livelihood changing

2.2. Challenges of Fish Resources for Fisheries Management

2.2.1. Fish Resources in Perspective Common Pool Resources

Natural capital, in this case can be identified as fish resources, has a crucial role in sustainability of fisheries livelihood. There are many perspectives why fish resources have to pay attention in fisheries livelihood. Within a theory of common pool resources (CPRs), fish resources can be included to CPRs (Gardner et al., 1989), great concern of major ecological challenge (Ostrom, 2008), and provide livelihood and income for fishing communities (Ostrom, 2008). Fish resources also has the characteristics of CPRs, such as: (1) excludability or control of access, referring to physical nature of the resources such that controlling access by potential user may be costly and virtual impossible; and (2) subtractability means that each user is capable of subtracting from the welfare of other user (Berkes, 2005). Fish resources are also managed using open access (free access), private property (individual or corporation right), state property (vested exclusively use

and regulated by government), and common property (used and regulated by identifiable community) regime (Berkes, 2005; Fennell, 2011).

Frequently, many resources users including fishermen presume that they can withdraw more of resources unit than the optimal availability due to the characteristics of CPRs. Fish resources are not unique and similar obstacles are encountered on other cases of CPRs (Gordon, 1953). Hardin (1968) argued that user of commons over-exploited and in an inevitable process, which leads to the destruction of resources on which they depend. In the classical issues of the common of fisheries resources, devastation of this resource was led by population growth (Hardin, 1968), overharvested (Ostrom, 2008), human disturbance to all coastal ecosystem (Ostrom, 2008), industrialization of fisheries (Jackson et al., 2001), liberalization of fish trade for open access regime (Pauly et al., 2002), and poor fisheries management (Hannesson, 2001). It is classical evident that fisheries resources as common property has always driven fishermen into a dilemma because some fishermen withdraw fish from a common fishing ground, and reduces the availability of fish to other fishermen in the short term. It is obviously rationale for some fishermen to increase fishing effort to catch more fish. Gordon (1953) called this condition as “exploited under conditions of individualistic competition or among fishermen”. Inevitable, fish resources will become into overfishing condition.

Recently, analyzing of contemporary issues of the common fisheries resources have been concerned by many scholars in Southeast Asia. There are several interesting issues which relate to contemporary issues, as follow: (1) generating income for fishermen and overcapacity of fishing boats (Pomeroy, 2012), (2) linking between coastal resources destruction and fishing communities poverty (Pomeroy, 2012), (3) depending on the scale of fisheries operation and migratory/not migratory of fish stock (Stobutzki et al., 2006), (4) conducting shelf-organization and shelf-regulation capability of fishing communities to solve the problems (Berkes, 2005), (5) using collaborative management for fisheries management (Berkes, 2005), and (6) implementing ecosystem approach to the fisheries management (Berkes, 2005).

2.2.2. Fish resources in Perspective Fisheries Management

Fisheries management system needs to ensure that fish resource will be utilized in sustainable and responsible way, and potentially benefit for human and other purposes. There are various factors considered in fisheries management system. Charles (2001) compressed the factors of fisheries management to: (1) natural system, consisting of the fish, the ecosystem, and the biophysical environment, (2) the human system, including the fishermen, the post-harvest sector, consumer, fishing household, fishing communities, and socio-economic-cultural environment, and (3) the fishery management system; arranging fishery policy and planning, fisheries management, fisheries development, and fishery research. Meanwhile Cochrane (2002) argued that fisheries production and yield are constrained by a number of factors which can be classified into biological, ecological and environment, technological, social and cultural, and economic consideration. This thesis only focuses on production aspect. The most interesting stage is how to determine the state of fish resources to ensure that it can be utilized in sustainable way, in particular for fisheries livelihood.

Several approaches can be examined fish stock assessment for fisheries management objective. Biology, economics, and bio-economic model are common approached using to define the state of fish resources for estimation total allowable catch (TAC) and maximum sustainable yield (MSY) (Gayanilo and Pauly, 1997; Sparre and Venema, 1998). They explained that the basic principle of analytical method deals with age structure model of fish catch which is represented by analyzed weight and length relationship. Meanwhile, the holistic model use when availability of input and output data are limited to assess MSY (i.e.: swept area and surplus production model approach). Because many researches on biology field have prepared the great bulk of fishery production for consideration, this research deal with biological approach to estimate weight-length relationship (WLR) and MSY of fish resources. Commonly, both of WRL and MSY result are great important to define fish resources state within a certain fishery management area (FMA).

WRL is one of common use for fishery analysis data for fishery management target. Generating of WLR is significant because it can use for biomass measurement, morphology comparison, fish condition estimation (Moutopoulos and Stergiou, 2002),

parameter a (constant) and b (exponent) estimation (Mendes et al., 2004). Le Cren (1951) explained that the series data of weight and length was common analyzed to yield biological information of fish. He added that general purpose using WLR was to measure the variation from the expected weight for length of individual fish or relevant group as indication of fatness, general well-being, and gonad development. In fisheries biology, WLR is useful to determine biomass by using the series weight and length measurement to analyze and compare the fish condition and growth between different regions (Koutrakis and Tsikliras, 2003). Instead, identification species and its characteristics are interesting steps for not only WLR but also assessment of fish stock.

Implementation of WLR in fishery biology may determine whether the somatic growth is isometric or allometric. Many scholars have defined a categories of fish growth using exponent b . According to Enin (1994), weight growth is isometric when the value of exponent b is 3 (without changing shape). If b value un-equal 3, weight growth can be classified into allometric type. It can be either allometric positive ($b > 3$, where weight growth is faster than length growth) or allometric negative ($b < 3$, where length growth is faster than weight growth). In case of anchovy, the result of literature review found that the categories of weight growth might be classified to either allometric positive or allometric negative.

There are some factors influencing on shifting allometric growth of anchovy. Karachle and Stergiou (2012) remarked that anchovy growth is influenced by (1) feeding habit and habitat, might be effected to morphological characteristics; and (2) oceanography and type of ecosystem (such as current, temperature, existence of mangrove and coral reef) might be contributed in establishment of anchovy population. Another factors could be caused by the population strategies to the seasonal upwelling ecosystem that it has relationship with the enrichment of coastal water and growth investment (Cubillos et al., 2001).

In fishery management, MSY as a holistic model is widely accepted concept in many national and international fisheries management. As a fisheries management strategy, MSY concept was initiated in Belmare New Jersey in early 1930s (Russell, 1931) and introduced by Graham in 1935 (Russell, 1931). It has become considerably popular when surplus production model (SPM) is used to estimate explicit MSY in 1950 (Schaefer,

1954) and it is well known as “Graham-Schaefer Model” (Sparre and Venema, 1998). This model has been reviewed by the famous scholars such as Ricker (1975), Gulland (1983), and Pauly (1983). As simple model, MSY concept was adopted by International Whaling Commission (IWC), Inter-American Tropical Tuna Commission (IATTC), and other international arrangements of fisheries management.

What is MSY model? Schaefer (1954) stated that MSY is the level of maximum equilibrium catch which the sizes stock may be maximize catch. It can be said that MSY is the optimal catch that may be taken from a fish stock year after year without endangering its capacity to regenerate for the future (EU-Fisheries Commission, 2006) or as maximum catch (yield) in number of mass can be removed from a population over an indefinite period (EU-Fisheries Commission, 2006). Regarding fish stock term, MSY is meant the highest possible annual catch that can be sustained unlimited time by keeping the stock at the level maximum growth (Maunder, 2008).

The MSY can relies from surplus production¹², which is Graham-Schaefer model (linear) and exponential model (Gompertz) to provide sustainable yield. It can be calculated from SPM (Paterson, 1992). The principle concept of MSY was developed from population logistic growth and Paterson (1992) refined it to the most modern fisheries model which refer to the fraction differ among population depending on the life history of the species and the age-specific selectivity of fishing method. Maunder (2008) noted that MSY can be estimated from a combination of yield-per-recruit and the stock-recruitment theory relationship. Abundance of fish stocks using SPM is usually tracked in part at least from the relative catch per unit effort (CPUE) (Burkenroad, 1951). In many cases of fisheries management, SPM Graham-Schaefer is frequent used rather than exponential model¹³ to calculate MSY. The SPM estimates that MSY will occur when the population is declined to half of its carrying capacity (K) and $MSY=rK/4$, where r is the (intrinsic) rate of population increase when the population density is low (Burkenroad, 1951). Maunder (2008) suggested to use simple regression analysis (SRA) for SPM analysis, which the

¹² SPM is equal to reproduction and growth less natural mortality (Statistics Indonesia Agency, 2003)

¹³ Exponential model was developed by Fox in 1970 (Maunder, 2008)

equation is $y = a + b X$. This thesis defined that y is CPUE¹⁴, x is fishing effort, a is constant, and b is coefficient estimator.

SRA was applied in many research to estimate MSY for fisheries management. The famous using of SRA was applied to estimate MSY of California sardine (Pacific pilchard), Pacific halibut (Schaefer, 1954) and Peruvian anchovy (Schaefer, 1954). Some scholars in Indonesia also used SRA to analyze MSY of anchovy resources in Tegal's coastal water (Clark, 1976), Agam District (Sobari and Muzakir, 2008), and Galang waters-Batam, Pandan Bay-Kutai Timur District (Juliani, 2013). Modification of SPM using SRA was more easily implemented for the single species to estimate its MSY. Giuliani (2013) mentioned that MSY using SRA is static model; and it is also traditionally a single-species concept, conflicts with multispecies or ecosystem science and management. SRA in this research implied to compare MSY anchovy resources in the period 1999-2004 and 2007-2012 in Krueng Raya Bay-Aceh Province. The hypothesis of this research is MSY in the period recovery process will be less than the period before the tsunami (Figure 5).

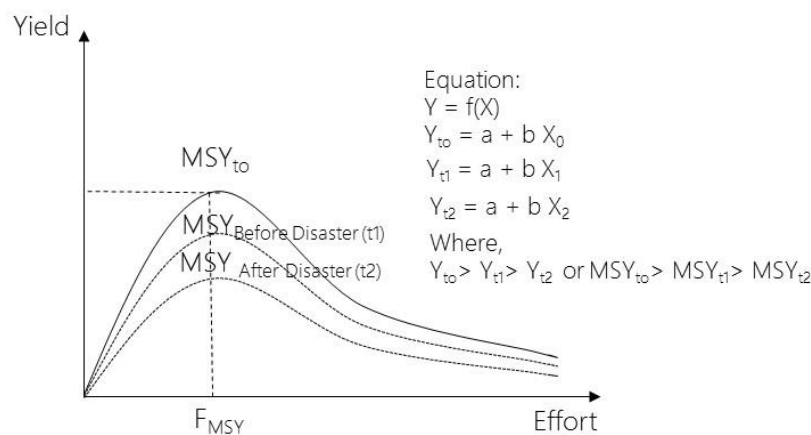


Figure 5. Forecasting of MSY for single species with increasing effort and after disaster

This hypothesis as mention above was supported by several condition, as follow: (1) disaster was impacted on fish resources in short term and direct affected on coastal

¹⁴ The number of fish or invertebrates caught per amount of time compared to the fishing power used for harvest. CPUE directly relates to the relative abundance of fish in a stock. It is a good evaluation tool, and part of what makes a comprehensive assessment.

ecosystem (such as coral reef and mangrove ecosystem) in long term; (2) destruction of coastal ecosystem can be impact on fish stock recovery; (3) asset production damage was not really significant for fish stock increasing. The result of SRA may be used to state that fish stock whether is overfishing or not. Overfishing might be defined as the condition in which an increase in fishing effort must result in a reduction (relative to what would otherwise have obtained) not only in density of stock but also in the total weight of catch (Burkenroad, 1951). Pauly (1983) mentioned that overfishing is “indeed the primordial sin, the bankruptcy of fisheries management”. Froese and Proelss (2012) emphasized that “a fishery is overfishing, if removals from the stock are higher than those that would allow the stock to grow and to maintain a size that can produce the maximum sustainable yield.

Some criterion could be used to define fish resources overfishing. In the simple way, the criterion of overfishing is occurred when fisheries activities caused a declining of abundance and fish catch (Burkenroad, 1951). He also clearly defined that fish resources overfishing is indicated by: (1) biomass of one or more important species fall below minimum biologically acceptable limits, (2) biological diversity declines significantly, (3) harvesting leads to increased year-to-year variation in populations/catches, (3) significant decrease in resilience or resistance of the ecosystem to perturbations, (4) lower cumulative net economic or social benefits than might be obtained with less intense fishing, (5) fishing damages long-term viability of ecologically important non-resource species. Technically, Froese and Proelss (2012) said that overfishing is occurred when fishing mortality F (actual fishing effort) is larger than F_{msy} ($F > F_{msy}$). Worm et al. (2009) argued that overfishing is occurred when exploitation rate (μ) exceed exploitation rate of multispecies of maximum sustainable yield (μ_{mmsy}). Sewell et al. (2013) noted that there are two dimension in case of fish stock overfished in USA, as follow: (1) a fish stock is overfished when it falls to a biomass or population level that endangers the stock's capacity to produce maximum sustainable yield (MSY) on a continuing basis regarding the Magnuson-Stevens Act; and (2) in practice, fish stock is overfished when a stock assessment (B) is less than the threshold stock (B_{msy}) or often 50% of B_{msy} according to the National Marine Fisheries Service and regional fishery management councils. In this thesis, MSY is defined regarding SLR analysis; thus, overfishing could be defined when actual production is less than MSY and actual effort is less then optimal effort.

When fish resources are overfishing, and if fishermen continue to catch fish more than MSY for many year, they will face a depletion state. Fish resources would be collapsed, when it is severely depleted. Some examples of fish species depletion had been reported in many countries. Peruvian anchoveta fisheries depletion or collapse was led by excessive fishing in 1972 (Clark, 1976; Hilborn and Walters, 1992). FAO (2014) estimated that 28.8% of the world's fish stock are currently being catch at an unsustainable level, thus high risk to collapse. In Indonesia, Over the past 40 years many fish populations have been severely depleted (Heazle and Butcher, 2007), for example trawl fisheries in Arafura Sea and purse seine fisheries in Java Sea.

Nowadays, classified the state of fish resources whether overfishing or depletion or collapse is debatable. Fish resources would collapse, if actual biomass less than 20% biomass of maximum sustainable yield (B_{msy}) (Worm et al., 2009). Meanwhile the criterion reported by (Worm et al., 2009) that fish resources is depletion if >50% decline over baseline abundance, collapse if >90% decline and extinction if 100% decline. Worm et al. (2009) used 10% of unfished biomass as a definition for collapse. According to Mohamed et al. (2010), using abundance data are difficult to come into tropical fish stocks, even assuming that catch is proportional to abundance. With assuming that catch is proportional to abundance and the historical maximum catch during the 34/35 year period was taken as the baseline catch, they defined the criterion for fish stock classification as can be seen in Table 3.

Table 3. Criteria use for fish stock classification

Stock Classification	Recent average catch in historical maximum (%)
Abundant	> 70
Less Abundant	50 – 69
Declining	11 – 49
Depleted	6-10
Collapsed	< 5

Sources: Mohamed et al. (2010)

2.2.3. Identification Factors on Declining of Fish Resources

Entering 21 century, worldwide concern and aware on the state of fish resources is increasing because of overfishing or depletion issues. Overfishing or depletion of fish

resources could be caused by several factors. This phenomenon could be attributed by fisheries factor. Pauly et al. (2005) inferred that fisheries factors have contributed for declining of fish resources. In the small scale fisheries term, modified fishing technology and added a number of fishing boat were selected to increase fishing effort for catching more fish. In Indonesia, using light fishing for purse seine and lift net boat has given negative impact on sustainable fish resources because this fishing technology harvests a large volume of immature fish such as Indian mackerel (*Rastralliger kanagurta*), Russel scad (*Decapterus ruselly*), and anchovy (*Stolephorus insularis*) (Sudirman and Musbir, 2009). Heazle and Butcher (2007) reported that improvement of fishing technology of purse seine had indicated severe decline in small pelagic fish in Java Sea.

Another fisheries factor, using the destructive fishing might give indirect impact to fish resources habitat. UNEP (2011) reported that destructive fishing methods, including bottom trawling, blast fishing, fishing with poisons, muro-ami nets, and several other locally employed fishing methods, significantly degrade aquatic habitats. This institution gives an example that blast or bomb fishing, which uses small explosives to kill or stun fish, it destroys the structure of coral reefs and can sub-sequent cause the collapse of reef fisheries. Heazle and Butcher (2007) mentioned that fishing with poisons and explosives would destruct fish habitat, such as coral reef. Overfishing or depletion of fish resources could not ban to fisheries factors alone, but also it was contributed by environment changing and natural disaster, socio-economic, and anthropogenic factors (Table 4).

Table 4. The factors sources/activities affect in fisheries resources declining

No.	Factors	Sources/Activities	References
1.	Environmental change and natural disaster	the degradation of fish habitat or ecosystem	(Heazle and Butcher, 2007; Gordon, 1953)
		El Niño influenced to Peruvian anchoveta	(Gordon, 1953); Pauly et al., 2002)
		increasing eutrophication	(Jackson et al., 2001)
		climate change	(Jackson et al., 2001)(Hauge et al., 2007)
		organic matter	(WorldFish Center, 2007)
		changes or fluctuation in the marine environment	(Burkenroad, 1951)

Table 4. Continue...

No.	Factors	Sources/Activities	References
		Un-favorable climatic conditions affected s large fishes and the migratory species	(Laë, 1995)
		The el niño southern oscillation (ENSO) effects on marine ecosystems, fish productivity and composition of marine communities	(Laë, 1995); WorldFish Center, 2007)
		storm impact on wild fish recruitment and stock	(WorldFish Center, 2007)
2.	Socioeconomic	increasing investment and ineffective fisheries management to fish trade liberalization	(WorldFish Center, 2007)
		increasing fisheries trade and improvement of fishing technology	(Hannesson, 2001)
		the absence of property rights	(Pauly et al., 2002)
		human exploitation degraded of marine ecosystems	(Hauge et al., 2007)
		Intensive human exploitation and disturbance degraded marine ecosystem such as coral reef, estuarine, mangrove, and sea grass beds	(Burkenroad, 1951)
		marketing may cause increased fishing effort	(Jackson et al., 2001); (Burkenroad, 1951)
		increasing human population	(Gordon, 1953; Laë, 1995; Lotze et al., 2006)
3.	Anthropogenic	Pollutants such as petrochemicals, human sewage, and sawdust have contributed to the degradation of ecosystem.	(Duxbury and Dickinson, 2007; Heazle & Butcher, 2007)
		Pollutant in sediment might cause disease and reduce salmon populations	(Hauge et al., 2007)

2.3. The Sustainable Livelihood Approach

2.3.1. The Concept of Sustainable Livelihood

The livelihood has played the center role for rural families including fishing communities. Originally the term of livelihood used to express the capability of rural families to cope with crisis such as drought and flood (Arkoosh et al., 1998). Swift (2006) described that livelihood focuses on asset of rural people change and their ability to withstand shock. In context of sustainability, livelihood has a link with resilience which is meant the ability of livelihood system to rebound from stress or shocks (Allison and Ellis, 2001). The livelihood approach also borrows ideas from an ecological literature concerned with the

sustainability of ecosystems (Holling, 1973). It is not only economic attribute, but also include the social relationship and institution that mediate people's access to different assets and income streams (Holling, 1973). Ellis (2008) emphasized that the core of livelihood can be expressed by a living which is supported by livelihood capabilities (people), claims and access (intangible asset), and store and resources (tangible asset) components (Figure 6).

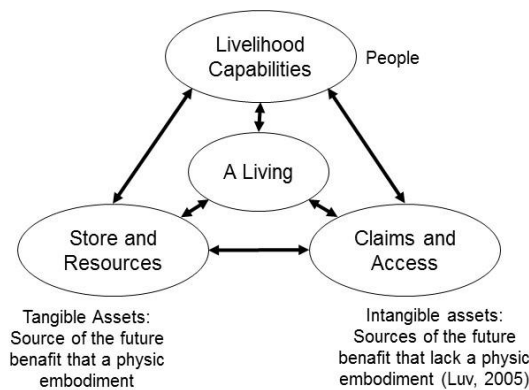


Figure 6. Component and flows in livelihood (Chambers and Conway, 1992)

There are various definition of livelihood. Early definition of livelihood is defined as adequate stock and flows of food and cash to meet basic need (WCED, 1987). In simple sense, WCED (1987) called that a livelihood is a mean of achievement a living and comprises the capabilities, assets (including both material and social resources) and activities required for a means of living (Chambers and Conway, 1992; Scoones, 1998). DFID (2000) adopted this definition and modified that a livelihood comprised the capabilities, assets (include both material and social resources) and activities required for a mean of living. Ellis (1999) proposed that the assets (natural, human, financial, and social capital), the activities and the access (mediated by social relationship and institution) that jointly determine the living gained by an individual or household can be inferred as a livelihood. In the level of household, a livelihood is people activities and their ability, and all the different elements that contribute and affect to ensure a living of themselves and their household (Messer and Townsley, 2003). While the definition of a livelihood can be applied to different hierarchical levels, the scholars stressed that it is used most commonly at the household level (Krantz, 2001).

Considering reduction of poverty, recovery of livelihood, and improvement of people quality of life; some scholars and institutions put livelihood into sustainable livelihood concept (SLC). The SLC idea was first introduced by the Brundtland Commission on Environment and Development as a way of linking socioeconomic and ecological considerations in a cohesive, policy-relevant structure (Krantz, 2001). The United Nations Conference on Environment and Development (UNCED) expanded the concept for the achievement of sustainable livelihoods as a broad goal for poverty eradication (Krantz, 2001). WCED (1987) argued that SLC can cope with and recover from stress and shock, maintain or enhanced its capabilities and assets, and provide sustainable livelihood opportunities for the future generation; and which contribute nets benefits to other livelihoods at the local and global level in short and long term.

There are several objectives and principles should be consider in developing of the SLC. Krantz (2001) proposed that SLC objectives would be useful for policy implication the poorer research. He also argued that this concept should integrate and link the principles of capabilities, equity, and sustainability¹⁵ in both normative and practical; but they are not always or necessarily mutuality.

Chambers and Conway (1991) promoted that a livelihood is sustainable when it can cope, withstand and recover from stress and shocks¹⁶ and enhance its capabilities and assets both now and in the future, while not undermining the natural resource base. Utilization of natural capital in an efficiency due to carrying capacity of ecosystem might retain the sustainability of livelihood (Duxbury and Dickinson, 2007). Holling (1973) argued that livelihood will be sustainable if natural resources system has the capacity to maintain productivity and it can cope from disturbance force whether stress or shock. If external factors (seasonal, trend and shock) are beyond the household or communities control, livelihood might be sustainable (Allison and Horemans, 2006).

¹⁵ Capability refer to being able to perform certain basic functioning, to what a person capable of doing and being (such as able to cope with stress and shock and to find and make use livelihood opportunities); equity can be measure in term by relative income distribution; and sustainability mean the ability to maintain and improve livelihood while maintaining or enhancing the local and global assets and capabilities on which livelihood depend (Maunder, 2008)

¹⁶ Stresses are defined as pressures which are typically continuous and cumulative and therefore to some extent predictable, such as seasonal shortages, rising populations or declining resources, while shocks are impacts which are typically sudden, unpredictable and traumatic, such as fires, floods and epidemics (Chambers and Conway, 1991).

Developed the previous concept of sustainable livelihood, DFID (1999) elaborated SLC into sustainable livelihood framework (Figure 7) to achieve poverty elimination rather than a goal in its own right. SLF set out to conceptualize how people operate within a vulnerability context, draw on different livelihood capitals in different combination and (3) use their assets base to develop a range of livelihood strategies. Chambers and Conway (1991) suggested that the result of livelihood outcome should be refer to social and environment sustainability.

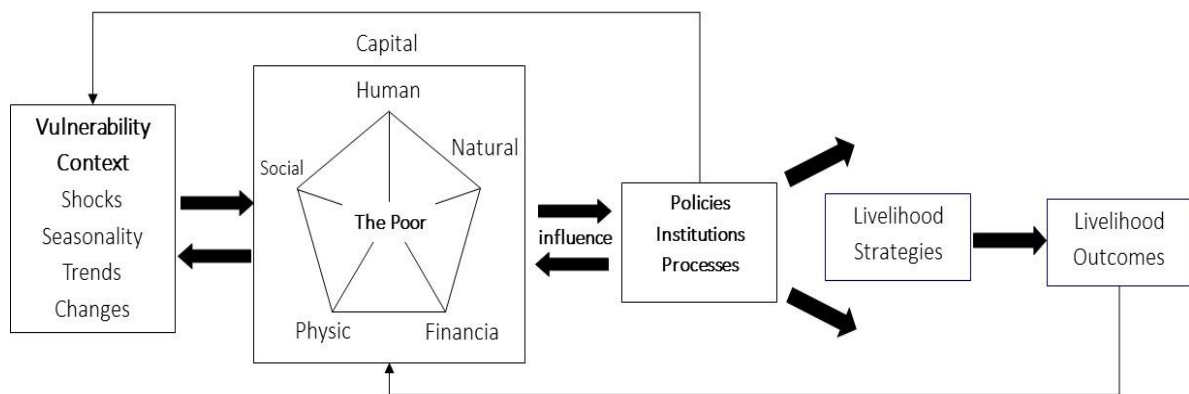


Figure 7. Sustainable livelihood framework (DFID, 1999)

Five elements of SLF must be paid attention for development of sustainable livelihood (DFID, 1999). The vulnerability context is affected to people's livelihoods. The main factors of this element, the seasonality-trends-shocks, are not susceptible to control by local people themselves, at least in the short and medium term. The livelihood capital¹⁷ is needed to achieve livelihood outcomes directly and indirectly (Messer and Townsley, 2003). Portfolio of livelihood assets are the most complex part of SLF because people construct their living with integration the tangible assets, resources, intangible assets (Chambers and Conway, 1992; Krantz, 2001). Transforming structures and processes within the livelihoods framework are the institutions, organizations, policies and legislation that shape livelihoods (DFID, 1999). Livelihood strategies comprise the range,

¹⁷ Human capital represents the skills, knowledge, ability to labor and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives; social capital is taken to mean the social resources upon which people draw in pursuit of their livelihood objectives; natural capital is the term used for the natural resource stocks from which resource flows and services (e.g. nutrient cycling, erosion protection) useful for livelihoods are derived; Physical capital comprises the basic infrastructure and producer goods needed to support livelihoods; and Financial capital denotes the financial resources that people use to achieve their livelihood objectives (Chambers & Conway, 1991)

combination and choices of activities to achieve livelihood goals (DFID, 1999). Scoones (1998) called it as “livelihood portfolios” which focus on intensification/extension livelihood, livelihood diversification, and migration. Livelihood outcomes are the achievements or outputs of livelihood strategies, such as more income, increased well-being, reduce vulnerability, improved food security, more sustainable use of natural resources (DFID, 1999). The impact of livelihood outcome have to eradicate poverty; decrease vulnerability context and increase resilience of individual, household and people (Chambers and Conway, 1991). The implementation of five elements SLF must be consider to the characteristics of local communities and location of target.

SLF has different perspectives and interpretations. (DFID, 1999) mentioned that SLF put the poor at the center of analysis. Carney (2002) added that SLF can be interpreted as a set of principles, an analytical framework, and a development objective. In perspective fisheries livelihood, SLF can decrease poverty and vulnerability context by using the fisheries livelihood capital to reach optimum outcome of fishing communities (Allison and Horemans, 2006).

2.3.2. Integration of SLA into Fisheries Livelihood

Why SLA integration into fisheries livelihood is needed? In context of fisheries livelihood, the SLF might accommodate the fisheries livelihood strategies, the formal and informal institutions role on livelihoods, the socioeconomic heterogeneity of fisheries household, and the strategies of small-scale fisheries confronted by fluctuating fish resources (Carney, 2002). Stirrat (2004) argued that SLF in recent proponent of fisheries development program might reduce poverty and vulnerability for fishing communities’ engagement in small scale fishing, fish processing and trading.

The principles of SLA should be considered into sustainable fisheries livelihood approach (hereafter is called SFLA). SFLA should consider to the principles SLF which is composed the normative (tell us what we should do) and operational (guidelines flow from the normative principle) aspect (Carney, 2002). In term of normative, users can adopt the principle of *people* center (human freedom and choice), empowering, (decreasing poverty), responsive and participatory (priority poor people as key actor), sustainable: (balance of economic, institutional, social and environmental). In term of

operational, users might follow the principle of multi-level and holistic, partnership, disaggregated, and long-term and flexible.

The principles of SFLA is relevant to guide the fishing communities reducing poverty due to their characteristics. The fishing communities are the multi-dimensional poverty and it has relationship with vulnerability context (Allison and Horemans, 2006). Townsley (1998) revealed that they are often characterized by overcrowded living conditions, inadequate services, low levels of education, a lack of skills and assets (particularly land). Other characteristics are high resources dependent, small scale, family base fisheries (Westlund et al., 2007; Clay and Olson, 2008), lack of livelihood diversity, and income uncertain and seasonal (Charles, 2001). In Indonesia, the patron-client system, low education, and high dependent on fishing are influenced the fishing communities characteristics (Bailey et al., 1987).

Westlund et al. (2007) suggested to integrate all elements of SLF for development of fisheries livelihood. Because these elements are useful as a checklist of issues for policy and practice, easily in management and policy change, acceptable for partners. However, these SLF integration into fisheries livelihood development also has several weakness because SLF's elements are insufficient for analyzing and addressing power and power relations in managerial and structural perspective; limited utility in conceptualizing human agency, experience and conflicts over values; it does not explicitly consider intra-household differences in livelihoods, limited utility for understanding the shape of livelihood and its relationship with local institutional practices; limited engagement with community development approaches and concepts; and lack of emphasized the importance of markets and their roles in livelihood development and poverty reduction; and over emphasize on the asset pentagon (Allison and Horemans, 2006).

2.3.3. Integration of Sustainable Livelihood Strategies into Fisheries Livelihood

The integration of sustainable livelihood strategies into fisheries livelihood are interesting to increase the capabilities of fishing communities. SLF emphasized that livelihood strategies are enormous diversity at every level within geographic area, across sectors, within household, and over time (Allison and Horemans, 2006). But, DFID (1999) said that the most interesting of livelihood strategies are how the greater people achieve ability

to withstand or adopt to the shock and stress of the vulnerability context. In context of fisheries livelihood recovery, Allison and Horemans (2006) argued that livelihood strategies need to address not only to the factor vulnerability context, but also to the factors of unsustainable livelihood, high level of poverty, and declining of quality of live in fishing communities.

Livelihood strategies are composed of various activities undertaken by people to generate livelihood, generally adaptive over time, responding to opportunities, and changing constrains (DFID, 1999). As livelihood portfolios, livelihood strategies should also consider to socio-economic difference and basic livelihood resources access (Scoones, 1998). Devereux (1993) and Davies (1996) made a distinction between survival¹⁸, coping¹⁹, adaptive²⁰ and accumulative²¹ for livelihood strategies in household level (Table 5).

Table 5. Typology of different livelihood strategies

Type of livelihood strategies	Internal livelihood system component		
	Change to assets	Strategies and activities	Consumption outcome
Accumulative	<ul style="list-style-type: none"> - Increased stock of assets - Diversified activity 	As for adaptive	More income, improve nutrition, increase security, improve livelihood
Adaptive	<ul style="list-style-type: none"> - Change in mix of assets precautionary saving of financial and other assets - Developing alternative livelihood 	<ul style="list-style-type: none"> - Intensification (aquaculture and marine-culture), fish processing diversification, intensification of cash harvesting, investment in social capital, migration - Developed activities non fisheries resources base - Keep fisheries activities 	<ul style="list-style-type: none"> - Income and consumption smoothing, risk reduction, risk spreading, labor smoothing - Improve household income - Improve family participation

¹⁸ Survival strategy is dramatically reducing asset and consumption

¹⁹ Coping is to absorb the impact of an adverse shock by reducing consumption and assets

²⁰ Adaptive strategy seeks to spread the risk of consumption that may occur through diversification of activity

²¹ Accumulative strategy is identical with increased consumption and stock

Table 5. Continue...

Type of livelihood strategies	Internal livelihood system component		
Coping	<ul style="list-style-type: none"> - Intensified sale of fish production, calling down informal claims - Extensive alternative livelihood base on fisheries resources - Re-evaluate fisheries policy - Development community base management 	<ul style="list-style-type: none"> - Piecework, fisheries worker, temporary migration, withdrawing children from school - Adding aquaculture and marine-culture plot in prospective area - Reduce the number of lift net boat and gear - Developing fishing communities surveillance 	<ul style="list-style-type: none"> - Reduce frequency, quantity and quality of meals, use where available of relief food, social and ceremonial obligation - Increase quality product of anchovy processing - Reduce destruction fishing - Maintain fish stock - Reduce violation
Survival	<ul style="list-style-type: none"> - Sell of productive assets, sell of household effect - Keep maintain relationship with middleman 	<ul style="list-style-type: none"> - Illegal activities begging, permanent out migration - Borrowing money to middleman - Sell the boat and gear 	<ul style="list-style-type: none"> - Starvation and destitution - Sustained livelihood activities - Sustained household economy

Sources: Modified from Devereux (1993), Davies (1996) and Field Survey (2012)

In case of natural disaster strike fishing communities, Pomeroy et al. (2006) argued that recovery of fisheries livelihood strategies should focus for the key issues due to various factors by location. He added that these issues are defined by engagement of fishing communities to generate fisheries livelihood strategies. Duxbury and Dickinson (2007) suggested that integration of sustainable strategies into fisheries recovery must consider to the principle of sustainability, adaptive management, participation and integration.

2.4. Toward the Strengthening of Fishing Communities Resilience

2.4.1. Integration of Livelihood Strategies on Recovery of Fisheries Livelihood

Recently, SLF is widely used for fisheries livelihood recovery post disaster. DFID exercised the SLF and link it with vulnerability analysis through enhance communities' capability on development of policy for reducing social vulnerability to natural hazard in Mexico and Central America (Cannon et al., 2003). Pomeroy et al. (2006) reported that SLF was also implied on recovery of fisheries livelihood within affected area of earthquake and tsunami of 26 December 2004.

There are several justifications why SLF imply into fisheries livelihood recovery. It is clearly that natural disaster²² increasing in a few decade can cause on weekend of fisheries livelihood capital and changing of the structure and process in fishing communities in both short and long term (Westlund et al., 2007). Cannon et al., (2003) argued that natural disaster will affect to social capital through initial well-being, resilience, self-protection, social protection, social network, political networks, and social institutions. However, fisheries household decreased ability to earn income and sustain their livelihood when earthquake and tsunami destroy their productive assets in 24 December 2004 (Pomeroy et al. 2006).

SLF integration into recovery of fisheries livelihood is needed adequate knowledge. Salagrama (2006) suggested that five elements of SLF have to integrate on development of fisheries livelihood and these element should modify regarding the condition and location of the target. Fisheries livelihood recovery should be more concerned on rebuilding livelihoods, increasing capacity of fishing communities, and providing resources for self-recovery rather than physic reconstruction (Pomeroy et al., 2006). They also suggested that fisheries livelihood strategies should consider to several factors such as equity, power relations, access to resources and markets, asset ownership and sustainability of resource use.

2.4.2. Resilience of Fishing Communities

Resilience concept is well known in ecology perspective. Originally, the resilience emerged to study the population interaction and their functional respond like predators and prey in relation to ecological stability theory since the 1960s (Holling, 1961). Folke (2006) concluded that resilience in ecology perspective address to dynamics of ecology system and human actions understand on the capacity of ecosystems to generate natural resources and ecosystem services.

Holling (1973) defined that resilience is to measure the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist. Resilience

²² Natural disasters include disasters originating from hydro meteorological hazards (floods, waves and surges, storms, droughts, etc.), geological hazards (earthquakes, volcanic eruptions, etc.) and biological hazards (epidemics, insect infestations, etc.) (Krantz, 2001).

can be emphasized for the speed of recovery from a disturbance (Adger, 2000); the capacity of a system to absorb disturbance and re-organize while undergoing change so as to still retain essentially the same function, structure, identity and feedback (Walker et al. 2004); and referred to the ability of a system to withstand or to recover from a stress or perturbation and adapt to future stresses and perturbations (Adger, 2000).

Resilience in perspective social aspect has a significant role for the ecological system. It was begun to influence social science like is anthropology (1967), cultural theory (1990), human geography (1993), and common property (1996). It was an important component for individuals and social groups to adapt on environmental change (Folke, 2006). Social resilience was contributed to develop the theoretical of social-ecological resilience²³; link the dependence of ecology system on communities and their economic activities, and show the dependency of ecological systems on the social systems (Folke, 2006).

There are various definition of social resilience. At the beginning, Adger (2000) promoted that social resilience is the ability of communities to survive from external shocks for their social infrastructure. Keck and Sakdapolrak (2013) called it as social entities capacities for protecting themselves from all kinds of hazardous events. And the second step, Cutter et al. (2008) defined that social resilience is the social system ability to respond and recover from disasters through adaptive processes. Recently, social resilience is formulated that the communities' ability and willingness to cope with threats, learn from them, and adjust for the future crises and invest into mitigating and adaptive measures (Lorenz, 2010).

What is resilience in the context of the fishing communities? The concept of fishing communities' resilience, as part of coastal communities, was promoted when many scholars realized that the fishing communities are exposed and influenced by natural disaster. Many scholars agreed that people living within 100 km of coastal area are exposed to natural hazard and it's influenced to their resilience. Another reasons are high vulnerability and risk of fishing communities in changing of environment, natural resources, and natural disaster. Thus, fishing communities' resilience can refer to social

²³ Social-ecological resilience is the capacity of linked social-ecological systems to handle disturbance at the same time as maintaining the capacity for adaptation, learning and transformation (Folke et al., 2005). Social-ecological resilience approach is more emphasize on interdependency social and ecological system and their resilience.

resilience concept which are mentioned above. Exactly, the resilience of fishing communities could be defined as the capacity of fishing communities to adapt and influence the possibility of environmental, social, and economic change (Lorenz, 2010).

The final goal of various efforts in recovery and development of fisheries livelihood is toward the strengthening and sustainable of fishing communities resilience. Lorenz (2010) called it as sustainable and resilient communities. To reach these condition, U.S. Indian Ocean Tsunami Warning System Program (2007) argued that the communities should be able (1) to withstand extreme geophysical processes and recover rapidly from disasters whenever they occur; and (2) to arrange contingency planning and organization of society, both to improve the impacts of disasters and to facilitate the recovery processes. The high communities resilience can be indicated by low level of risk and vulnerability, provision adaptable and appropriate planning, supported from responsible agencies and political leaders, a good partnerships, and strength networks (Tobin, 1999).

Commonly, the communities have some capacities to increase their resilience. Tobin (1999), Béné et al. (2012), Obrist et al. (2011), and Keck (2012) suggested that there are three types of capacities for social resilience: coping capacities²⁴, adaptive capacities²⁵ and transformative capacities²⁶ (see matrix of social resilience in Table 6).

Table 6. Three capacities of social resilience

	Coping capacities	Adaptive capacities	Transformative capacities
Response to risk	Ex-post	Ex-ante	Ex-ante
Temporal scope	short-term	long-term	long-term
Degree of change	low, status quo	medium, incremental change	high, radical change
Outcome	restoration of present level of well-being	security of future well-being	enhancement of present and future well-being

Source: (Keck, 2012), Lorenz (2010), Obrist et al. (2011), Béné et al. (2012), Keck (2012), Keck and Sakdapolrak (2013)

²⁴ Coping capacities is represented by re-active (ex-post) and absorptive (Béné et al., 2012), it is indicated by people cope with threats and relief to the present level after a critical event.

²⁵ Adaptive capacities is referred to the pro-active (ex-ante) (Obrist et al., 2011) or preventive measures (Béné et al., 2012), it describe the people learning from past experiences, anticipating in future risks and adjusting their livelihoods.

²⁶ Transformative capacities, or participative capacities is people's ability to access assets and assistance from the wider socio-political aspect for participating in decision making processes and improving their individual welfare and foster societal robustness toward future crises. (Voss, 2008; Lorenz, 2010).

2.4.3. The Role of Fisheries Livelihood Recovery in Fishing Communities Resilience

There are many ways to recover communities' resilience. In case of fishing communities, they needed fisheries livelihood recovery for rebounding their resilience after shock and stress by natural disaster. Obrist et al. (2011) mentioned that resilience thinking is implicit in the sustainable livelihoods approaches because five livelihood assets play a crucial role in the building of resilience. In white paper of SLF, (DFID, 1999) mentioned that poor people are always on the brink of extreme insecurity, sometimes falling below, sometimes rising above. Besides that, resilience has a close relationship with vulnerability context (DFID, 1999). Therefore, recovery of fisheries livelihood has a link to the resilience of fishing communities.

Fisheries livelihood recovery has played role for re-building the resilience of fishing communities. Establishment of livelihood baseline data, building process within a very dynamic environment, and helping adaptability of conditions change are indirect contribution of livelihood recovery toward resilience of communities (DFID, 1999). In fact, UNDP (2010) revealed that livelihood recovery can be affected for vulnerability reducing and resilience of communities increasing by using the combination issues of enabling livelihood protection (such as cash grants and material assistance) and improving livelihood promotion (such as building and strengthening microfinance institutions).

Fisheries livelihood recovery has had a function to revitalize the indigenous institution of fishing communities. Some program of fisheries livelihood recovery is not only address for fisheries livelihood but also for indigenous institution re-vitalization and capacity building. Consortium CCMRS-LEIMA (2007) noted that one of key factor in recovery of fisheries livelihood in Aceh Province is re-vitalized indigenous institution such as Panglima Laot (sea commander) through intensive meeting, training, and engagement on decision making on recovery process. This consortium also suggested to use co-management schema to increase the capacity of Panglima Laot. UNDP (2010) mentioned that the earthquake and tsunami emergency support project (ETESP) fisheries component provided the some activities to increase the capacity of Panglima Laot Lhok for establishment of livelihood capture fisheries center in 8 district of Aceh Province. Re-

functioning of indigenous institution might help to re-build the resilience of fishing communities.

Fisheries livelihood recovery also integrated coastal ecosystem rehabilitation. Network of Aquaculture Centres in Asia and Pacific (2009) reported that rehabilitation of mangrove and coastal forest program in ETESP Fisheries Component was useful to support capture fisheries and aquaculture livelihood for the long term. Rehabilitation of mangrove ecosystem was strongly linked to coastal community which their livelihood are depended on associate resources with this ecosystem in West Coast of Aceh Province (Kanagaratnam et al., 2006). Coral reef rehabilitation also paid attention by Word Conservation Society through in cooperated transplantation of coral reef into capture fisheries livelihood improvement post tsunami in Sabang Island during the period 2006-2009. Adger et al., (2005) elaborated this approach into social-ecological resilience. They mentioned that the capacity of coastal ecosystems to regenerate after disasters and to continue to produce resources and services for human livelihoods cannot longer be taken for granted, thus socio-ecological resilience must be understood at broader scales and actively managed and nurtured.

2.4.4. Institution Role in Strengthening of Fishing Communities Resilience

Institution supporting is needed to enhance the resilience of communities. Adger (2000) identified that institutions are not only formal structure of government, but also behavior, rules and norms that govern society, as well as the more usual notion of formal institutions with memberships, constituencies and stakeholders. He added that the broadest sense definition is important because institutional structures (i.e.: property rights, govern the use of natural resources creating incentives for sustainable or unsustainable use) and they are a central component to enhance social resilience.

There are many roles can be taken by institution in strengthening social resilience. Institution should have the capacity to manage social capital. Social capital means here the existence of integrating features of trust, norms, and networks (Pelling, 1998). As long as the institutions can be adaptable to manage the social capital assets and give positive response on changing of the cultural context and society-environment interaction, communities resilience would be maintained and sustainable (Pelling, 1998). In case of

Indian Ocean Tsunami, the PLL played a center role in delivery aid for fishing communities because this institution has the ability to maintain their trust and network (Pelling, 1998). Other institutions, such as fishermen associations, cooperatives, women's groups, are also effectively engage in collective action to overcome a threat, or to influence the direction of policies and decision-making (Adger, 2000). Instead, they suggested that livelihood recovery program had to reinforce social structure to facilitate community participation to re-organize their resilience.

Indigenous institution should concern and maintain the resources access regulating, natural resources rehabilitation, and demography change. Pomeroy et al. (2006) found that the indigenous institution such as PLL has a legitimation on fisheries resource management, helping function of coordination, leadership and social support, and controlling migration as a result of the December 2004 tsunami. Indigenous institution have to sustain the local knowledge in facing of natural disaster, because it might support the local communities preparedness before disasters struck (Adger et al., 2005).

However intervention by external institution is needed to re-establish the resilience of communities. In case of natural disaster impact such as huge tsunami of 26 December 2004, local institution including local government unit and government could not restore the resilience of communities and communities affected by disaster need external intervention. These intervention can be direct aid to recovery communities' livelihood or indirect technical assistant to restore ecosystem damage. Adger et al. (2005) mentioned that external institution (formal and informal) took place to mitigate the social effects of extreme natural hazards and overcome to reinforce society resilience.

2.5. Linking Fisheries Livelihood, Fish Resources and Social Resilience

Natural disaster, such as Indian Ocean earthquake and tsunami of 26 December 2004, shown that coastal communities are vulnerable and it can bring out the massive change. Fishing communities today face an unprecedented rate of change due to population growth, human induced vulnerability, global climate change, and increasing of natural disaster. The interesting impact of natural disaster would be affected for decreasing social resilience. As well known that strong or weak of social resilience is depended on how strong the resilience of natural resources to support people livelihood. Instead, social

resilience concept can be linked to ecological manifestations and it is an important aspect of the sustainability of development and resource utilization (Adger et al., 2005). In this case, ecological aspect can be represented by fish resources²⁷. Therefore, linking between sustainability of fisheries livelihood and fish resources is needed to examine to investigate the resilience of fishing communities.

Fish resources provide a great support for fishing communities. If fish resources have managed properly, people can secure fisheries livelihood sustainability and increase the resilience of fishing communities. However, if the fish resources are degraded or collapsed, fishing communities may be systematically denied access or displaced on the resources. As a result, the resilience of fishing communities can increase because its vulnerability and poverty will increase. Conflict among fishermen as user of fish resources could not be neglected and tragedy of commons occurred as a result of malpractice in resources management. Adger (2000) reminded that a further aspect of social resilience is depended on livelihoods stability (in particular income sources), assets distribution, social stability (population change, mobility and migration), and environment variability.

There are several examples of fish resources declining impact for fishing communities. Adger (2000) listed the overfishing or depletion or collapsed effect on fisheries sector, such as the collapse of the Argentinean hake (*Merluccius hubbsi*) in 1970, depletion of capelin (*Mallotus villosus*) stocks in northwest Russia at the end of the 1980s, increasing overfishing 300% over the past 20 years in India in 1980s, and over exploitation of living resources in Bahamas. As consequence, the overfishing or depletion or collapsed would increase the poverty of fishing communities and it would be affected to their resilience (UNEP, 2011).

Due to the phenomena above, social-ecological resilience approach²⁸ can be linked to address sustainable of livelihood. Adger (2000) suggested that social and ecological resilience should be linked and adopted as a concept of social stability (of populations

²⁷ Fish resources as natural resources to be a representation of ecological aspect because it has interrelationship between resources and its ecosystem.

²⁸ Social-ecological resilience approach is more emphasize on interdependency social and ecological system and their resilience. Meanwhile, sustainable livelihood approach is the concept or framework which used human, natural, financial, physic, and social capital to develop livelihood and reduce poverty in rural communities.

within social systems) and resource dependency. The key point in this concept of social-ecological resilience is how to link between vulnerability and resilience in the communities. Adger et al. (2005) formulated that the resilience can be conversed from vulnerability in coastal communities and it is more tightly linked to larger scale process today than in the past. Adger (2000) promoted the precise concept about relationship vulnerability-resilience, as follow:

“Social vulnerability encompasses disruption to livelihoods and loss of security. Meanwhile vulnerable groups such stresses are often pervasive and related to the underlying economic and social situation, both of lack of income and resources. Social vulnerability to environmental change and other causes of vulnerability can be observed at different scales. And social resilience increases the capacity to cope with stress and is hence a loose antonym for vulnerability.”

Based on evidence above, the simple link among fisheries livelihood, fish resources and social resilience as can be seen in Figure 8.

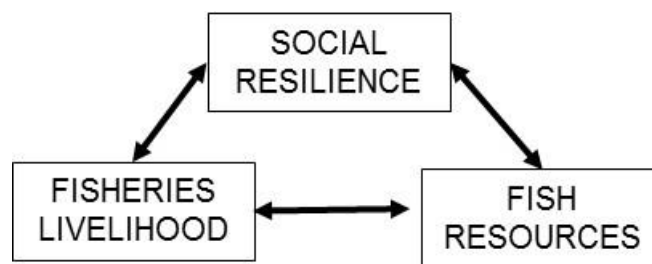


Figure 8. Triangle link of fisheries livelihood, fish resources, and social resilience

The issues of linking resilience and vulnerability are likely to become more important in the framework of resource management questions in the future (Adger, 2000). In context of fisheries resources management, many countries including Indonesia have improved the policy and regulation framework for community based management. This is not easy to change the behavior of fishing communities into ecologically friendly in fisheries resources uses. There are some major factors constraint should set up to long term social-ecological resilience such as production demand, poverty, low level of education, law enforcement. GOI has tried over two decade to improved better management in fisheries resources and over one decade to rehabilitate fisheries resources including in case of natural disaster impact.

The best alternative option for fisheries livelihood and fisheries resources sustainability is to combine between communities based management and SLF. Since 1999, GOI has integrated the concept of communities based management (CBM) through decentralize fisheries resources management at district level. This regulation has also accommodated the local wisdom or indigenous role to rule fisheries resource management. Nowadays, the collaborative system between CBM and decentralization system have become a good governance of fisheries resources management and it need strong commitment among the stakeholders.

Almost in the same period, GOI encouraged to integrated livelihood strategies development into fisheries resources management for improving community participation and capacity building of fishing communities. The goals of integration of livelihood strategies are to eradicate poverty, decrease vulnerability and increase resilience of fishing communities. Adger (2000) emphasized that sustainable livelihood will be reached if the community can combine the strategy of intensification, diversification and migration. In fishing communities, aquaculture or marine culture can be alternative when fisheries resource has been decreased, or collaboration between capture fisheries and marine culture or capture fisheries and non-fisheries resource base can be alternative option in the future. These option to set up adaptive strategies for fishing communities to sustain their livelihood activities and maintain their resilience on changing of fisheries resources and natural disaster.

CHAPTER 3. METHODOLOGY

Methodology encompasses general description of study area, procedure of survey, data collection, and data analysis. The purpose of this chapter will address general and specific objective of this thesis, and to figure out the geographical information, socio-economic condition, ecosystem characteristics, and justification of study areas selected. Moreover, the procedure of survey, data collection, and analytical method will be illustrated in detail for accomplishment of this methodology part.

3.1. Study Area

3.1.1. Defined Social-Ecological Boundaries

Research site was defined base on social-ecological boundaries. The research was conducted in Krueng Raya Bay, Aceh Besar District (Figure 9). It is located in western part of Indonesia and belongs to Mesjid Raya Sub District. Traditionally, this sub district is divided into Krueng Raya and Lamnga Sub Sub-District (Kemukiman²⁹). Indigenous fisheries management institution, namely Panglima Laot Lhok³⁰ (PLL, sea commander), follows this traditional boundaries to manage fishing communities in Aceh Province. Moreover, this indigenous institution also define ecological boundaries; such as bay, estuary, and beach; in order to regulate capture fisheries activities. This fisheries management based on social-ecological boundaries can be adopted for sustainable of small scale fisheries. The administrative structure of Mesjid Raya Sub District as can be seen in Figure 10.

²⁹ Kemukiman is one of traditional institution and it can be defined as legal unit community in Aceh Province. It consist of several villages which directly belonging under head of sub district or another name and led by Imelum Mukim or any other name (Aceh Provincial Regulation Number 4/2003, Chapter I, Article 1, Point 4)

³⁰ Panglima Laot Lhok is indigenous institution in Aceh Province who has authority to manage fishing communities due to certain ecological boundaries such as bay and estuary. This genuine institution is both the name of the institution and the title of the elder fishermen who are elected from among the senior boat captains to lead the fishermen in the immediate area (Wilson and Linkie, 2012). It was established since 14th century as part of Aceh Kingdom for collecting tax in coastal area (Abdullah et al., 2006).

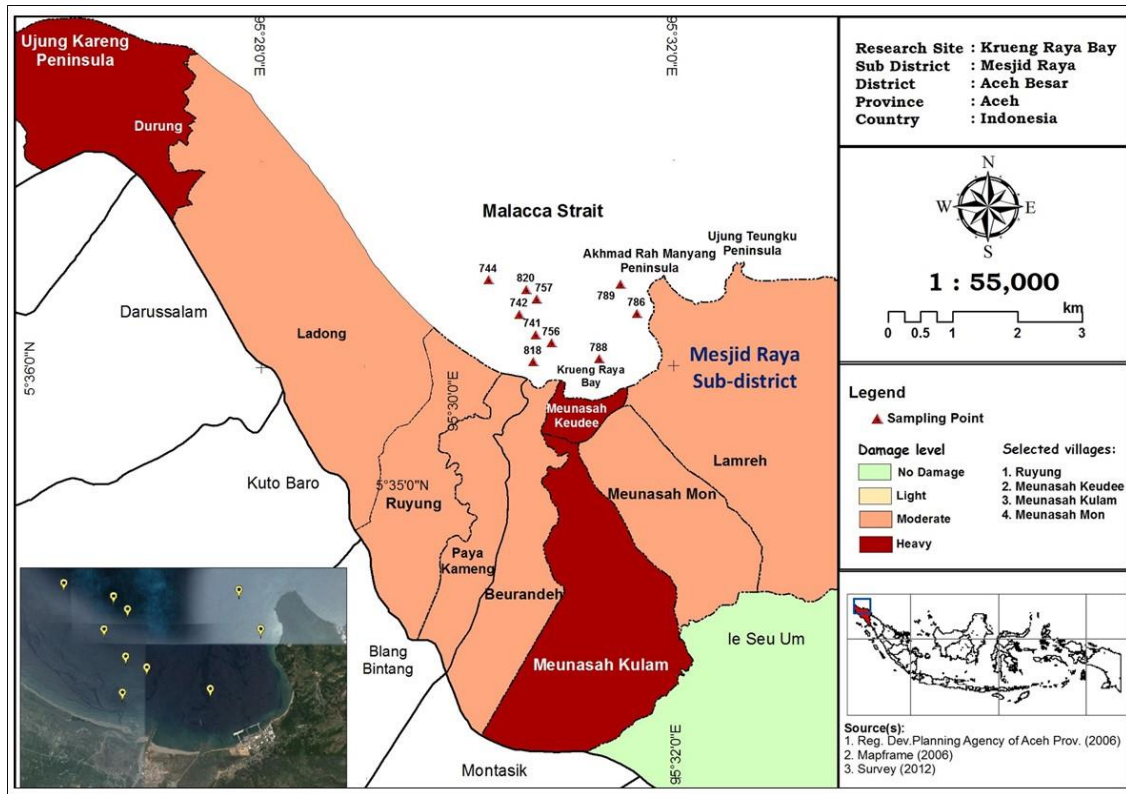


Figure 9. Research site of Krueng Raya Bay, Aceh Besar District-Indonesia
 Source: Regional Development Planning Agency of Aceh Province (2006) and (BRR NAD-Nias et al., 2006) and Field Survey (2012)

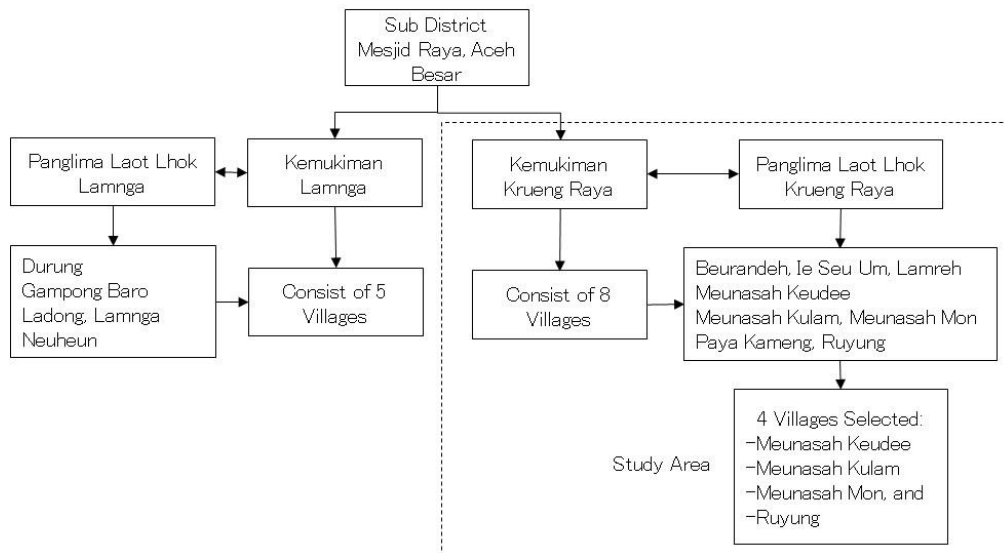


Figure 10. Structure of Research site position in Sub District Mesjid Raya

3.1.2. Research and Its Justification

This research investigated fisheries livelihood capital in case of fisheries livelihood recovery in Krueng Raya Bay. The objective of this case study was not only to explore the problems emerged which were faced by fishing communities, but also to identify the causality factors relationship and their influence for fisheries livelihood capital. Analyzing these factors changing might be indicated by the vulnerability and resilience of fishing communities change after shock and stress by natural disaster. Therefore, this research had to choose the representative study area in both social and ecological boundaries.

For intensive data collection, four villages (desas) were selected among 8 villages, namely: Ruyung, Meunasah Keudee, Meunasah Kulam, and Meunasah Mon. There are several justification to choose four villages as study area. First, people are highly dependent on fish resources and fisheries livelihood. According Statistic Indonesia Agency (2005), 68% of 679 household engaged in fisheries livelihood such as capture fisheries, aquaculture, fish processing, trader, and others that have linkage with fisheries activities (logistic supplier, fuel retailer, boat builder, workshop, etc.) in 2003. Nowadays, these activities has been still become a main source income for the majority household living in these four villages.

Second, these villages can be categories into coastal village. They are established nearby beach and mouth river of Krueng Raya which are determined by coastal ecosystem and vegetation such as mangrove, coral reef, sand beach, cliff beach, pine tree, and coconut tree. These village also exist pond to cultivate shrimp and milk fish before tsunami that are located in flat topography or 4-13 meter above sea level (Statistics Indonesia Agency, 2005). As a coastal village, the majority people in four village is inhabited in nearby shoreline area.

Third, anchovy fisheries and their related business have developed rapidly, thereby making the four villages the center of anchovy fisheries in Aceh Province. Since 1970s, fishermen living in four villages have engaged in anchovy fisheries which was shown by using lift net boat for anchovy catch. In the earlier stage, only 2 lift net boats had been put into operation for fishing anchovy, and rapidly increased to 70 units in the 1980s,

reached 89 units in the 1990s, and became 91 units in 2004. Increasing a number of lift net boat, it was followed by small unit of processing development to produce dry anchovy and others derived business which were related to anchovy in the same period. As consequence, fisheries infrastructure, such as fish market and fish landing, was established near to four villages. In another word, it can be said that anchovy fisheries have become the economic driver for fishing communities in these villages, in particularly for fisheries livelihood.

Fourth, PLL, a traditional management system of coastal resources, has also existed and played an interesting role to recover fisheries livelihood. Abdullah et al. (2006) mentioned that the early idea of PLL establishment was to collect tax in harbor since the sixteenth century when the Kingdom of Aceh was led by Iskandar Muda, including in study area. And then, it shifted to manage fishermen, capture fisheries activities, and coastal resources. It has also taken a function as government partnership in implementing fisheries program for fishermen. When the tsunami hit four villages, this genuine institution was collaborated with donor agency to deliver fisheries aid for fishing communities.

And fifth, those villages were also moderate to heavy impacted by tsunami of 26 December 2004. Samek et al. (2004) described that Krueng Raya Bay is one of heavily damaged region in Aceh Province. However, fishing communities in four villages has the capacity to cope the shock circumstance and they could relief using self-organizer which was supported by internal institutions (such as international and national non-government organization, university, and other agencies).

3.2. Survey Procedure

Survey procedure was designed for fishing communities, fish population, and coastal ecosystem, by using random sampling method. The fishing communities living in four villages with their livelihoods are relate to utilized fish resources such as fishermen, fish processor, trader, and others. Meanwhile, fish population in this case was anchovy resources as main fish catch in this study area. And coastal ecosystems were focused on mangrove and coral reef ecosystem to support fish resources living. A number of

respondents were selected randomly by using the Cochran's sample size formula (Adger, 2000), as follow:

$$n_i = \frac{n_o}{\left(1 + \frac{n_o}{\text{Population}}\right)} \dots\dots\dots (1)$$

Where:

n_o = required return sample size according to Cohran's formula

n_i = sample size

By using $\alpha = 0.1$, n_o result is 68 and Cochran's formula recommended to select 67 respondents from 4,162 people (2011) within the fishing communities. However, we selected 83 respondents to answer structured and semi-structured questionnaires (see Appendix 1). Those respondents were chosen according to the structure of fishing communities in Krueng Raya Bay which were determined by fishermen (lift net, hand line boat, beach seine, and mini purse seine boat), financial trader, and fish processor. Interview with key respondents and focus group discussion with representative of fishing communities were also used to get supporting information which were answered by the selected respondents (see Appendix 2). There were 120 respondents (see Appendix 3) which were involved according to target group for this survey (Table 7).

Table 7. A number of respondents based on target group and type of respondent

Target Group	Type of respondent	Number (persons)
Fishermen	Lift net Boat, beach seine, hand line, mini purse seine, and gill net fishermen	69
Fish Processing	Owners and worker of fish processor	8
Fish Market	Toke bangku (financial trader)	6
Key Person Respondents	Head of Mukim, Panglima Laot Lhok, head of lift net boat, head of hand line boat, head of mini purseine fishermen, and gill net unit, head of fish processing	7
Local Goverment Unit	Head of Meunasah Keudee, Head of Meunasah Kulam, Head of Meunasah Mon, Head of Ruyung Village, Tuha Peut (four person) each Village	4

Table 7. Continue...

Target Group	Type of respondent	Number (persons)
District and Provincial Government	Head of Bappeda Aceh Province Head of Coastal and Conservation, MMAF Aceh Besar Staf of MMAF Aceh Province for Statistical Data and Coastal Management Unit	4
NGO	Director of Wahana Lingkungan Hidup Aceh Province Director of Transparansi International Aceh Director of Aceh Ocean Coral	3
FGD 1	The persons who involve in LGU	6
FGD 2	Hand line fishermen	5
FGD 3	Panglima Laot Lhok and the committee of this indigenous institution	8

Sources: Field Survey (2012)

According to questioner analysis, from 83 respondents could be identified their characteristics (Table 8) and others perception on recovery of fisheries livelihood. The average age of respondents were 38 year old which range between 17-70 years. Their education level was relatively low, which are at 1-6 years or primary school education, reaching 63.86%. They had 2-4 dependents (57.83%) and more than 4 dependents (18.07%). The majority of respondents were male and only 8.43% was a female.

Table 8. Characteristics of fishing communities

N0.	Characteristics	Classification	Respondent	
			Number (N=83)	Percentage (%)
1.	Age	Young workforce, 16-21	11	13.25
		Productive workforce if 22-55 year	66	79.52
		Un productive workforce age if >55 year	6	7.23
2.	Education	Low if Elementary school 1-6 year	53	63.86
		Moderate if Junior to High School 7-12 year	30	36.14
		High if University >12 year	0	0.00
		Good experience if 1-18 year	43	51.81
		Very good experience if more than 18 year	39	46.99
3.	Dependents	Low if 0 - 1 dependent	20	24.10
		Moderate if 2 - 4 dependents	48	57.83
		High if more than 4 dependents	15	18.07
4.	Gender	Male	76	91.57
		Female	7	8.43

Sources: Data Analysis (2012)

Survey in fishing communities were supported by enumerators (Figure 11). Four enumerators interviewed and delivered questionnaire in fishing communities randomly.

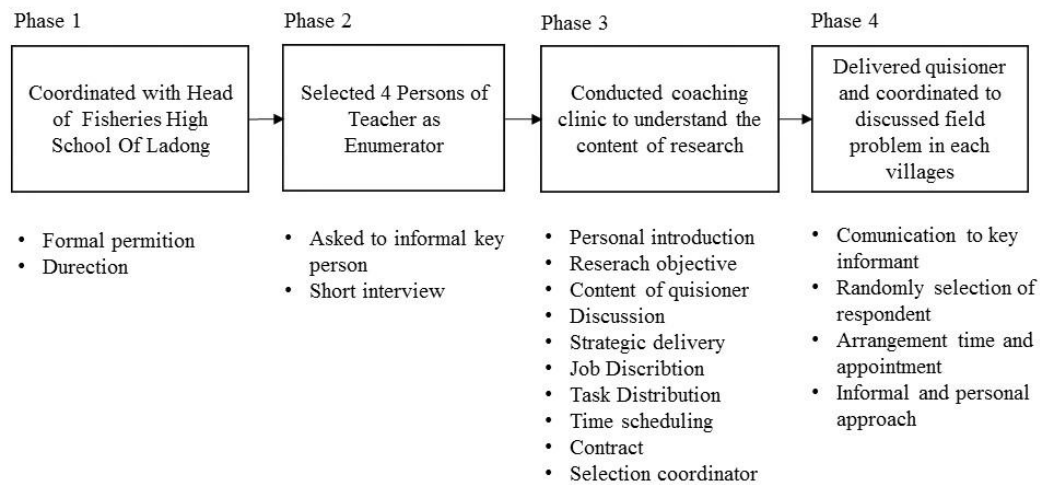


Figure 11. The phase of enumerator recruitment and questioner delivery

Survey method was also conducted to collect fish resources data. In this case study, it was decided to measure only main target fish of lift net boat, namely anchovy. The procedure to measure total length and weight of fish sample were as follow:

- *Anchovy catch.* Using lift net boat and its fishing gear. Fishermen operate this fishing fleet from 18.00 pm to 06.00 am (see Appendix 4). They haul 2-3 times lift net fishing gear in fishing ground area within Krueng Raya Bay for harvesting small pelagic fish including anchovy. They often separate fish catch by species into basket (size 25 kg) to make easier in estimation of total fish catch. At least, 8 times of sampling were conducted to collect anchovy each point of fish catch was marked by global position system (GPS) (Garmin etrex VISTA Cx) (Table 9).
- *Total length and weigh measurement.* Anchovy samples were taken at random until they represent 10% of the total catch and amounted to 188. Each fish was identified by numbering, measured the total length and weigh by standard ruler and scale, and recorded into data sheet.
- *Anchovy identification.* Recorded several characteristics such as body color, type of fin, others to match with book identification which is FAO Species Catalogue Volume 7.

- *Other information of fish resources.* Semi structure and structure questioner was used to obtain specific information of fish resources. Interviews and Focus Group Discussions (FGD) were also carried out to explore deeper information of factors contributing on declining of fish resources.

Table 9. Geographic position of fish sampling

Position	Identity	North Latitude	East Longitude	Date	Local Time
Sampling 1	744	5°36'50.5"	95°30'12.3"	9/26/2012	19:49
Sampling 2	752	5°37'05.0"	95°31'02.6"	9/28/2012	20:22
Sampling 3	756	5°36'13.6"	95°30'48.6"	10/6/2012	19:53
Sampling 3	786	5°36'30.4"	95°31'38.6"	10/7/2012	10:45
Sampling 5	788	5°36'04.2"	95°31'16.05"	10/10/2012	20:39
Sampling 6	789	5°36'47.5"	95°31'29.0"	10/10/2012	23:32
Sampling 7	818	5°36'02.6"	95°30'38.0"	10/12/2012	19:28
Sampling 7	820	5°36'44.8"	95°30'39.34"	10/12/2012	23:56

Sources: Field Survey (2012)

Mangrove, coral reef, and other coastal ecosystem survey were conducted by using ground throating method (see Appendix 5). General procedures of this method as follow: selected and marked position of mangrove ecosystem randomly by using GPS; identified the mangrove species and measured the area (ha) of tree, sapling and seed; recorded data into data sheet. However, coral reef ecosystem was just marked the position and measured the total length of these ecosystem.

The result of ground throating was divided to several block (total length is 15.27 km) and matched with google earth map to estimate length of mangrove and coral reef ecosystem, and identified other coastal ecosystem (Table 10). Moreover, factor affecting on these ecosystem destruction were explored by using depth interview key respondent. Other information were taken from related institution with mangrove and coral reef research and their management.

Table 10. Block defining, distance and characteristics

Block Name/ Position	Geographical Point	Distance (Km)	Block characteristics
Krueng Raya 1: Aron Meudawa - Mouth of Krueng Raya River	5°36'05.70" N and 95°30'49.38" E - 5°36'26.23" N and 95°29'35.47" E	2.48	Sand Beach, Mouth of Tombolo, Tombolo, Lagoon, Mangrove Ecosystem
Krueng Raya 2: Mouth of River Krueng Raya - Point Transition of Clift Beach	5°35'43.75' N and 95°30'49.90" E - 5°36'19.07" N and 95°31'46.24" E	2.35	Krueng Raya River, Sand Beach, Mangrove Ecosystem Fishermen Home Base, Settlement, Harbor, Oil Collector Station, Asphalt Collector, Cement Manufactory, Center of Mesjid Raya Sub District
Krueng Raya 3: Point Transition of Clift Beach - Akhmad Rahmanya Peninsula	5°36'05.70" N and 95°30'49.38" E - 5°36'26.23" N and 95°29'35.47" E	1.18	Coral Reef Ecosystem Clift Beach
Krueng Raya 4: Akhmad Rahmanya Paninsula - Glee Kapai Peninsula	5°36'51.80" N and 95°31'53.72" E - 5°36'50.88" N and 95°32'40.83" E	2.32	Clift Beach White Sand Beach Coral Reef Ecosystem
Krueng Raya 5: Glee Kapai Paninsula - Ujung Teungku Peninsula	5°36'17.54" N and 95°32'43.5" E - 5°37'41.0" N and 95°36'41.94" E	8.12	Clift Beach White Sand Beach Coral Reef Ecosystem Mangrove Ecosystem

Sources: Field Survey (2012)

3.3. Data Collection

Primary and secondary data were collected in this research. Primary data of fisheries capital was collected using questioner delivery, in-depth interview, and FGD. Meanwhile, fish resources and coastal ecosystem were collected using fish sampling method and ground trotting respectively. Secondary data was collected from various sources to support analysis data. Type and source of primary and secondary data collection as can be seen in Table 11.

Table 11. Primary and secondary data collection

No.	Data	Type Data	Sources
I.	Primary		
1.	Human capital	Internal characteristics, damage and loss, type of livelihood, duration of fishing, ownership of production assets, mental recovery, dependency on donor aid, perception	Field survey
2.	Social capital	Norm, trust, social network, social relationship, type indigenous institution, indigenous role, external institution role, strategy and program, fishing communities perception	Field survey
3.	Financial capital	Income, expenditure, sources of financial capital, operational cost, production cost, maintenance cost, type of assets and source, fishing communities perception	Field survey
4.	Physical capital	Production assets, fisheries infrastructure, fishing communities perception	Field survey
5.	Natural capital	Fish identification, target fish species, fish production, length and weight, fishing ground, season, factor affecting the decline of anchovy catch, fishing gear, fishing communities knowledge, coastal ecosystem identification, identification problem of coastal ecosystem, fishing communities perception	Field survey

Table 11. Continue...

No.	Data	Type Data	Sources
II.	Secondary		
1.	Human capital	A number of population, a number of fishing communities, type and source of income	Indonesia Agency of Statistics
2.	Social capital	Indigenous role, norm, trust, social network, social relationship, social facilities	Journals, books, reports
3.	Financial capital	Source of aid, type of aid	Reports
4.	Physical capital	Fisheries infrastructure, damage and loss	Reports
5.	Natural capital	Series data of fish production (1999-2012), effort, fish price, type of fishing gear	Aceh Province of Marine Affair and Fisheries, Ministry of Marine and Fisheries Affair
		Mangrove ecosystem state	Reports and journals
		Coral reef condition state	Reports and journals
		Factors contributing and affecting on destruction of fish resources declining	Reports and journals
		Factors contributing and affecting on destruction of coastal ecosystems	Reports and journals

3.4. Data Analysis Tools

This research adopted several types of analysis tools, namely: (1) damage and loss analysis, (2) descriptive statistics analysis, (3) inferential statistics analysis, (4) stock classification analysis, (5) Social Vulnerability Index (SoVI) and Social Resilience Index (SRI), (6) Likert type scale analysis, (7) Aid Dependency Index (ADI), (8) stakeholders analysis, (9) comparative analysis, and (10) quantitative contents analysis. These data analyzes were calculated using Microsoft Excel Ver. 2013 and SPSS Ver. 20.

3.4.1. Damage and Loss Analysis (DaLA)

Damage and loss (DaLA) was developed by the Economic Commission for Latin America and the Caribbean (ECLAC) since the early 1972 and this handbook was published in 1991. The methodology has also been applied in other regions of the world–

most notably in Asia and, recently, in Africa—to quantitatively determine the effects of major disasters (The International Bank for Reconstruction and Development, 2010). This institution described that, as follow:

- Damage is total or partial destruction of physical assets existing in the affected area. Damage occurs during and immediately after the disaster and is measured in physical units (i.e. square meters of housing, kilometers of roads, etcetera). Its monetary value is expressed in terms of replacement costs according to prices prevailing just before the event;
- Losses is changes in economic flows arising from the disaster. They occur until full economic recovery and reconstruction is achieved, in some cases lasting for several years. Typical losses include the decline in output in productive sectors (such as agriculture and fisheries sector).

This research used this method to estimate preliminary damage and loss on direct and indirect assets of capture fisheries by conducting several steps. First step: identified what kind of physics captures fisheries assets damage and loss two weeks after the tsunami of 2005. Second step: collected data and information how much cost had been spent by interviewing some fishermen and assets owners. Third step: validated fisheries data damage and loss by conducted FGD in the end of 2005. Fourth step, verified data and information one more time by conducted survey in 2012. And fifth step, estimated how much damage and loss of capture fisheries both direct and indirect assets to show how much budget is needed to prepare in the recovery process in the small ecological boundaries area.

3.4.2. Descriptive Statistics Analysis

Descriptive statistical analysis was focused on all fisheries livelihood capital (human, social, financial, physic and natural capital), research location condition, and internal characteristic of fishing communities. It is the branch of statistics which focuses on collecting, summarizes, and presents a set of data for describing what occurred in the sample. It also helps researchers detect sample characteristics that may influence their results of analysis. The performers obtained from field survey, key informants opinion,

informal investigation were used to support the data analysis. The type, definition and equation of these analyzes as can be seen in Table 12.

Table 12. Definition and equation in descriptive statistics analysis

No.	Type	Definition	Equation
1.	Frequency distribution	a valuable method for describing ordinal or nominal level data, which are consist of a description of the number of subjects selecting each possible option and may include the percentage, proportion, and trend of the sample that this number represents	Percentage = $(\chi / \sum \chi) \times 100\%$ Growth = $(\chi_{n-1} - \chi_n) / \chi_n \times 100\%$ .....(2) Where: χ = value of χ $\sum \chi$ = Sum of χ value
2.	The mean (or average)	The most common measure of central tendency, which is calculated by adding up the value for all subjects and dividing by the total number of subjects (n)	$\bar{x} = \frac{\sum x}{n}$ .....(3) Where: \bar{x} = mean or average $\sum \chi$ = Sum of X value n = number of scores in sample
3.	Range	The difference the greatest and lower value, which is very sensitive to outliers or measurements that are greatly different than the rest of the sample	Range = $\chi_{\min} \pm \chi_{\max}$ .....(4) Where: χ_{\min} = χ value minimal χ_{\max} = χ value maximal
4.	Standard deviation	A mathematical calculation of the variance of all the measurement in the sample	$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$ .....(5) Where: s = sample standard deviation \sum = sum of... \bar{x} = sample mean n = number of scores in sample.

3.4.3. Inferential Statistics Analysis

Inferential statistics³¹ analysis was used to examine weight-length relationship (WLR) and maximum sustainable yield (MSY) (Table 13). WLR was applied to analyze the relationship between weight and length and t test were determined to assess the relationship between weight and length, and growth categories. Simpler regression

³¹ Inferential statistics: (1) infer from the sample to the population; (2) determine probability of characteristics of population based on the characteristics of sample; and (3) help assess strength of the relationship between independent variables and dependent variables

analysis was applied to estimate anchovy's MSY and explore the state of anchovy production.

Table 13. Length-weight relationship, length size classification, and MSY analysis

No.	Data Analysis	Equation	Where
1.	Length and weight		
	- Length and weight relationship	$W = aL^b$ .....(6) To estimate a and b parameter using $\text{Log } W = \text{Log } a + b \text{ Log } L$	W = total weight (gram) L = total length (mm) a = constant b = coefficient estimator
	- t test	$t_{\text{test}} = |b - 3|/S_b$ .....(7) with the hypothesis: $H_0 = 3$, weight growth is <i>isometric</i> $H_1 \neq 3$, weight growth is <i>allometric</i> (allometric growth can be positive ($b > 3$) or negative ($b < 3$))	b = regression coefficient Sb = standard error of b H ₀ = hypothesis null H ₁ = hypothesis one Reject H ₀ if $t_{\text{test}} > t_{\text{table}}$ Accept H ₀ if $t_{\text{test}} < t_{\text{table}}$
2.	Length size classification	$K = 1 + 3.3 \text{ Log } N$ .....(8) $r = (\chi_{\text{min}} \pm \chi_{\text{max}})/K$ .....(9)	K = a number of class W = interval/range r = wide of interval χ_{max} = maximum value χ_{min} = minimum value
3.	Maximum Sustainable Yield ¹ Vessel optimal ³	$Y = a + b X$ .....(10) Where $\text{MSY} = a^2/4b$.....(11) and $f_{\text{opt}} = a/2b$.....(12) $V_{\text{opt}} = f_{\text{opt}}/\bar{e}$ .....(13)	Y = catch per unit effort X = effort (unit/trip/years) a = constant b = coefficient estimator f _{opt} = effort optimal (unit/trip/years) V _{opt} = vessel optimal (unit) \bar{e} = average trip in certain period (trip/years)

Sources: Gayanilo and Pauly (1997)

Chi-square and F-test, were used to analyze correlation among the factor in population. Chi-square was applied to examine the correlation factors which are influenced to ADI. Meanwhile, F-test was used to estimate the relationship among the factors which are related to fisheries livelihood recovery strategies.

3.4.4. Stock Classification Analysis

A modified version of the previous study of Mohammed et al. (2007) was also inferred in this research. The percent average catch for the last two to three years in relation to the historical maximum value was used to define the state of fish stock. This study applied

the percent average catch in relation to the MSY before the tsunami to determine the state of anchovy stock (Table 14).

Table 14. Equation and fish stock classification

Equation	Stock classification	Recent average catch in MSY (%)
$\% \text{ of recent catch in MSY} = [\bar{y}/\text{MSY}] \times 100\%$ <p>.....(14)</p> <p>where:</p> <p>\bar{y} : average catch last three years before or after tsunami;</p> <p>MSY : MSY during the period before disaster.</p>	<p>Abundant</p> <p>Less Abundant</p> <p>Declining</p> <p>Depleted</p> <p>Collapsed</p>	<p>> 80</p> <p>50-80</p> <p>26-49</p> <p>6-25</p> <p>< 5</p>

Sources: Modified from Mohamed et al. (2010)

3.4.5. Social Vulnerability Index (SoVI) and Social Resilience Index (SRI)

In context of vulnerability context, this research focused on social vulnerability index (SoVI) to analyze the vulnerability of fishing communities. There are many factor to define SoVI, (The International Bank for Reconstruction and Development, 2010) mentioned that SoVI consider to lack of access to resources, limited access to political power and representation, social capital, building stock and age; frail and physically limited individuals; and type and density of infrastructure and lifelines. However, this research used SoVI, which was developed by Indonesia's National Agency for Disaster Management (Badan Nasional Penanggulangan Bencana, 2012), to calculate fishing communities vulnerability with consider to: (1) population density (population/km²), (2) sex ratio, (3) poverty ratio, (4) disable population ratio, and (5) age population ratio. The equation was formulated by this institution, as follow:

$$\begin{aligned} \text{SoVI} = & (0.6 \times ((\log (\text{population density}/0.01)/\log (100/0.01))) + \\ & (0.1 \times \text{sex ratio}) + (0.1 \times \text{poverty ratio}) + (0.1 \times \text{disability}) + \\ & (0.1 \times \text{age class}) \dots \dots \dots (15) \end{aligned}$$

Categories:

- SoVI < 0.25 = low
- 0.25 ≤ SoVI ≤ 0.50 = moderate
- SoVI > 0.50 = high

Because social resilience is converted from SoVI; therefore, social resilience index was calculated by the following equation:

$$SRI = 1 - SoVI \dots\dots\dots(16)$$

Categories:

$SRI < 0.25$ = high

$0.25 \leq SRI \leq 0.50$ = moderate

$SRI > 0.50$ = low

3.4.6. Likert Type Scale Analysis

A Likert type scales analysis is a psychometric response scale primarily used in questioner to obtain respondents preferences or degree of agreement with a statement. A Likert type scale analysis is used to analyze internal characteristics of fishing communities, indigenous and external institution role, financial capital on recovery of livelihood, and optional strategies on fisheries livelihood.

3.4.7. Aid Dependency Index (ADI)

Fishing communities did not have their own financial support aftermath tsunami. They were heavily dependent on external institutions assistance and their aid delivery. According to these condition and respondents respond using Likert scale analysis, this research promoted ADI to calculate the level of fishing communities' dependency on aid, which was defined several step and equation, as follows:

Step 1. Arranged the statement which represented the capacity of fishing communities and their dependency on external aid. This research defined two statements for asking respondents: (1) fishing communities have the capacity on recovery of fisheries livelihood using their own financial capital (SP1); and (2) external institution and their aid delivery had an interesting played role on fisheries livelihood recovery (SP2).

Step 2. Defined Likert scale which were answered by respondent's preference to the statement. This research defined score 1 to 5: 1 = very disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = very agree.

Step 3. Tabulated the respondent's answer and calculated individual's aid dependency index using the equation:

$$ADI_i = |SP_2 - SP_1| / (S_{max} - S_{min}) \dots\dots\dots(17)$$

Where:

ADI_i = aid dependency index (individual)

SP_2 = individual score for the statement 2 (1-5)

SP_1 = individual score for the statement 1 (1-5)

S_{max} = Score maximal (5)

S_{min} = score minimal (1)

Step 5. Calculated fishing communities's aid dependency index using the equation:

$$ADI_{fc} = \sum ADI_i / n \dots\dots\dots (18)$$

Where:

ADI_{fc} = aid dependency index of fishing communities

n = total respondents

Step 6. Defined 5 criteria to classify the level of fishing communities' dependency on aid, as follow:

0.00 - 0.19 = very low; 0.20 - 0.39 = low;
0.40 - 0.59 = moderate; 0.60 - 0.79 = high; and
0.80 - 1.00 = very high

3.4.8. Stakeholders Analysis

Stakeholders' analysis offers a quick and useful way for identifying stakeholders and their interests, clarifying stakeholders' views of a focal organization (or other entity), identifying some key strategic issues and beginning the process of identifying coalitions of support and opposition. This analysis was used in order to identify the key actors and to assess their knowledge, interests, positions, alliances, and importance related to strategies and program on recovery of fisheries livelihood. The stakeholders can be local institution, LGU, National Government, non-government organization (NGO) and others which have a role on recovery of livelihood process.

3.4.9. Comparative Analysis

In this research, comparative analysis is used to compare fisheries livelihood capital changing before and after the tsunami disaster. This analysis was also used to compare income and poverty in fishing communities. The shifted of SoVI and SRI were also analyzed using the comparative analysis for comparison the state before and after the tsunami. The general equation was used for comparative analysis, as follows:

$$\Delta X_{nt-no} = X_{nt} - X_{no} \dots\dots\dots(19)$$

Where:

ΔX_{nt-no} = the factor value or index changing

X_{nt} = the value of factor or index in n time (nt)

X_{no} = the value of factor of index in initial time (no)

According to above equation, this research defined the trend of fisheries livelihood capital, SoVI, and SRI whether these factors or index increase or decrease or steady state.

3.4.10. Quantitative Contents Analysis

Content analysis is a research method for a systematic and objective means of describing and quantifying phenomena which make the replicable and valid inference from data to their context, with the purpose of providing knowledge, new insights, a representation of fact and practical guide to action. Bryson (2004) defined that the content analysis may be used with either qualitative or quantitative data and this analysis could be applied using inductive or deductive way. Deductive content analysis is used when the structure of analysis is operationalize on the basis of previous knowledge for the theory being test (Krippendorff, 2004). Inductive analysis is based on data movement from the specific to general, and then particular instance are observed and the combined into a larger whole general statement (Krippendorff, 2004). Content analysis does not proceed in a linear method and it is more complex and difficult than quantitative analysis because it is less standardized and systematic.

Qualitative content analysis was used to analyze the content of strategy on strengthening social resilience and optional strategies on fisheries livelihood recovery. The essence of these strategies would be picked up and discussed by using this analysis tool.

This methodology was useful in both conducting survey and analyzing data, in particular for a case study research which implement sustainable livelihood approach. The series tools analysis would be used within chapter IV, chapter V, chapter VI, and chapter VII.

CHAPTER 4. FACTORS AFFECTING CHANGES OF FISHERIES LIVELIHOOD

Fishing communities are exposed to natural hazards (Small and Nicholls, 2003). They face high vulnerability and dependency on severely depleted and overharvested fisheries resources. In 2004, the tsunami disaster had directly affected on fisheries livelihood in Krueng Raya Bay. It had heavily affected fishermen's settlement, fisheries facilities, and social facilities. It killed 44 fishermen, increased fishing communities' stress, and fishermen's income loss was around USD 150/month. Definitely, it severely impacted both tangible and intangible assets of fishing communities. Total fisheries livelihood assets damage and loss was around USD 2.7 million. This amount approached 0.4% of total fisheries assets damaged and lost in Aceh Province. Thus, tsunami impact changed the fisheries livelihood assets in this semi-enclosed water area.

This chapter presents the result and discussion of examination of factor affecting on fisheries livelihood pattern changing in fishing communities as case study in Krueng Raya Bay. The first part of this chapter analyzed tsunami impact on fisheries livelihood assets. And the second part determined fisheries livelihood option and livelihood pattern changing in affected of fishing communities.

4.1. The Tsunami Impact on Fisheries Livelihood Assets

Postulate's Chamber and Conway (1991) explained that household livelihood assets comprise tangible and intangible assets which provide material and social means. Livelihood assets drawn with the pentagon shape framework and divided to human, natural, financial, physical, and social capital (Scoones, 1998; DFID, 1999). This research restrained on fisheries capital damage and loss to support fisheries livelihood. Table 15 shows that around USD 2.7 million of fisheries livelihood assets was damaged and lost in Krueng Raya Bay, which composed USD 2.3 million direct asset and USD 0.4 million indirect assets.

Table 15. DaLA analysis on fisheries livelihood capital in Krueng Raya Bay

No.	List of Asset Damage	Unit Price (USD)		Damage Status			Estimation Lost (US\$)
		Price	Unit	Loss	Heavy	Slight	
I	Direct assets						2,294,489.32
1.	Mini Fish Landing	109,890.11	Unit		1		109,890.11
2.	Lift Net Boat & Engine	10,090.05	Unit		58	18	857,654.50
3.	Long Line Boat & Engine	4,534.83	Unit		33	31	219,939.50
4.	Beach Seine Boat	10,880.19	Unit		16	2	184,963.20
5.	Lift Net	678.95	Packet	76			51,600.00
6.	Long line	315.79	Packet	64			20,210.50
7.	Beach Seine Net	2,173.68	Packet	18			39,126.30
8.	Fish Aggregate Device	368.42	Packet	3			1,105.26
9.	Average Income	150.00	18 month	144	156		810,000.00
II	Indirect assets						352,896.81
1.	Fish Market	4,395.60	Unit		3		13,186.81
2.	Docking	33,000.00	Packet		1		33,000.00
3.	Salty Fish Trader	110.00	Packet		15		1,650.00
4.	Mini Workshop	2,000.00	Packet		4		8,000.00
5.	Dry and Salty Fish	220.00	Packet		16		3,520.00
6.	Mobile Market (Moge)	2,111.00	Packet		10		21,110.00
7.	Anchovy Fish Processing	450.00	Packet		58		26,100.00
8.	Mini Shop Fuel Seler	250.00	Packet		9		2,250.00
9.	Average Income	120.00	18 month		113		244,080.00
	Total (US\$)						2,647,386.14

Source: Rapid Assessment and FGD (2005); Field Survey (2012)

Note : Heavy = 100% damage; Slight = 50% damage; and loss = totally replace

USD 1 = IDR 9,100 due to BI Currency Report (2005)

The wide magnitude of the losses of fisheries livelihood assets in the four villages of Krueng Raya Bay was understandable because about 50.1% of 679 households (340) were involved in fisheries in 2003; and 49.9% of total households in this area were engaged in agriculture, husbandry, trader and other livelihoods and workers (Statistics Indonesia Agency, 2005). As Gibbs (2009) described that natural disaster was potentially impacted on the fishing communities and they were more severe than inland communities. The percentage of direct and indirect loss to fisheries livelihood capital in Krueng Raya Bay is presented in Figure 12.

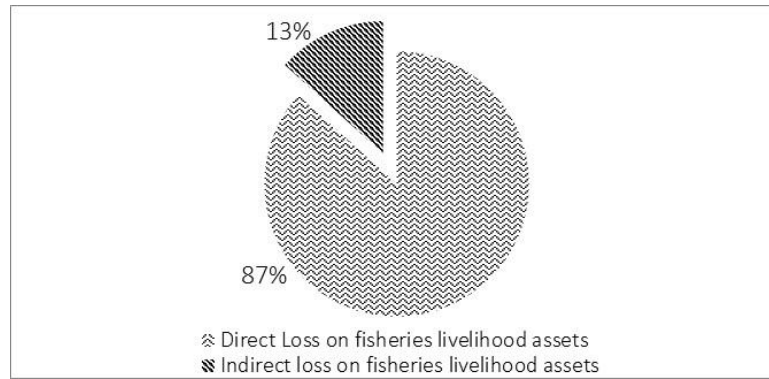


Figure 12. The percentage of direct and indirect loss of fisheries livelihood assets

The tsunami not only demolished the tangible fisheries assets, but it also affected human and intangible assets. This disaster killed 44 of 360 fishermen and it caused 110 fishermen shifting their job to “cash for work projects” in Ruyung, Meunasah Keudee, Maunasah Kulam, and Meunasah Mon (FGD, 2012). Two hundred six (206) fishermen had retained their jobs by using un-damaged fishing boats. For example, one lift net boat was used by 15 crews; commonly, this boat had been usually operated by 7-8 crews including skipper prior to the tsunami.

This tremendous disaster also led in the changing of fishermen composition. In four villages, the number of fishermen was 10.6% of total population in 2003, being 6.5% of total population after tsunami struck (2005), and increased to 15% of total population in seven years after this tragedy (2011). This evidences show that the communities in four villages were not only dependent on fisheries resource but also other resources. Garces et al. (2010) gave an example that livelihood in Meunasah Keudee comprised fish resource, non-fish resources, and non resources based.

4.2. Changing on Fisheries Livelihood Assets

4.2.1. Change in human capital

It is noteworthy that a change in structure of age population had occurred in Krueng Raya Bay as an aftermath of the tsunami. Initially, this research analyzed age population structure in four villages (Figure 13) to compare its change before and after the tsunami. According to Figure 13, the percentage of labor force (18-59 year old) in these villages grew 12.1% or increased from 45.8% of total population in 2003 to 57.9% of total population in 2009.

2003

2009

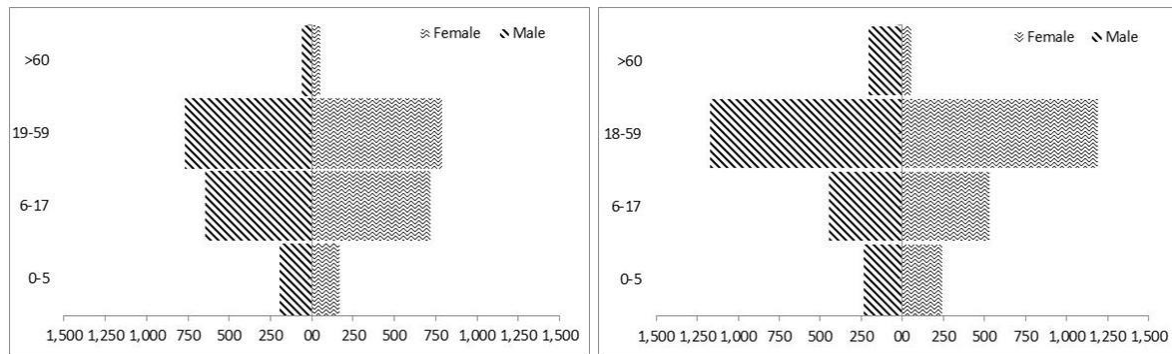


Figure 13. Age population structure in four villages

Source : Analyzed from BRR NAD-Nias et al. (2006), Team of Ruyung Village (2012), (Team of Meunasah Keudee Village, 2012), (Team of Meunasah Kulam Village, 2012), and (Team of Meunasah Mon, 2012)

With reference to the composition of fisheries household (FH), it showed an upward trend (Figure 14a). FHs had been fluctuated during 2003-2009. In 2003, FH accounted for 50.1% of 679 households. It increased from 52.3% in 2005 to 59.8% in 2009. A remarkable increase of population appeared in the reconstruction phase (2005-2009), amounted to 666 or reach to double prior to the tsunami. The biggest number of FH has been inhabited in Meunasah Keudee Village because it is located in the center of anchovy fisheries during 2003-2009.

The most interesting phenomenon was found in Meunasah Kulam Village, where FHs sharply increased from 42% of total household in 2003 to 70% in 2005. In the emergency phase (2005), most of the victims were shocked and under stress. Most of the population including fishermen intended to move from heavily damaged villages to moderately damaged one, because the moderate damage of villages still had few properly settlements and it was also available in upland areas. Some of the refugees decided to build temporary shelter, following the recommendation of the Government of Indonesia in Meunasah Kulam. Instead, they stayed for a while in Meunasah Kulam Village during the emergency and recovery process, and then they gradually came back to their own villages after permanent houses were re-constructed and accomplished by donor agencies. A few moved permanently to other village, such as Ruyung and Berandeh Villages in Kemukiman Krueng Raya.

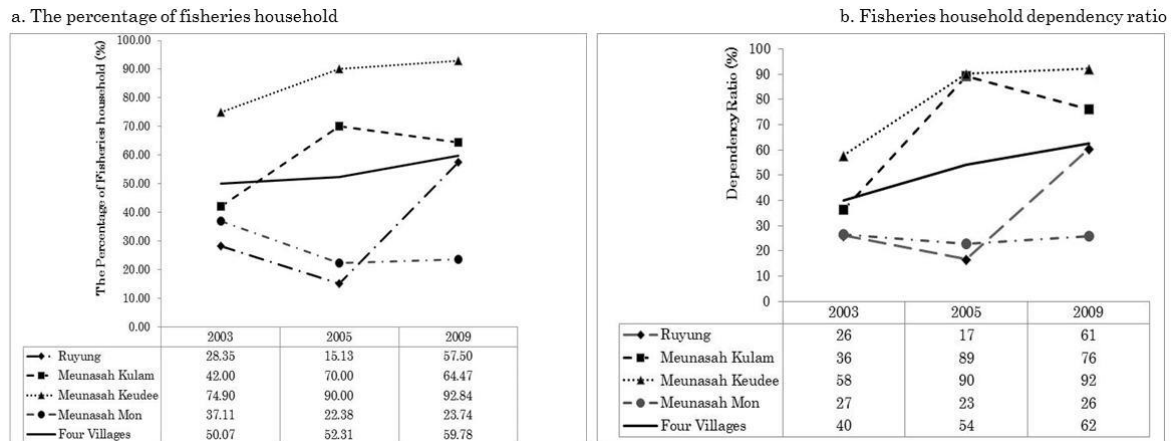


Figure 14. The percentage of FH and their dependency ratio in case study area

Source : Analyzed from BRR NAD-Nias et al. (2006), Team of Ruyung Village (2012), (Team of Meunasah Keudee Village, 2012), (Team of Meunasah Kulam Village, 2012), and (Team of Meunasah Mon, 2012)

There were many factors that influenced the shifting age structure of population and FH composition in this study area. Firstly, migrant workers engaged in various kinds of reconstruction projects. As regard “UNDP’s Fisheries Livelihood Recovery Project”, this research identified that at least 13 migrant workers were directly involved in this project during 2005-2007. Other migrant workers also facilitated various donor agencies to rebuild public infrastructure, housing, and livelihood in the same period. Whereas, unemployment rate increased after reconstruction missions were terminated and most of unemployment were likely to become fishermen because they easily accessed to skippers as decision maker.

Secondly, ex-combatants return back to the four villages. The Aceh civil war had disturbed the development of agriculture, fisheries, livestock and plantations. World Bank (2008) analyzed that Aceh had dropped to the lowest level of economic growth over the last 3 decades (1986-2005). These had encouraged the ex-combatants to work in many humanitarian relief jobs as a result of post peace agreement signing between the Aceh Movement and GOI. Our research identified that at least 2.4% of 83 respondents were ex-combatants and they returned back to their jobs as fishermen and fish processors. One of ex-combatants mentioned that he organized a group of lift net boats and got new fishing fleet aid from UNDP-Fisheries Livelihood Recovery Program in 2007.

Thirdly, a large number of FHs were also affected by the quantity of aids for fisheries and assistance such as investment and working capital in the reconstruction phase. BRR NAD-Nias and donor agencies had provided fisheries livelihood relief program and production facilities (i.e., fishing boat and working capital). For instance, UNDP fisheries program extended aid of around USD 1.5 million for the recovery of fisheries livelihood in Krueng Raya Bay, while Earthquake and Tsunami Emergency Support Project Asian Development Bank (ETESP) Fisheries Component promoted more modern purse seine navigation device. These aids attracted other livelihood workers to change to fisheries livelihood. According to field survey (2012), around 3.6% of 83 respondents shifted their job to become a fishermen.

Fourthly, school age (6-17 year old) was shifted to workforce. Around 28% of school-age was changed to workforce-age (see Figure 13); but, it could be not conclude that all belonged to labor force. For example, 22% of the fishermen were aged 9-17 year old before the tsunami hit. These numbers remained at 3% in 2012 and 19% of them still continued as crews in lift net boat.

And fifthly, public transportation reduction caused unemployment increase. Mobilization and transportation had already advanced before the tsunami disaster. There were 8 units “labi-labi (public transportation)” for Krueng Raya Bay-Banda Aceh return route. However, after it, the number of passengers dramatically decreased. As a consequence, drivers had to change to other jobs. For example, few population in Krueng Raya Bay had worked as a labi-labi’s driver for daily income; however, they had to quit their job due to declining income and decided to become the crews of the lift net boat in 2009.

An increasing number of FH could also figure out that the communities in case study area were dependence on fisheries livelihood. A FH had to maintain 3 family members on average. Shown in Figure 14b, FH dependency ratio was 40.1% or it could be conversed that around 30% of total population had depended on the fisheries livelihood before the tsunami. The great disaster propelled the population increase dependency ratio to 54.3% and their dependency gradually increased on reconstruction phase, and it reached 62% in 2009. Meunasah Keudee has the highest dependency ratio of FH in 2003, 2005, and 2009, followed by Meunasah Kulam, Ruyung, and Meunasah Mon.

Nowadays, the Asian tsunami has continued to influence fisheries livelihood capital. Instead of negative impact, the disaster has had a positive impact on economic activities and job opportunities in Aceh Province. However, it was not significant when recovery process had been terminated in some affected provinces in Indonesia (Statistic Indonesia Agency, 2007).

4.2.2. Production asset changing

The changing composition of number production assets are presented in Table 16. It is shown that lift net boat had shifted from 89 units in 2004 to 0 units (54 units lost and 35 units damaged) in 2005 because of the tsunami disaster. The number of fishing boats rapidly increased to 62 units during 2005-2009; and eventually, only 29 units of lift net boats were properly operated in case study area (Field Survey, 2012).

Table 16 presents changes in types of fishing boats. Nowadays, the hand line fishing boats have an important role for fisheries livelihood in the case study area. In 2004, it accounted for 31.3% of the total number of boats and it sharply increased to 69.4% in 2012. Shifted fishing boats was also caused by introducing of the new type of fishing boat. In the reconstruction phase, the UNDP built and delivered 3 units of mini purse seine boats as alternative fishing methods according to the fishing communities' request.

Table 16. Production assets composition in Krueng Raya Bay

No.	Type of fishing boat	Amount (unit)			Aid assistances ³⁾ (2005-2009)	Current operation ²⁾ (2012)
		Before tsunami ¹⁾	After tsunami ¹⁾ (2005)			
			Lost	Damaged		
1.	Lift net boat	89	54	35	62	29
2.	Beach seine boat	18	0	16	5	5
3.	Hand line boat	64	33	31	45	84
4.	Gill net boat	6	2	4	2	2
5.	Mini purse seine	6	0	6	3	1

Sources: ¹⁾ADB (2006) and ²⁾Field Survey (2012), ³⁾BAPPENAS (2012)

The changes in the number and type of boat had influenced fish resources, particularly anchovy. Prior to the tsunami disaster, increased number of lift net boats (89 units) had brought out overexploitation of these resources. After the disaster, there are 84 units boat rebuilt in order to increase catch per unit effort (CPUE) and it could cause overfishing of

anchovy. As of field survey, only 29 units of these vessels was put into operation eventually. These boats number should be reduce to 23 due to surplus production surplus model recommendation for anchovy fisheries sustainable development.

Sixty (60) percent of former lift boat crews, including owners, changed their boats into hand line boat to catch coral reef fish as target species because rebuilding lift net boat needed high investment costs (IDR 250 million per unit) and higher operational cost per trip than before the tsunami. Yet another reason was the decrease in catch of small pelagic fish using lift net boat. Therefore, fishermen preferred to operate mini purse seine boat because it had more effectively caught for all size of pelagic fish if it compared to lift net boat.

4.2.3. Operational Cost per Trip

Operational cost (OC) is a decisive factor in sustainability of fisheries livelihood. Mostly, it encompasses fuel, food, cigarettes and bait component and covering one day fishing. Amount of operational cost depended on type of fishing boat, and fishing gear which is used by fishermen. The research found that OC was an upward trend and diverse for each fishing vessel in Krueng Raya Bay (Table 17). It increased to 32-60% in the aftermath of the tsunami and reached 2-2.5 times in 2012.

Table 17. Various operational cost of fishing boat in Krueng Raya Bay

Type of Fishing Fleet	Average Operational Cost (IDR)			Breakdown Operational Cost (2012) ¹⁾					
	2004 ¹⁾	2005 ²⁾	2012 ¹⁾	Fuel Value (IDR)	%	Food Value (IDR)	%	Bait Value (IDR)	%
Lift net boat	225,000	360,000	450,000	315,000	70	135,000	30	0	0
Hand line boat	20,000	45,000	50,000	10,000	20	20,000	40	20,000	40
Beach seiner	100,000	160,000	200,000	130,000	65	70,000	35	0	0
Mini purse seiner	125,00	175,000	250,000	150,000	60	100,000	40	0	0

Sources: ¹⁾ Field survey (2012) and ²⁾ Consortium CCMRS-LEIMA (2005)

Shown in Table 17, lift net boat operation required the largest amount of cost (10-12 hours); being IDR 450 000/trip in 2012, and OC became twice as that in the pre-tsunami period. For a short distance trip, it expended around IDR 300,000 and it increased to IDR 800,000 for far fishing grounds. Consortium CCMRS-LEIMA (2005) found that one day

fishing spent roughly IDR 360,000 which consisted of fuel, oil, water and ransom in 2005. Meanwhile, hand line boat expended the smallest cost for one day trip, being IDR 50,000, but the cost went up 2.5 times compared to OC before the tsunami.

Fuel was the higher OC in 2012, which reached 60-70% to operate lift net boat. Muchlisin et al. (2012) also found that the percentage of OC per trip reached 60.6% in Krueng Raya Bay. However, hand line boat just spent 20% of fuel for one day fishing. Most of the respondents emphasized that fuel was a determined factor for fishing operation.

A rapid increase in OC has occurred since 2005. Fuel became scarce because the tsunami had destroyed fuel storage facilities, loading harbors and access roads in Krueng Raya Bay. These facts immediately caused a rapid increase of fuel price in this affected area. Panglima Laot Lhok (2012) said that kerosene and diesel price per liter reached IDR 10,000 and IDR 15,000 in June 2005, respectively. Legally, GOI released a new policy about fuel prices in October 2005. Muchlisin et al. (2012) reported that fishermen must spent extra money (around IDR 500-1,500 per liter), because there was no gasoline station in the fishing port area. Meanwhile, a retailer sold premium fuel at IDR 5,000 per liter until October 2012 (Field Survey 2012).

During 2005-2007, ransoms component did not contribute significantly to OC because donor agencies distributed various types of food to fishermen and GOI continued to deliver rice until the end of 2007. Indeed, OC could be reduced through omitted cigarettes cost. Before the tsunami, its cost had belonged to the responsibility of boat owners; but as of consensus between crews and skipper, they agree to provide by themselves.

In reality, OC might influence as to how much the fishermen can earn their income indirectly. This research revealed that the incomes of crews of lift net boat decreased to 16.4% until the end of 2012. Fuel was one factor that might affect fishermen income. Fishermen income also was influenced by other factors, such as season, technology, availability of fish resources, and social characteristics. In fact fishermen income per trip and yearly income would decrease, if fuel price would increase in South Sulawesi Province for instance.

4.2.4. Production Cost of Fishing Boat and Fish Processing Unit Assets

Production assets can be categorized into capture fisheries and fish processing unit (FPU) assets. Capture fisheries assets encompassed lift net, hand line and beach seine boat. Some of these production assets costs significantly changed in investment value, compared to before and after the tsunami (Table 18). Shown in Table 18, the cheapest production cost, amounting to IDR 6 million, had been invested in FPU prior to the tsunami. Meanwhile, the expensive one had been IDR 90 million for lift net boat. The value of FPU and lift net boat sharply increased to IDR 18 million and IDR 130 million, in 2005; and rose to IDR 29.9 million and IDR 200 million, respectively.

High investment of production assets resulted from raising all component prices to rebuild these assets, particularly specific wood. Taken as example under the scheme of “UNDP Fishery Livelihood Project,” hulk wood with size 9 m X 40 cm X 2 cm was proposed as USD 26.3 per piece in 2005; however, this wood went up to USD 30.5 per piece during 2006-2007. Other woods type also went up in price, followed by other equipments such as engine and fishing gear. Eventually, this may indirectly affect fishermen income.

Table 18. Production cost of various asset in Krueng Raya Bay

No.	Type of Asset Production	Production cost					
		Before (2004) ¹⁾		After (2006) ²⁾		Estimation 2012 ³⁾	
		IDR	USD	IDR	USD	IDR	USD
I.	Capture fisheries						
1	Lift Net	90,000,000	10,000	130,000,000	14,282	200,000,000	20,833
2	Hand Line	8,000,000	889	12,000,000	1,319	15,000,000	1,563
3	Beach Seine	63,000,000	7,000	90,000,000	9,890	130,000,000	13,542
4	Mini Purse Seine	165,000,000	18,889	300,000,000	32,967	425,000,000	44,271
II.	Fish Processing						
6	Fish Processing Unit	6,000,000	667	18,000,000	1,978	29,900,000	3,115

- Sources : ¹⁾ Consortium CCMRS-LEIMA (2005); ²⁾ Consortium CCMRS-LEIMA (2007), and ³⁾ Field Survey 2012

- Note : 1 USD = IDR 9,000 Bank Indonesia Report in 2004, 1 USD = IDR 9,100 Bank Indonesia Report 2006; and 1 USD = 9,600 Bank Indonesia Report 2012

4.3. Summary

Fishing communities are exposed on unpredictable disasters. In 2004, the tsunami had directly affected on fisheries livelihood in Krueng Raya Bay. Definitely, it severely impacted on both tangible and intangible assets of fishing communities. The impact of the tsunami on fisheries livelihood asset could be measured using damage and loss analysis. As a result, USD 2.7 million fisheries livelihood assets was damage and loss. This amount approached 0.4% of total fisheries assets damaged and lost in Aceh Province. Moreover, the pattern of fisheries livelihood was changed by the tsunami struck. It led a number of fishermen increasing from 10.6% of total population in 2003 to 15% in 2011. It also caused a number of fishing boat decreasing sharply, and operational cost and re-investment of asset production increasing significantly. And the most interesting impact of the tsunami was to increase the percentage of fisheries household dependency on fisheries resources from 40% in 2003 to 60% in 2005. The changing of fisheries livelihood pattern might be led by direct and indirect factors.

A declining of fish production in both volume and value could be identified as direct factor which shifted the income of fishing communities. An upward of food, fuel, wood, and equipment price; a change of workforce and livelihood; and an increasing immigration were contributed as indirect factor on change of fisheries livelihood. To sum up that the tsunami impact and the recovery process have become the opportunities and challenges on development of fisheries livelihood in sustainable way. Fisheries livelihood capital change would be affected to the income and poverty level of fishing communities and it will be discussed in chapter 6.

CHAPTER 5. ASSESSMENT FACTOR CONTRIBUTING TO THE DECLINING OF THE ANCHOVY FISHERIES

Aceh Province has high potency of marine capture fisheries (MCF). It had 102,824 tons/year of maximum sustainable yield (MSY) before the tsunami disaster. Total production was still lower than MSY, amounting to 17,351.7 tons in 1989, and rose 3.8%/year during 1989-1997. However, it considerably dropped -6.5%/year in the period 1998-2002 (Indrawan et al., 2003; Data Analysis, 2014) and declined to 82,482 tons in 2005. Aceh Besar District is one of main producer centers in MCF of Aceh Province, in particular anchovy.

This research focused on anchovy which contributed greatly to the catch of capture fisheries in Krueng Raya Bay-Aceh Besar District. Although there are not many records of anchovy caught for human consumption and fish bait, anchovy production has shown a decline trend in Aceh Province over the past 14 years after 1989. In fact, anchovy production declined to 5,516 tons (2004) from 7,062 tons (2001), being a -21.9% decrease. And it gradually dropped in the period 2005-2010, with an average decline of -3.4% per year (Aceh Province of Marine Affair and Fisheries, 2011).

There were several factors contributing to anchovy production decrease in Aceh Province. The most decisive factor is the rapid increase of lift net boats. The number of these boats increased from 593 units in 1994 to 607 units in 2004. After the 2004 tsunami, lift net boats dramatically dropped to 194 units, but again increased gradually to 224 units in 2012. Another factor was environmental degradation that affected anchovy resources. Nowadays, overfishing, mangrove and coral reef destruction, and waste pollution, have become worse and they would expectedly impact on anchovy fisheries in the near future. Moreover, the tsunami indirectly influenced the declining anchovy production during the period 2005-2012.

Overfishing of anchovy resources has also occurred in Krueng Raya Bay. Anchovy production showed a sharp decrease from 2,072 tons in 1999 to 1,050 tons in 2004 and dramatically went down further to 171 tons an aftermath of the tsunami (Imran and Yamao, 2014). Anchovy production showed fluctuation in the period 2005-2009. It was less than its pre-tsunami production that reached 126.57 tons in 2012. On the contrary,

the number of lift net boats increased from 8 units in 2005 to 31 units in 2009. In-depth interviews with the PLL in 2012 indicated that both coral reef and mangrove ecosystem degradation were determined factors in reducing anchovy catch before and after the 2004 tsunami.

Past data were not appropriate to fully account for the anchovies' state and condition. Scientific data are also limited to reveal whether anchovy fisheries are subjected to either overfishing or depletion in Krueng Raya Bay. This chapter will describe to several parts, as follow: (1) the condition of marine capture fisheries in Aceh Besar District, and (2) the condition of anchovy resources and factor contributing on it declining.

5.1. The condition of marine capture fisheries in Aceh Besar District

5.1.1. The volume of marine capture fisheries production

Aceh Besar District is the major production area of capture fisheries in Aceh Province (see Appendix 6). The average growth rate of production was 2.1% during 1989-2004, which total production was nearly 11,724 tons in 2004. The tsunami brought a dramatic decrease of production to 4,059 tons (65.4%), compared to the production of 2004. It fluctuated after the tsunami disaster, just reached 5,916.7 tons in 2011, which was extremely below the level of production in 2004. In the same condition was also faced by anchovy production (see Appendix 7). It was shown the declining trend in period 2005-2010, went down to 285.2 and 195.8 tons in 2005 and 2010 respectively.

MCF production decline could be caused by reduction of boats, coastal ecosystem degradation and overfishing. A number of boats significantly decreased to -15% from 1,304 units in 1989 to 1,109 units in 2004 (Aceh Province of Marine Affair and Fisheries, 2005) and extremely dropped to -78.3% in 2005. In the period 2006-2011, the growth rate of boats in number was 16.9% per year, but these number only reach 53% (584 units) of the boat number 2004.

Both destruction of coastal ecosystem and overfishing were probably major causes of fish production decline (Dahuri, 2003). In fact, 35.7% of coral reef ecosystems were reported in poor condition in Aceh Besar District (Research Center for Oceanography-Indonesia Institute of Science, 2005); mangrove ecosystems were converted to shrimp ponds during

1980-1990 along the east coastline of this district (Aceh Province of Marine Affair and Fisheries, 2012); and fish resources had been also overexploited since 2004 (Wahyudin, 2013).

5.1.2. The value of marine capture fisheries production

Decreasing production of capture fisheries revealed a significant influence on total production value. It showed a positive growth 8.2% annually in the period 2001-2004 and reached to USD 10.5 million in 2004. On the other hand, the value of production dramatically declined to 70.9% after the tsunami in 2005 (Aceh Province of Marine Affair and Fisheries, 2006). During the period 2006-2011, the production value increased at a 31.2% per year.

The highest growth rate was 122.7% in 2007, in which the total production value went up to USD 10.5 million. It can be explained by: (1) catch per unit effort (CPUE) increased after the recovery of fisheries livelihood assets; (2) local fish price went up, being IDR 5,500-10,000/kg during 2005-2011 from IDR 4,000-5,000/kg in the pre-tsunami period; and (3) increasing demand for a certain fish such as anchovy in a regional market (Medan Market). Afterward, production value rapidly fell down in 2007 and then gradually rose during 2008-2011; as a result, annual growth rate reached 19.5%.

In case the total value of anchovy production, it shown a fluctuation condition. The total value was ranged USD 589,148 - 1,073,303 during 1999-2004, in which average growth rate reached -10.6% annually. It might be caused by decrease of anchovy production, consumer capability, and commodity substitution. In the anchovy case, growth rate of total production reached -10.2% on supply side in the period 1999-2004. On the other hand, fresh anchovy price per kg went up from IDR 3,600 in 1999 to IDR 5,180 in 2004, being 8.4% annually. Indeed, substitution fish like mackerel had indicated an oversupply in the same period, in which production volume increased 19.6% per annum in Aceh Besar District, and its price was much cheaper than anchovy, in range of IDR 6,080-7,650 per kg. Instead, consumer capability on anchovy might decrease and consumer might shift to mackerel as substitution product.

Anchovy production value sharply declined to USD 91,543.6 after the tsunami, being 84.5% of the total value 2004 because anchovy production volume rapidly dropped after

lift net boat damage. Total value of anchovy catch gradually rose to USD 202,933.7 in 2012 because anchovy price growing from IDR 5,550 in 2006 to 15,400 in 2012 and it was influenced by increasing fuel retail price per liter from IDR 1650 in 2005 to IDR 6,500 in 2012.

In fact, range prices of anchovy, sardine, pony fish, mackerel and yellow tail trevally were IDR 12,000-48,000 per kg at the end of west season during survey period in Krueng Raya Bay. Small fresh anchovy was the highest price, being about IDR 48,000/kg. The lowest one was pony fish, which was around IDR 12,000/kg.

5.2. The condition of anchovy resources in Krueng Raya Bay

5.2.1. Anchovy identification and it role in fisheries management

In Indonesia, anchovies are generally called “ikan Teri” , but it is known as “ikan bileh” in Aceh. Anchovies sampled in this study belonged to *Stolephorus commersonii* Lacepède, 1803 (Figure 15b). Fishermen in Krueng Raya Bay divide anchovies into small, medium, and big sizes. These samples of anchovies identified that they have size ranges of 6.8 - 9.9 cm standard length (medium-big size), 5.3-8.3 g weight (see Appendix 8), a silver stripe line in the compressed body, and a little rounded belly. Commonly, *S. commersonii* is used for daily consumption and fish bait. Therefore, it can become a commercial species for the fishing communities to earn income and sustain their livelihood.

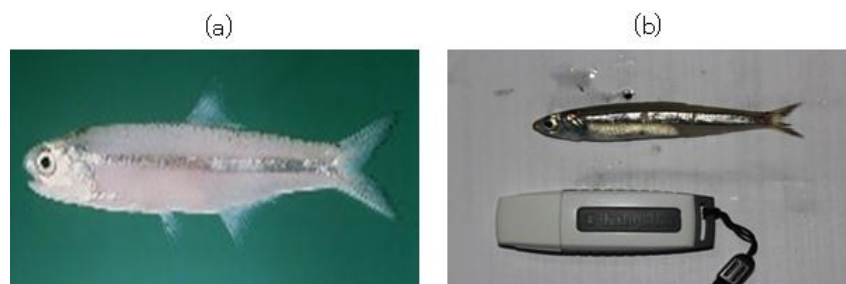
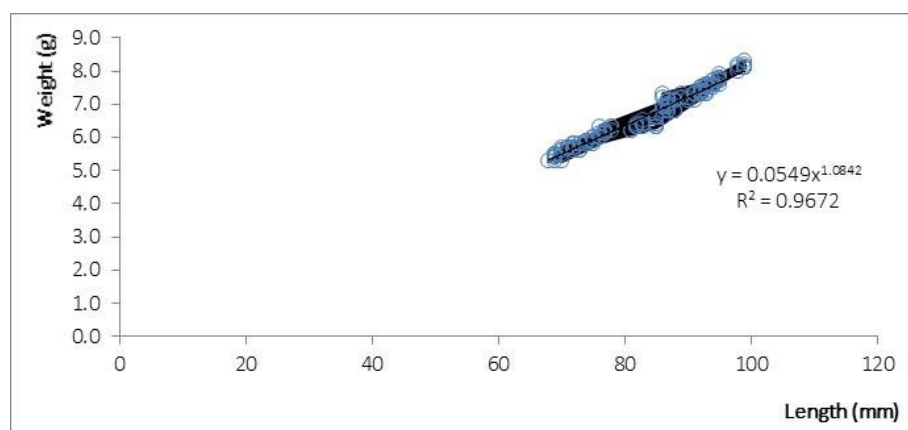


Figure 15. *Stolephorus commersonii* (Randall, J.E. 1995) (a), *Stolephorus commersonii* Field Survey, 2012)(b)

As an initial research, this research started to identify anchovy species and its characteristics in Krueng Raya Bay which was established as one of anchovy centers in Aceh Province prior to the 2004 tsunami. The distribution of anchovy in Aceh Province had been known in coastal waters of the Malacca Strait and the Indian Ocean from our observation during the period 2005-2012. However, there was no previous research that defined the characteristics of anchovy. In this case, the identification of anchovy as *Stolephorus commersonii* Lacepède (1803) in Krueng Raya Bay was an interesting task to initiate anchovy fisheries management in the future. Because this species is widespread distribution in the Indian Ocean and Western Pacific (Whitehead et al., 1988), Ambon Bay (Sumadhiharga and Yulianto, 1987), Bima Bay-West Nusa Tenggara (Andamari et al., 2002), and Kabuy Bay-Raja Ampat (Bailey et al., 2008).

Moreover, a regression was calculated for all the length and weight of anchovy sample. The regression formula found was $W = 0.0556 L^{1.0809}$ ($R^2 = 0.9625$) (Figure 16). These computations did not consider: (1) the WLR of the juvenile; and (2) the separation of male and female samples. Regarding t test to coefficient estimator (b), it revealed that t test (123) was more than t table (0.05, 187) (1.972), and it means in this case to reject the null hypothesis ($H_0 = 3$). Logarithmic transformation analysis performed has revealed that b (1.0809) was less than 3. Therefore, anchovy growth could be subjected to a negative allometric growth, meaning length growth is faster than weight growth (Gayanilo and Pauly, 1997).



Note: $y = W$ and $x = L$

Figure 16. Weight-length relationship of *Stolophorus commersonii*

However, some characteristics of *S. commersonii* identification and its WLR analysis were inappropriate for the holistic determination of the stock concept in term of fisheries management purposes. Begg et al. (1999) concluded that a fundamental of fisheries management requirement is to consider the full impact of management actions, including identification of the stock complexity of a fish species. As morphometric study, WLR in this research was a small part of fish stock identification. Nowadays, anchovy that has a negative allometric growth pattern was not only found in Krueng Raya Bay, but also this similar pattern of WLR was identified for anchovy in Bima Bay-Ambon Province (Andamari et al., 2002) and Cirebon' s coastal water (Supriadi, 2008). (Samsun et al., 2004) also found that the anchovy functional regression was a negative allometric growth pattern ($b < 3$) in the Mid-black Sea.

Karachle and Stergiou (2012) noted that the allometric growth model was (1) the most appropriate in describing fish morphometric relationship; and (2) study on effect of feeding habit and habitat to morphological characteristics. They stated that anchovy, as small pelagic filter feeder which prey on small zooplankton (copepods), has small mouth and strong dentition in adaption of food habit. This research predicted that seasonal migration of *S. commersonii* might has relationship with food habit, monsoon season, enrichment of nutrient into water column regarding FGD with fishermen. Furthermore, oceanography and type of ecosystem; such as current, temperature, existence of mangrove and coral reef; might be contributed in establishment of anchovy population. For instance, the population strategies of European Anchovy to the seasonal upwelling ecosystem has relationship with the enrichment of coastal water and growth investment (Cubillos et al., 2001). Integration of anchovy identification, its characteristics and food habit, WLR, and factors contributing on seasonal migration should be paid attention on anchovy fisheries management in the future. Otherwise, these crucial factors might have influenced on unsustainability of *S. commersonii* in Krueng Raya Bay.

5.2.2. Anchovy production trend in monsoon season

As regards production change in Krueng Raya Bay, the anchovy fisheries can be categorized into three distinct periods, namely: (i) before the tsunami disaster (1999-2004), (ii) after the tsunami (2005-2006), and (iii) the recovery process period (2007-

2012) (see Appendix 9). Before the tsunami, anchovy production had shown a decreasing trend (Figure 17). Anchovy catch dropped to 1,050 tons in 2004 and it sharply plummeted to 171 tons in 2005 after the tsunami. Eventually, it fluctuated between 126 and 279 tons in the period 2006-2012. Figure 17 also points out that actual production has been less than the result of production surplus model recommendation.

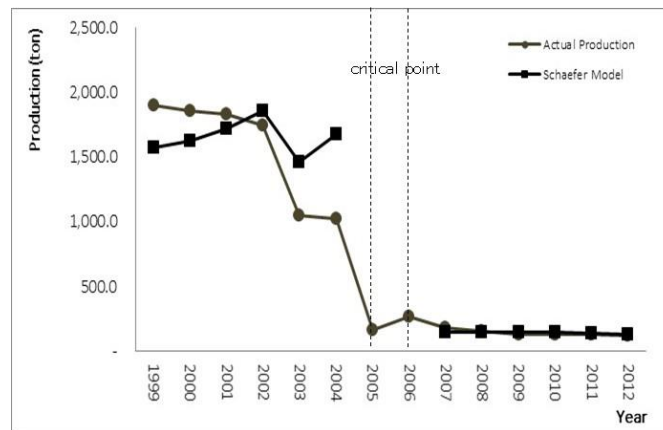


Figure 17. Comparison of actual production of anchovy and surplus model recommendation during 1999-2012 (Aceh Province of Marine Affairs and Fisheries, 2000-2012; Data Analysis, 2013)

During the field survey on September-October 2012, anchovy catch was very low in the east monsoon season (see Appendix 10). With the operation of 7-29 units of lift net boats, anchovy production was 7.8 tons. Average CPUE reached 13.5 kg/day or total catch of 100-425 kg/day. During this operation, anchovy catch composition was 52% of the total catch. Other small pelagic fish catch composition were sardines (*Sardinella* sp., 25%), pony fishes (*Leiognathus* sp., 14%), yellow tail trevally (*Caranx* sp., 6%) and mackerels (*Decapterus* sp., 3%).

As a typical fishing gear operated only in the coastal water zone, lift net boats can catch various small pelagic fishes including anchovy throughout the year (Figure 18). Fishing operation starts at 04.30 pm and finishes the following morning at 07.00 am. Various pelagic fish species were caught and total volume of catch differs between west (October-March) and east monsoon season (April-September).

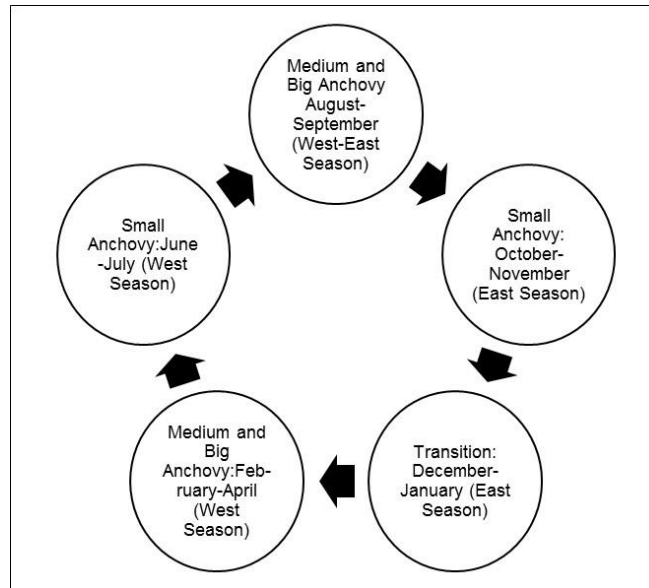


Figure 18. Harvesting anchovy throughout the year and life cycle

The size of anchovy caught is diverse during the east and west monsoon seasons. The change in anchovy size occurs as follow. First, small anchovy was caught in the beginning of the east monsoon season (June-July) and the west monsoon season (October-November) when wind and waves were calm. Second, both medium and big sized anchovies were usually harvested from August to September and from February to April (at the end of west and east monsoon seasons, respectively) when wind and waves gradually changed from moderate to strong. Third, other small pelagic species such as sardines, pony fishes, mackerels and yellow tail trevallies were harvested in the same season when medium and big anchovies are caught. The result of measurement shown that 23% and 15% of anchovy size were distributed within intervals of 84.4-88.4 mm and 88.5-92.5 mm during the period September-October 2012, respectively (Figure 19). The mean of total length value was 84 ± 0.02 mm (see Appendix 11); thus, it can be classified as adult stage.

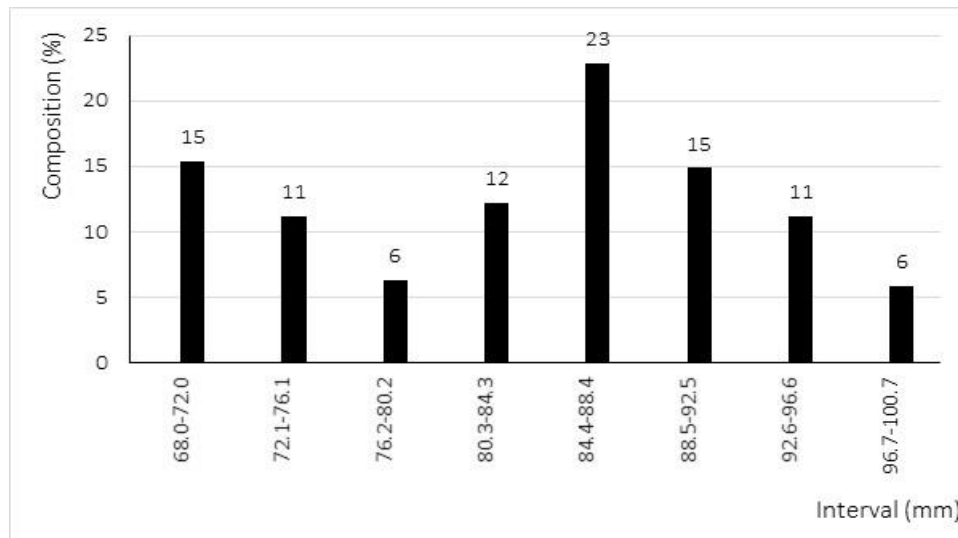


Figure 19. Size class of anchovy's distribution in the period September-October 2012
(Data Analysis, 2013)

5.2.3. The state of anchovy and factor contributing on it decline

The state of anchovy can be shown using MSY and stock classification. MSY computation was divided to the period 1999-2004 and 2007-2012. Two point data were excluded to estimate MSY in both the periods because those data showed an extreme decline in anchovy production in 2005 and 2006. These points can be called as an outlier point (in statistical terms it can be classified as biased data) or critical year for anchovy for stock recovery and equilibrium.

Anchovy production was significantly correlated with effort as indicated in the data for the period 1999-2012 (Table 19). When the effort reached 9,344 trips in 1999, anchovy catch was 1,905.58 tons. Afterward, catch volume fluctuated and fell sharply in 2003. This fact indicated that the critical point of anchovy fisheries occurred after the 2004 tsunami. Production dropped extremely down to 166.94 tons in 2005 using 432 trips. Even though the fishing effort was three times than that in 2005, anchovy production only went up almost twice in 2006. Simultaneously, the total effort gradually increased during the recovery process, but anchovy catch continued to show the constant decline.

Table 19. Anchovy production, effort, and catch per unit effort from 1999-2012 in Krueng Raya Bay

Period	Year	Production (ton) ¹	Number of vessel ²	Effort (unit/trip/years) ²	CPUE
Before Tsunami	1999	1,905.58	73	9,344	0.2039
	2000	1,855.47	72	9,216	0.2013
	2001	1,833.11	71	8,946	0.2049
	2002	1,743.29	68	8,568	0.2035
	2003	1,053.47	76	9,576	0.1100
	2004	1,024.18	73	9,198	0.1113
After Tsunami	2005	166.94	6	432	0.3864
	2006	272.12	18	3,067	0.1575
Recovery Process	2007	182.32	24	2,715	0.059
	2008	156.79	22	2,839	0.055
	2009	129.82	23	3,086	0.048
	2010	136.28	24	3,150	0.044
	2011	129.87	26	3,325	0.039
	2012	126.57	29	3,654	0.035

Sources: ¹APMAF (2000-2012) and ²Field Survey (2012)

A lift net boat operated from 18 to 22 days each month for a total of six months per year. PLL (2012) mentioned that these boats were not operated to maximum capacity, but only around 60-80% of the total capacity were used for fishing anchovies both before and after the tsunami. As a consequence, the number of boats, total efforts, and anchovy catch fluctuated during the period 1999-2012 (Table 19).

Data revealed that CPUE in both the period 1999-2004 and 2007-2012 show a downward trend with increasing efforts (Figure 20). Correlation between CPUE as a dependent variable (y) and effort as an independent variable (x) was computed using simple regression analysis (SRA). According to SRA, it could be proposed two distinguishable models of anchovy MSY in Krueng Raya Bay. Model 1 represented the period before the tsunami with equation $y = 0.8696 - 0.00008x$ ($r^2 = 0.307$)³² and Model 2 addressed the period 2007-2012 with equation $y = 0.1138 - 0.00002x$ ($r^2 = 0.596$). Both model shown that r^2 were low; however, effort (x) and CPUE (y) have a significant correlation

³² There were several reasons why $r^2 = 0.307$ was low. Firstly, this model might be built through using high effort during the period 1999-2004, meanwhile the anchovy production show a declining trend and much more less than maximum sustainable yield. Secondly, it was due to less time series data, which were estimated using 6 points of effort and production data. In another words, the variation of data was low. Thirdly, 0.307 of R2 means that only 30.7% of effort data could explain CPUE and it can be influenced by others variable such as technology and environment factors.

regarding t test analysis³³. Both models recommended the MSY of anchovy fisheries and the optimum effort to be spent in a managed area of Krueng Raya Bay (Table 20). To sustain the anchovy fisheries for each period, models 1 and 2 also performed the optimum number of 43 units and 23 units of lift net boats, respectively.

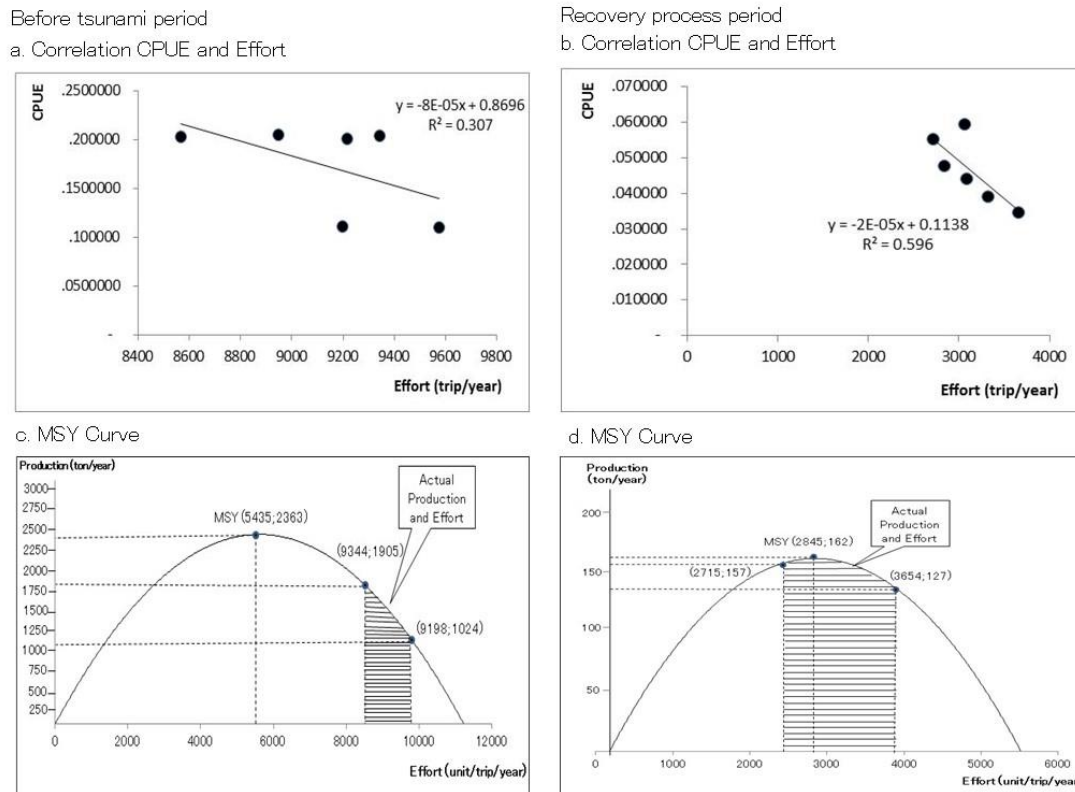


Figure 20. CPUE-effort correlation (a-b) and MSY curve (c-d) of anchovy resources in the period 1999-2012 (Aceh Province of Marine Affairs and Fisheries, 2000-2012; Data Analysis, 2013)

Later on, anchovy's MSY curve can be directed using both constant (a) and coefficient (b) estimators (Figure 20). This research revealed that MSY in the period before tsunami (1999-2004) and recovery process (2008-2012) were 2,363.138 tons/year and 161.881 tons/year, respectively. Meanwhile, actual productions in the same period were in range of 1,024.18-1,905.58 ton and 126.57-156.79, respectively. According to Figure 20 actual

³³ To prove the significance correlation between effort (x) and CPUE (y), the series data of effort before the tsunami have to analyze together with these data after tsunami. Instead, the series effort data could be classified to be two group: effort > 5000 trip/year (E2) and effort < 5000 trip/year (E3). According to data analysis, performed that average of CPUE was 0.1725 and 0.0467; in before and after the tsunami respectively. Its means, the average of CPUE before and after the tsunami were different, significant at 5% level confidence; therefore there were the correlation between effort and CPUE.

production was less than anchovy's MSY, but the actual effort had already been over the optimum efforts as this model suggested for both periods. Interestingly the findings in this research were: (1) the fishery's MSY in the period of recovery process was 20 times less before the tsunami (Table 20); (2) the recent average catch in MSY was 53.9% of MSY and it can be classified to the less abundant stock in before tsunami; and (3) the recent average catch in MSY went down to 5.5% of MSY, it means the stock faced imminent depletion.

Table 20. Surplus production model and its calculation of MSY and optimum effort

Period	Estimator		Model (Equation)	Result	
	Constant (a)	Coefficient (b)		MSY ($a^2/4b$) (ton/year)	Optimum Effort ($a/2b$)(trip)
Before Tsunami	0.8696	- 0.00008	$y = 0.8696 - 0.00008x$	2,363.138	5,435
Recovery process	0.1138	- 0.00002	$y = 0.1138 - 0.00002x$	161.881	2,845

Source: Data Analysis (2013)

5.2.4. Overfishing of anchovy fisheries prior to the tsunami disaster (1999-2004)

Overfishing of anchovy fisheries was shown by actual effort being more than the optimum effort and actual production less than the MSY (see Figure 20c and Table 19). Indeed, anchovy stock could be considered into less abundant state, which is shown by the recent average catch in MSY (53.9%). There were several major factors that caused overfishing of anchovy fisheries prior to the tsunami disaster. Firstly, the number of lift net boats³⁴ definitely increased in the 1980s and the 1990s. In the earlier stage of anchovy fisheries development in the 1970s, only 2 lift net boats had been put into operation for fishing anchovy, according to PLL. The number of lift net boats rapidly increased to 70 units in the 1980s, and reached 89 units in the 1990s. PLL mentioned that the number of fishing boats was 91 units just before the disaster in 2004.

Secondly, since the 1990s, equipment and materials used for fishing have become rapidly sophisticated with a sharp rise of productivity. In the 1970s and the 1980s, the lift net boats used simple kerosene lamps; they operated fluorescent lamps (capacity 10 watts)

³⁴ Lift net boat is more efficient than beach seine boat in term of fish catch, because beach seine boat is operated to catch seasonal pelagic and demersal fish nearby shoreline; meanwhile, lift net boat is mobile and can operate from shoreline to shallow sea water for various target species, throughout the year, and catch all size of fish.

after the 1990s to attract phytoplankton and small schooling fish, including anchovy. Motorization of pull boats equipped with outboard engine was a decisive factor to increase catch effort. In the last two decades, generators were equipped on board as power source of 25-40 white fluorescent lamps and one green lamp. Light intensity and distribution have influenced fish harvesting. For example, Sudirman et al. (1992) reported that using light intensity of 6,000 watts by lift net boats in South Sulawesi waters since 1987 resulted to higher fish catch than those using 5,000 and 4,000 watts lamps.

Thirdly, the mesh size of the lift net fishing gear is becoming smaller. Fishermen used the mesh size 0.95 cm on the bottom side, 1.27 cm in the middle side, and 2.54 cm on the top side to construct a set of lift net fishing gear with wide 18 m X 18 m and depth of around 15 – 20 m. This fishing net is not selective, targeting juvenile stage of anchovy (fishermen knew such fish as small anchovy or “Teri Medan”), and catching all kind of small pelagic fish. In fact, the design of lift net also harvested the small size of anchovy (10-15 mm) during east and west monsoon seasons. As a consequence, stock of anchovy faced pressured condition and declined year after year, because it has no chance to reach sexual maturity stage. There is no special record the interval length of first stage maturity for *S. commersonii*. However, Luther (1979) reported that minimum size of *S. commersonii* at first maturity is 110 mm in the southwest coast of India. Andamari et al. (2002) mentioned that the maturity stage of *S. commersonii* was identified in average length 109.9 ± 0.5 mm in Bima Bay.

Fourthly, anchovy is harvested throughout the year in both west and east monsoons. It might cause a decline of stock to support reproduction system of anchovy. In case of tropical anchovy, spawning season may have occurred throughout the year and reproductive seasons are often linked to the monsoon season (Tiews et al., 1970).

5.2.5. Other factors to boost anchovy fisheries depletion during 2005-2012

Overfishing of anchovy fisheries continued during the period 2005-2012. Because the actual production and fishing efforts were more than MSY and optimum efforts in the same period (Table 18 and Table 19), means anchovy fisheries was in overcapacity condition. (FAO, 2008) noted that overcapacity might occur when the fishing boat is larger than it needs to be to catch the available fish resources. Lift net fisheries was in

overcapacity at around 16.7% by using the effort of 3,325 trips in 2011. Thus, the number of lift net boats had to be reduced by 23 units for sustainable anchovy fisheries. Otherwise, anchovy resources sustainability would be threatened and depleted due to the recent average catch in MSY (5.5% of MSY).

Besides the factors mentioned above, there are many other factors as to why anchovy fisheries showed depletion. Firstly, coral reef and mangrove ecosystem degradation might cause anchovy depletion. There were no research activities conducted to analyze the state of this ecosystem in prior the tsunami in Krueng Raya Bay. According to the Center for Oceanography-Indonesia Research Institute (2005), coral reefs in the western part of Indonesia are in poor condition (35.7%), including the reef in this study area. As an aftermath of the tsunami, the area, length and average living cover of the coral reef ecosystem were 196.4 ha, 13 km and 10%, respectively (Long et al., 2006); and the live cover of hard coral was 36.9 % (Ocean Divinf Club, 2011). Therefore, the coral reef ecosystem was in poor condition based on the classification developed by (McAllister, 1988). It is estimated that 62-90% of this ecosystem was in degraded condition. We also observed that the point of Akhmad Rahmanyang Peninsula and Lhok Mee Beach are frequently used for harvesting the small anchovy during October-November in the west monsoon.

Commonly, coral reef damage in the study area has been caused by increasing intensity of hand line boat activities, anthropogenic factors, and tsunami impact. Increasing number of hand line boats to 31.3% before the tsunami might have caused the destruction of coral reef ecosystems because these boats captured reef fish as a target species. These boats also frequently dropped anchors on reefs that can cause severe damage to coral reef ecosystems.

Anthropogenic factors have simultaneously occurred toward contributing to anchovy depletion after the tsunami. Nowadays, potassium cyanide that can kill coral polyps, symbiotic algae, and other small organisms necessary for healthy reefs has been used to catch ornamental reef fish by some fishermen in the study area. Explosives, land-based pollution, destructive fishing, oil spills, sand mining and untreated human sewage might cause much stress towards coral reef degradation. Indeed, mangrove conversion,

deforestation, agriculture, shipping and harbor construction have destroyed the coral reef ecosystem indirectly.

The tsunami also affected the mangrove ecosystems in Krueng Raya Bay. It is estimated that 77.1 ha of mangrove ecosystem is distributed along a 15.27 km stretch within the Aron Meudawa-Ujung Teungku Peninsula zone. The percentage cover of mangrove trees had remained at around 5% and it can be classified as under the severely damaged category according to the Ministry of Environment Classification (Ministry of Environment, 2004). In the 1980s, the mangrove area was estimated at around 300 ha in Krueng Raya Bay. The mangrove ecosystem has been converted into brackish water shrimp ponds, which was a major factor for the ecosystem degradation in this area. As a comparison, Wibisono and Suryadiputra (2006) reported that 26,823 ha mangrove ecosystem in Aceh Besar District was affected by the huge tsunami disaster. However, the tsunami's effect was less than the other anthropogenic impacts on the mangroves which are harvested for charcoal, housing and fire wood.

Secondly, rapid human population growth in Krueng Raya Bay after the tsunami disaster has urged fishing communities to depend more on fish resources (in particular anchovy) than before the 2004 tsunami. Before the disaster, around 69% of the population in this region had been dependent on capture fisheries and 31% on other livelihoods such as agriculture and livestock. After the tsunami disaster, those who were engaged in capture fishery and relied on it for their income increased to 78%. Lotze et al. (2006) stated that rapid human population growth caused an increasing demand, commercialization of resources, technology development, unselective and destructive fishing gears that caused a sharply upward trend on the depletion of fish resources. They added that human activities have impacted to more than 90% of important species depletion; and 60% sea grass and wetlands habitat destroyed, water quality degradation, and accelerated species invasion.

5.3. Summary

Fish resources, in particular anchovy in Krueng Raya Bay faced a depletion state aftermath the tsunami. This chapter explores some crucial factors contributing to the declining of anchovy which was identified as *Stolephorus commersonii* due to characteristics identification. According to the results of focus group discussion and fishermen interviewed, fish resources shown a downward trend and anchovy could be categorized into a depletion state aftermath the tsunami. Anchovy growth could be subjected to a negative allometric growth, meaning length growth is faster than weight growth. A downward trend of anchovy production could be revealed by less of catch during west monsoon season of 2012, amounted 7.8 tons or 52% of the total catch with the operation of 7-29 units of lift net boats.

The result of surplus model calculation showed that maximum sustainable yield (MSY) of anchovy after the tsunami disaster was less than 20 times of MSY before the tsunami. Simple regression analysis resulted two different models of MSY either before or after the tsunami in 26 December 2004 which were shown as $y = 0.8696 - 0.00008x$ and $y = 0.1138 - 0.00002x$, respectively. Model 1 recommended to reduce the number of lift net boat to 43 units for optimization of yield. On the other hand, Model 2 suggested that only 23 units could be operated for optimal effort each year. Average recent catch in MSY showed 53.9% (less abundant) before the tsunami and 5.5% of Average recent catch in MSY (depletion) after the tsunami. These conditions were led by increasing catch effort, destructive fishing gears, and degradation of coral reef and mangrove. Such a tragedy of resource depletion was accelerated by anthropogenic factors and compounded by the tsunami factor (natural environment). The tsunami's environmental impact on anchovy fishery depletion may be lesser than the combined effects of destructive fishing and anthropogenic factors. The fish resource change, in particular anchovy as natural capital would be affected to the income and poverty level of fishing communities that it will be discussed in chapter 6.

CHAPTER 6. INCORPORATE SUSTAINABLE LIVELIHOOD STRATEGY ON RECOVERY OF FISHERIES LIVELIHOOD

Immediately after the tsunami disaster in 2004, quick response on tsunami impact focused on physical reconstruction in Krueng Raya Bay (Field Survey, 2012). However, donor agencies did not pay much attention on recovery of fisheries livelihood, in order that the fisheries communities could maintain their livelihood in sustainable way. As regards aid composition, the economic sector including recovery of livelihood was roughly estimated to be 8.8% of the total (Data Analysis, 2014), amounting to USD 84.4 million. The highest priority of budget disbursement was oriented for short term effect, such as cash payment for work program, by using un-sustainable approach. Due to a short-sighted approach, the fishing communities often unable to drive their own recovery after program accomplishment.

The integration of the sustainable livelihood approach (hereinafter it is called SLA) is interesting on recovery of fisheries livelihood. SLA is well-known in development program, not only to reduce poverty and vulnerability but also recover livelihood post disaster in developing countries. SLA established the objectives for protecting and rebuilding livelihood and communities after disaster; and reducing vulnerability to the future disaster (Cannon et al., 2003). This approach was selected on recovery of livelihood both in western and eastern part of coastal area in Aceh Province. Local Governance Innovations for Communities in Aceh Phase 2 Project was a success in introducing the financial and human capital knowledge for the beneficiaries and evolving their alternative livelihood in Aceh Timur, Biruen, and Aceh Barat Daya District (Borgese, 2012). The similar fact also shown that SLA integrated into Fisheries Livelihood Recovery Program (FLRP) by UNDP in the period 2005-2007, effectively revitalized fishermen income and inspired them to develop alternative livelihood in Krueng Raya Bay, Aceh Besar.

This chapter will describe the tsunami impact on income and poverty of fishing communities, the characteristics of fisheries communities on coping crisis condition, aid delivery factor (source of financial capital) on recovery of fisheries livelihood, and the

strategies are selected by fishing communities on recovery of fisheries livelihood. In discussion part, it might link factors contributing which are explained in chapter 4 and 5.

6.1. Tsunami impact on the income of fisheries households and their poverty

6.2.1. Decreasing income of fisheries household

Tsunami directly impacted on fisheries household income. This research found that the income of fisheries household after the tsunami disaster had been less than before the tsunami (Figure 21). Before the tsunami, fisheries household that earned more than IDR 1,000,000 per month accounted for 57.83% of the total, followed by their income in range IDR 500,000-1,000,000 (18.7%) and less than IDR 500,000 (10.8%). However, after 2004, the fisheries households with income of more than IDR 1 million declined 7.23% and their income in range IDR 500,000-1,000,000 increased 22.8%. Another percentage of fisheries household income shifted as can be seen in Figure 21.

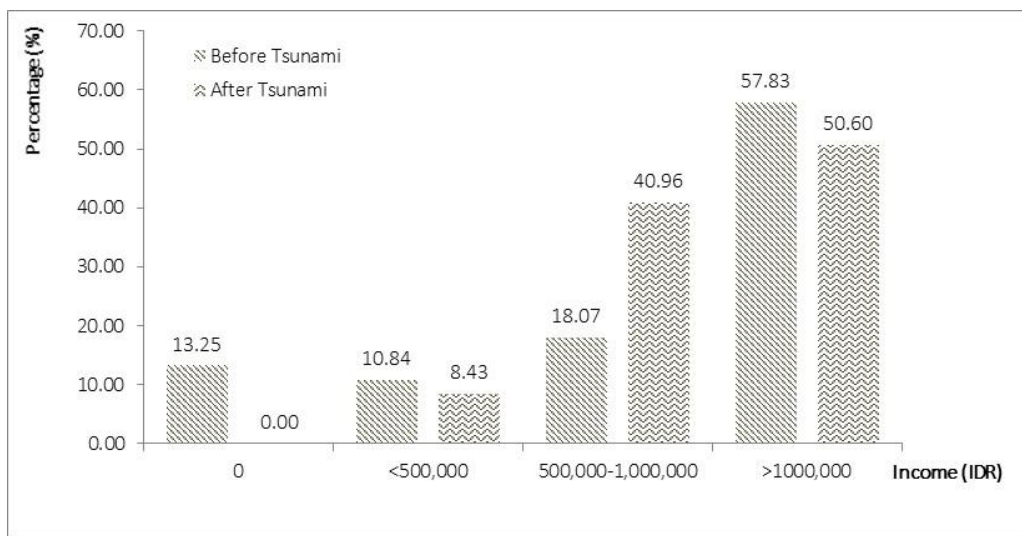


Figure 21. The structure of fisheries household income in period before and after tsunami

The effect of the tsunami on fisheries household differed between the types of fisheries. This research identified that the highest damage of the tsunami disaster was on the household of beach seine net, followed by the household of financial trader, hand line, and fish processor, and lift net. According to the figures of Table 21, a household engaged in gill net and beach seine net (No.3) decreased average income by 40.83%. In

a much contrast, those household with lift net boat slightly decreased its income, being - 7.84% only.

Table 21. The composition and changing of fisheries household income

No.	Type of Fisheries Household	Average Income (IDR)		Change of Income (%)	Remark
		Before Tsunami	After Tsunami		
1	Lift net	1,110,000	1,023,000	(7.84)	Decrease
2	Hand line	1,500,000	1,270,000	(15.33)	Decrease
3	Gill and beach seine net	2,400,000	1,420,000	(40.83)	Decrease
4	Financial trader	3,500,000	2,500,000	(28.57)	Decrease
5	Fish processor	412,500	350,000	(15.15)	Decrease

Sources: Data Analysis (2014)

Declining of fisheries household income was caused by several factors such as asset production damage, declining value of fish production, and change of fishing boat composition. Naturally, production, processing and marketing assets were damaged and lost. Before the tsunami, the numbers of lift net, hand line, beach seine, gill net, mini purse seine boat, and fish processor unit were 89, 18, 64, 6, 6, and 58 units, respectively (Imran and Yamao, 2014). Only 8 units of lift net boat were remained and used three months after this huge disaster (FGD, 2012). On the recovery process, as of 2012, 29 units of lift net, 5 units of beach seine, 2 units of gill net, 1 unit of mini purse seine, and 18 units of fish processing were put into operation.

Naturally, capture fisheries production in value declined sharply. The figures of fisheries statistic data in the period 2005-2012 indicated that the value of production was fluctuated and declined in Aceh Besar including Krueng Raya Bay. The total value of production dramatically declined to USD 3.0 million in 2005 from USD 10.4 million in 2004, and recovered to USD 10.4 million in 2007; however, it again fell down to USD 7.7 million in 2010 (Imran and Yamao, 2014). In Krueng Raya Bay, the fishermen with lift net boats faced a declining of anchovy catch and little eastern tuna to 16.7-37.5% and 20-50%, respectively. In particular, anchovy production decreased from USD 589,148.0 in 2004 to USD 202,933.7 in 2012.

Composition of the fishing boats changed. The fishermen were more favorable to shift lift net fisheries to hand line ones. We found that 60% of former lift net boat crews,

including owners, had changed their boats to hand line ones to catch coral reef fish as target species. This was mainly because rebuilding lift net boat needed high investment costs (IDR 250 million per unit) and higher operational cost (OC) per trip (IDR 450 000/trip in 2012). Whereas, operation of hand line boat spent only IDR 50,000 for one day trip. In reality, OC might influence as to how much the fishermen can earn their income indirectly. The incomes of crews of lift net boat decreased to 16.4% until the end of 2012.

The tsunami effect heavily damaged beach seine fishermen. Reduction of income were caused by severe damage of coast line and increased operational cost. The tsunami impact was leaved the debris in shoreline and it also changed the geographical conditions of coastline. According to FGD (2012), the debris could cause the net damage and fish harvesting reducing. The fishermen of beach seine also reported that mangrove and pine tree degradation had influenced on declining of fish catch. Indeed, Increase in OC could become a key factor of reducing beach seiner's income. OC of this fishing boat increased 40% compared to before the tsunami, and it went up to 42.9% if compare to OC of 2005. This is mainly because of a sharp rise of fuel price that accounted for the largest part of total operation cost. Kerosene and diesel price per liter reached IDR 10,000 and IDR 15,000 in June 2005, respectively (Panglima Laot Lhok, 2012). Fuel was a key component to decide fishing operation.

There is no national standard about fisheries household's income sufficiency in Indonesia after the tsunami. However, fishing communities got additional income from the cash for work project, GOI's rice aid, and international donor agencies' food aid to meet their living cost until 2006. During the recovery process, the fisheries communities could save their income and buy luxury goods such as refrigerator, television and motorbike because their daily primary goods had already been supplied by GOI and international donor agencies until 2007 (Field Survey, 2012). Fishermen said that their income insufficient after the aid delivery terminated and they just obtained income from fisheries livelihood since 2007. It is clear that poverty increased, thereby becoming a great threat to sustainable use of fish resources.

6.2.2. Increasing Poverty Population

Another impact of the tsunami was a rapid increase of poverty in the affected area. The proportion of the poor sharply increased immediately after the tsunami (Table 22). In 2003, 45.3 % of households in the four villages had faced the poverty condition (Statistics Indonesia Agency, 2006). After the tsunami, almost all households (97.7%) were regarded as poor. However, along with the economic recovery during the period 2006-2009, their economic condition got improvement and income of households continued to increase. As a result, the poor accounted for 56.58% in 2009.

Table 22. Poverty household distribution in four villages located in Krueng Raya Bay in 2003, 2006, and 2009

No.	Villages	Percentage of Poverty Population (%)		
		2003 ¹	2005 ²	2009 ³
1.	Ruyung	61	96.7	90
2.	Meunasah Keudee	38	100	45.85
3.	Meunasah Kulam	43	94.1	71.5
4.	Meunasah Mon	39	100	18.96
	Average in study area	45.25	97.70	56.58

Sources: Data Analysis from BRR NAD-Nias et al. (2006), Team of Ruyung Village (2012), Team of Meunasah Mon (2012), Team of Meunasah Keudee Village (2012) and Team of Meunasah Kulam Village (2012)

Table 22 points out a change of poverty population in four villages of Krueng Raya Bay. Before the tsunami, 61% of the households had been under poverty line in Ruyung village, and Meunasah Keudee showed 38% only. In Meunasah Mon Village, the poor reduced its portion in 2009. However, the figure of the poor in four villages shows a higher percentage than that in Aceh Besar District, both before and after the tsunami disaster.

FH income can be classified into a lower income group in Krueng Raya Bay. The poverty condition of FH would naturally influence to the fishing communities. After the tsunami, the percentage of the poor might be not only contributed by FHs but also by other households such as traders, farmers, and local government officer; because the tsunami disaster affected to all people living in Krueng Raya Bay. Generally speaking, fisheries communities have high vulnerability on natural disaster.

An increasing number of FHs could also figure out that fishing communities were very dependent on fisheries livelihood. Imran and Yamao (2014) mentioned that FHs dependency ratio was 40.1%. Thirty percent (30%) of total population in the study area depended on the fisheries livelihood before the tsunami. The great disaster accelerated an increasing of people's dependency on fisheries livelihood by 54.3% and gradually went up to 62% in reconstruction phase (2005-2009).

Unemployment was a decisive factor to increase the number of the poor. Potential Village Data 2003 figured out that the percentage of unemployment was 4.15 % in four villages. We predicted this ratio extremely went up 100% shortly aftermath the tsunami. Reconstruction process had to urge to decrease a number of the poor to 33.38% (Team of Ruyung Village, 2012; Team of Meunasah Mon, 2012; Team of Meunasah Keudee Village, 2012; Team of Meunasah Kulam Village, 2012).

Production assets damaged compounded the condition of poverty population in fishing communities aftermath the tsunami. It was estimated that around USD 2.7 million of capture fisheries capital was damaged and lost in Krueng Raya Bay, which composed of USD 2.3 million direct asset and USD 0.4 million indirect assets (Imran and Yamao, 2014). Through calculating all fishing communities asset by using Damage and Lost Analysis, it can be said that the poor extremely increased aftermath the tsunami.

Many scholars agreed that highly poverty population is one of the fishing communities' characteristic. They are the poorest communities and increasing the rate of poverty over time in developing countries (Salagrama, 2006).

6.2. Characteristics of fishing communities

In this thesis, the term of fishing communities' characteristics is related to internal communities' capability on recovery of fisheries livelihood. As regards the attitude of fishermen, Table 23 points out that 54.22% of the respondents did not feel mental traumatic after the earthquake and tsunami struck, while 45.78% of them were very traumatic. As of 2012, some of those affected people suffered from the trauma. Indeed, the majority of respondents expressed that they were very high trust on the informal leader

(85.54%) and learning from past failures and successes (93.98%) to recovery their livelihood.

Table 23. Internal characteristics of fisheries communities

N0.	Characteristics	Classification	Respondent	
			Number (N=83)	Percentage (%)
1	Experience in fisheries livelihood	Un experience if less than 1 year	1	1.20
		Good experience if 1-18 year	43	51.81
		Very good experience if more than 18 year	39	46.99
2	Mental condition	Very traumatic	38	45.78
		No traumatic	45	54.22
3	Trust on informal leader	Very trust if more than 50% answer yes	71	85.54
		No trust if more than 50% answer no	12	14.46
4	Learning from past failure and success	High lesson learn if more than 50% answer yes	78	93.98
		Low lesson learn if more than 50% answer no	5	6.02
5	Participation in fisheries livelihood	Men	76	91.57
		Women	7	8.43

Sources: Data Analysis (2014)

Fishing communities could cope shock and crisis because they had resilient mentality which was reinforced by under civil war. The majority of Aceh's people including fishing communities had face armed conflicts for 32 years before peace agreement was established in 2005. This civil war had destroyed human live and mental health, and increased fear and distrust. In fact, the Aceh people had to cope these circumstance by themselves. As a consequence, long term period (32 years) of armed conflicts might contribute on building their mental to be more resistance and robust in the face of traumatic condition.

Social and religious value have a contribution on building of fishing communities' mentality. Social value, such as family and relative role, was very helpful for fishing communities to face traumatic condition aftermath the tsunami. Some tsunami victims could be more patient to cope traumatic because their family and relative gave them temporary settlement and small aid. Some of families and relatives could be a partner to share their problem. They could encourage the victims' motivation on survival. Most of the victims assured that the value of religion would help them to cope their life and

traumatic problems. The victims consulted their traumatic problems with religion expertise, family and relatives. Finally, they realized that the huge tsunami was the greatest problems in their life and it could be a lesson learnt for improve their mentality in the future.

The fisheries communities also maintained the attitude of trust on informal leader and lesson learnt from past failure and success. Many fishermen kept trust on sea commander because they still needed the leader to manage social interaction, capture fisheries activities, conflict solver, and communication with the government and other stakeholders. In case of fisheries livelihood recovery, the fishermen asked the sea commander to facilitate them on delivering aid from donor agency and government. If trust still establishes in personal resources, among the people may believe to cooperate in the same action and they can take mutual benefit (Cacioppo et al., 2011). Lessons learnt from past failure and successful experiences guided the fishermen to struggle their live. Technology improvement on fishing gear of lift net boat can be taken as a good example.

This research also identified that many women were engaged in fisheries livelihood in both before and after tsunami. Fishermen's wives involved mainly in fish processing (FP) and fish trading activities. It was reported that 250 women had had seasonal jobs in 58 FP before the tsunami. Miftachhuddin (2003) reported that 25 fishermen's wives were engaged fish processing and fish trader in Meunasah Keudee Village before the tsunami. Women could earn income approximately IDR 350,000-450,000/month (Field Survey 2012) to support their economic household. Retailing was the most favorable option by women as alternative livelihood. Houghton (2006) stated that that women participation needed to encourage on recovery process because they were in very vulnerability on disaster according to their socio-economic status and their lack of access on resources.

Work experience in fisheries activities can support the donor agencies on recovery fisheries livelihood. In the recovery of capture fisheries, the fishermen's experiences were very useful on planning and implementing of lift net boat. They avoided low quality of wood and monitored boat building in proper way. According to Consortium CCMRS-LEIMA (2007), a sea commander and senior fishermen were engaged in the process of lift net boat building and delivering.

Such a participatory approach was the most substantial factor to lead to the success of the recovery of fisheries and processing livelihood and their resilience. Work experience, mentality and attitude were important elements.

6.3. Aid delivery factor as a source of financial capital

The fishing communities expressed diverse respond on their capacity and external aid to recovery fisheries livelihood. Many respondents strongly disagreed and disagreed on capacity of fishing communities on recovery of fisheries livelihood (F4) are 49.4% and 31.3% respectively (Table 24). However, 16.9% of respondents undecided (neutral) that they could restore their livelihood by themselves. In another word, almost all agreed that the recovery of fisheries livelihood would have never achieved without any external aid.

Table 24. Perception of respondents about aid dependency (n=83)

Factor	Descriptive analysis	Initial Ordinal				
		Very Disagree	Disagree	Neutral	Agree	Very Agree
Fishing communities can relief their livelihood by themselves (F4)	Frequency	41	26	14	1	1
	Proportion (%)	49.4	31.3	16.9	1.2	1.2
Recovery of fisheries livelihood has been done by external aid and instution (F5)	Frequency	0	0	0	33	50
	Proportion (%)	0.0	0.0	0.0	39.8	60.2

Sources: Analysis Data (2014)

High dependency of fishing communities on external aid was understanding on recovery of fisheries livelihood aftermath the tsunami. Almost 99% of respondents' fisheries livelihood assets and other assets were damage and loss. The majority of respondents also lived in temporary shelter for two years while waiting for re-building their house. The only one expectation on recovery of fisheries livelihood was definitely access to external aid. To assess dependency on aid, this research formulated into aid dependency index (ADI). This describes how the fishing communities is dependent on external aid because of less themselves capacity on recovery of fisheries livelihood in Krueng Raya Bay (Table 25).

Table 25. Distribution of frequencies, proportion and ADI in Krueng Raya Bay

Villages/Region	Frequency of ADI					Total	Proportion of ADI (%)					ADI	Categories
	1	2	3	4	5		1	2	3	4	5		
Ruyung Village	0	1	0	0	3	4	0.0	25.0	0.0	0.0	75.0	0.81	High
Meunasah Keudee	1	9	8	8	29	55	1.8	16.4	14.5	14.5	52.7	0.75	High
Meunasah Kulam	1	2	4	4	4	15	6.7	13.3	26.7	26.7	26.7	0.63	High
Meunasah Mon	0	2	3	2	2	9	0.0	22.2	33.3	22.2	22.2	0.61	High
Krueng Raya Bay	2	14	15	14	38	83	2.4	16.9	18.1	16.9	45.8	0.72	High

Sources: Data Analysis (2014)

Over dependency on external aid is a controversial issue in any recovery process of disasters. Shown in figure of Table 25, all villages in Krueng Raya Bay indicated a high of ADI, ranging between 0.61 and 0.81. Indicators of ADI in Krueng Raya Bay were much high. There was correlation between productive asset damaged and ADI by using crosstab analysis; the result revealed that χ^2 Value (67.4) > χ^2 table (8:0.05) (15.5) and P value (0.00) < 0.05. Other factors which have correlation with ADI as can be seen in Table 26.

Table 26. Correlation between internal capacity factor of fishing communities and ADI

Factors	χ^2 value	χ^2 Table	P value	Conclusion	
Fishermen income	36.4	26.35	0.03	χ^2 value > χ^2 table (16:0.05); Pvalue < 0.05	Significance
Work experience	23.2	15.5	0.03	χ^2 value > χ^2 table (16:0.05); Pvalue < 0.05	Significance
A number of dependent	41.7	36.4	0.014	χ^2 value > χ^2 table (24:0.05); Pvalue < 0.05	Significance
Education	26.01	21.03	0.01	χ^2 value > χ^2 table (12:0.05); Pvalue < 0.05	Significance

Sources: Data Analysis (2014)

Regarding ADI result, this research definitely determined that fishing communities on external aid is high (Table 25). In case of fisheries recovery in Krueng Raya Bay, total budget of assistance was provided by external institutions such as NGOs and government agencies, was around USD 84.4 million. International donors provided more than USD 7.4 million as input factor to economic recovery (Table 27). These external institutions spent around 96% of total committed for economic sector including for recovery of fisheries livelihood. For example, UNDP spent USD 1.5 million on recovery of fisheries livelihood in Meunasah Keudee, Meunasah Kulam and Meunasah Mon Villages during the period 2005-2007 (BAPPENAS, 2012). Jesuit Refugee Service (JRS) spent out

money around USD 200,000 to re-construct 58 unit fish processing unit in Meunasah Keudee Village in 2005.

Table 27. Amount of commitment and realization fund in Ruyung, Meunasah Keudee, Meunasah Mon, and Meunasah Kulam Village during 2005-2009

No.	Sector	Value (USD)		Percentage (%)	
		Commitment	Realization	Commitment	Realization
1	Economics	7,432,698	7,132,092	8.81	96
2	Infrastructure and Housing	66,489,544	61,293,021	78.78	92
3	Social	377,223	348,458	0.45	92
4	Education	3,748,115	2,558,032	4.44	68
5	Health	6,351,162	5,212,922	7.53	82
	Total Aid	84,398,742	76,544,525	100.00	91

Sources : Data Analysis from BAPPENAS (2012)

Recovery of fisheries livelihood in a certain coastal zone should incorporate with reconstruction of infrastructure and housing, social, education, and health. Comprehensive restoration had a significant influence on relief of fisheries livelihood. According to Table 27, around USD 69.4 million had been disbursed to restore non economic sector. For example, Mercy Corp provided around USD 512,993 for infrastructure sector program (such as CFW scheme) which provided job opportunities such as beach and settlement cleaning with daily income (BAPPENAS, 2012). This scheme was implemented in Krueng Raya Bay (FGD, 2012). Panglima Laot Lhok mentioned that CFW project was really helpful on recovery of fishermen's livelihood because each fisherman could earn income between IDR 45,000 and 53,000 per day. However, a few boat owners could build their lift net boats.

6.4. Optional Strategies of Fishing Communities toward Sustainable Fisheries Livelihood Development (SLFD)

Fishing communities set up several strategies on recovery of fisheries livelihood. They have selected two main strategies toward development of sustainable fisheries livelihood according to their lesson learnt during the recovery process. Table 28 shows that S9 and S7 were ranked at the 1st and 2nd respectively, considering mean result and proportion of favorable respondent answer on neutral, agree, and very disagree. For example,

respondents were very confident about the improvement of their livelihood in the future. Agree and very agree respond were accounted for 30.1% and 67.47%, respectively, while only 2.4% of respondents had full of doubt.

Table 28. Perception of respondents on optional strategy of sustainable fisheries livelihood

Optional Strategies	Proportion (%)					Mean	Std. Deviation	Rank
	Very Disagree	Dis-Agree	Neutral	Agree	Very Agree			
Involvement on recovery management (S1)	0.00	3.61	13.25	26.51	56.63	4.36	0.85	5
Collaborative action (S2)	1.20	0.00	4.82	31.33	62.65	4.54	0.70	3
Strengthening bonding indigineous institution and LGU (S3)	0.00	0.00	15.66	34.94	49.40	4.34	0.74	6
Increasing capacity building of indigenous institution (S4)	0.00	0.00	22.89	34.94	42.17	4.19	0.79	7
Provided technical assistance for fisheries communities (S5)	6.02	2.41	27.71	42.17	21.69	3.71	1.03	9
Integrated social, finance, human, physical and nature capital building (S6)	0.00	0.00	4.82	37.35	57.83	4.53	0.59	4
Adopted social ecological system approach (S7)	1.20	0.00	3.61	26.51	68.67	4.61	0.68	2
Engaged women in fisheries livelihood (S8)	1.20	0.00	36.14	45.78	16.87	3.77	0.77	8
Developed alternative livelihood (S9)	0.00	0.00	2.41	30.12	67.47	4.65	0.53	1

Sources: Data Analysis (2014)

Fishing communities selected S9, as the first priority toward development of sustainable fisheries livelihood, could be explained by several factors, such as existing source of income, land ownership, fishing experiences, and dependency on fisheries resources in fishing communities. There was no significance correlation between existing source of income and the S9 ($P_{\text{value}} (0.478) > 0.05$). Firstly, the majority of fishing communities did not have alternative livelihood to earn additional income and 78.3% of them depend on of fisheries livelihood. And 21.7% of respondent obtain their income from non-fisheries livelihood base. Thus, they expected that alternative livelihood development could solve the lack of income from fisheries livelihood and alleviate poverty. In 2012, 7.2% of respondents had alternative income sources from livestock and agriculture livelihood; and 15.7% engaged in mini shop, fuel retailer, boat workshop, fisheries equipment shop, and electronic service. These figures pointed out that the fishing

communities had depended heavily on fisheries resources because they don't have another skills such as utilize agriculture resources.

Secondly, SFLD need physical capital such as land to create alternative livelihood in upland area. This research found that 66.3% of respondents had land for their settlement, 24.1% of respondents who did not have house land stayed with parent, and 9.6% really did not have house land. On the other hand, those respondents who had farmland and rental farmland were 14.5% and 1.2%, respectively. Ownership of land was based on alternative livelihood development (i.e. agriculture and livestock), however, it was very limited.

Thirdly, in the majority of fishing communities, those fishermen had a good skill in capture fisheries activities, but with less skill on alternative livelihood and low education. They only concerned on capture fisheries livelihood (86.6%), following by financial trader (10.8%), and fish processor (8.4%). Almost all respondents had experiences in fisheries more than 2 years; 48.0% were engaged in this livelihood more than 18 years. Less than 22.9% has other alternative skills. A few respondents became a fishing guide for outside visitor during Saturday and Sunday, and they could rent their pull boat to obtain additional income. Lack of skill was also supported by low education of respondents in adopting alternative livelihood, amounted 63.9% of them had been educated 1-6 years in elementary school.

This strategy must innovate to encourage the creation of alternative livelihood activities with such consideration to: (1) low investment and labor intensive; (2) seasonal or alternative livelihood; (3) utilization of coastal water and its ecosystem; (4) using their own production asset (lift net boat and pull boat); (5) low-medium technology content; (6) easy replication; (7) suitable for coastal water; (8) low harmful pollutant and organic matter loading; and (9) feasible on market demand.

Meanwhile, fishing communities selected the S7, adoption of social ecological system approach, as the second priority. Over exploitation of fish resources in particular anchovy would threaten the sustainability of their livelihood. 79.5% of respondents mentioned that fish catch dramatically declined during period 2005-2011. Anchovy resource had already been overfished in the period 1999-2004, and it was in depletion state during the period 2007-2012. Coastal ecosystems, such as mangrove and coral reef, were heavily affected

by the tsunami. Panglima Laot Lhok (2012) said that the fishermen had only concerned on market prices and demand before the tsunami hit Krueng Raya Bay, while they did not pay attention to the decrease of fish resources and ecosystem damaged. As a result, the number of lift net boats had increased by 91 units before the tsunami (Imran and Yamao, 2014). Nowadays, people in the fishing communities have understood that fish must be caught with consider to their sustainability and fisheries management system.

Fishing communities also selected other strategies as the third to ninth priority for recovery and development of fisheries livelihood. These strategies could be called as second and third level strategies to support the two main strategies as we mentioned above. For example, provided technical assistance for fisheries communities' strategy (S5) and integrated social, finance, human, physical and nature capital building (S6) as second level strategies could be linked with developed alternative livelihood (S9) on recovery and development of fisheries livelihood directly according to chi-square test analysis. As well as adopted social ecological system approach (S7) has a linkage with engaged women in fisheries livelihood (S8) and provided technical assistance for fisheries communities (S5). However, we predicted that the S1, S3, S4, S5, and S6 have indirect correlation with S9 (first priority) and S7 (second priority) due to chi-square test analysis. Based on chi-square test analysis, we could define the inter-correlation among the strategies as can be seen in Figure 22.

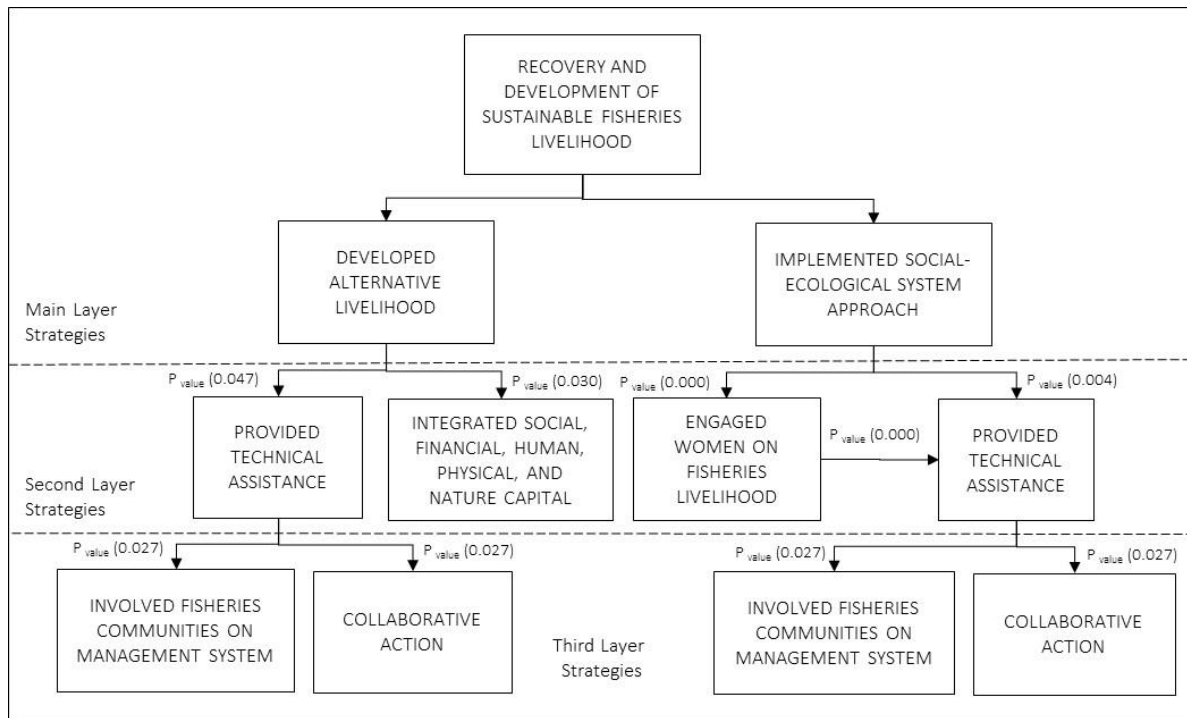


Figure 22. Inter-correlation among strategies of sustainable fisheries livelihood development (Data Analysis, 2014)

6.5. Summary

Strategy on recovery of livelihood should be promoted by community participation and their shelf-lesson learnt. This chapter discusses the integration of sustainable livelihood strategies into fisheries livelihood recovery in tsunami-affected fishing communities. Poverty alleviation through increase of income is a main target of sustainable livelihood. Increase of poor population is caused by a drop of income, a depletion of fish resource, assets production damage, and ecosystem degradation. In Krueng Raya Bay, high dependency on fisheries resources, ranging between 0.61 and 0.81, brought poverty condition in fishing communities. It can be seen that 65.9% of total population was lived within coastal area and 69.2% (or 9 villages) of the 13 villages were coastal villages before the tsunami disaster (Statistics Indonesia Agency, 2005). The recovery program of fisheries livelihood successfully reduced a number of poverty population to 56.58% on 2009 from 97.70% in 2005. The strong internal characteristics of fishing communities were regarded to cope fisheries livelihood recovery. But, their capacity of recovery process and financial capital were insufficient to restore fisheries livelihood without any

aid delivered from Government of Indonesia and other donor agencies. Lesson learnt from engagement in reconstruction process, people in fishing communities recommended to integrate alternative livelihood development and social-ecological approach into development of fisheries livelihood. These comprehensive strategies were supported by external institutions and their aids, which amounted to around USD 76.5 million. The sustainable livelihood strategies incorporate into fisheries livelihood recovery might strengthening of social resilience of fishing communities that it will be explained in chapter 7.

CHAPTER 7. TOWARD STRENGTHENING SOCIAL RESILIENCE THROUGH FISHERIES LIVELIHOOD RECOVERY AND INDIGENOUS ROLES ENGAGEMENT

The tsunami has influenced social resilience within the fishing communities in which people depend their livelihood on fisheries resources as one of common pool resources (CPRs). Indeed, it has affected them through the erosion of social resilience, coastal resources change and stakeholders interaction. In context of resilience, many scholars have studied on social ecological systems to cope variety of stresses since 2004. However, as Langridge et al. (2006) stated, there was paid less attention to the concept of social resilience, mainly to the conditions under which it is created.

Noorwijk et al. (2006) remarked that social capital in the fishing communities of Aceh has had an important role on resilience, especially the family and religious networks play role to relief fishing communities' living. The revitalization of indigenous institutions, such as PLL, has been relevant on recovery of fishing communities, especially for channeling the perspectives of the fishermen. In addition, PLL has significant function not only on recovering capture fisheries livelihood, but also conserving and managing the fishery resources and it's environmental. Besides PLL, there are also other local wisdom to strengthen social capital in Aceh's society, such as "Tuha Peut (Four Members)" and "Tuha Lapan (Eight Members)" which are established in each LGU or Village Level System (VLS).

In the recovery process of fisheries livelihood, central and local governments, donor agencies, universities and non-government organization (NGOs) provided fisheries infrastructure, livelihood, housing, and other necessary goods, to reconstruction and development phase (2005-2009). This involvement had appeared both positive and negative impacts on the social capital, particularly on social resilience which has long term existed in fishing communities. Donor agencies often adopted different criteria and mechanisms on the delivery of aid, which occurred conflicts among the beneficiaries and between them and non-beneficiaries in fishing communities. The ultimate impact of these problems would weaken social resilience which was established in fishing communities for long time ago.

This chapter will describe the tsunami impact on social capital, social vulnerability and resilience in fishing communities. It includes experiences, constraints and lessons learnt from the strengthening of social resilience in Aceh aftermath tsunami.

7.1. Tsunami impact on social capital

The tsunami affected the social facilities for supporting fisheries livelihood in the four villages. According to UNDP and Consortium CCMRS-LEIMA (2006), numerous (90%) of social facilities such as housing, fishermen meeting hall, mosque, meunasah (place for praying in village level), and schools, spread in four villages (Ruyung, Meunasah Keudee, Meunasah Mon, and Meunasah Kulam Village), were heavily damaged (Table 29).

Table 29. Damage condition of social facilities in four villages

Social Facilities	Village/Damage							
	Ruyung		Meunasah Keudee		Meunasah Kulam		Meunasah Mon	
	unit	Status	Unit	Status	Unit	Status	unit	Status
Housing	122	Heavy	255	Heavy	144	Heavy	162	Heavy
Fishermen meeting hall	0	-	1	Heavy	0	-	0	-
Meunasah/Prayer Hall	1	Heavy	1	Heavy	1	Heavy	1	Heavy
Mosque	0	-	1	Heavy	0	-	0	-
Kindergarten	1	Heavy	1	Heavy	0	-	0	-
Elementary school	1	Heavy	1	Heavy	0	-	1	Heavy
Junior high school	1	Heavy	0	-	0	0	1	Heavy
Village office	1	Heavy	1	Heavy	1	Heavy	1	Heavy
Meeting hall	1	Heavy	1	Heavy	1	Heavy	1	Heavy

Sources: Field Survey (2012)

In term of intangible asset, social capital of fishing communities was very difficult for measurement. Because it might be rather sensitive to investigate from the victims who faced shock and stress aftermath the tsunami. It might be built by trust and trustworthiness, civil engagement and cooperation, and social network (Grafton, 2005). However, the impact of the tsunami on social capital has disrupted the relationship, interaction, and networking among fishing communities within the time could not be determined. This huge disaster also impact on the patron-client relationship, trust system,

rule, and norm which were established base on the fishing communities's interaction and their experiences. The tsunami could increase the societal stress and social isolation as well. Cacioppo et al. (2011) argued that life stressor and social isolation were influenced to capacity of social resilience. Finally, it would effect on social resilience of fishing communities in simultaneously.

According to field observation and data analysis, the tsunami impact to social capital³⁵ and fishing communities can be seen in Figure 23. It directly impacted on both tangible and intangible assets of social capital³⁶. Tangible social capital, such as social facilities, public and fishing infrastructure, can accumulate damage from this tragedy and it might be estimated by using quantitative method. On the other hand, this great disaster also gave a direct negative impact to intangible social assets because it changed the patterns of the indigenous institutions, norms and values, social interactions and networks of fishing communities. Moreover, this huge disaster brought out an indirect negative impact on intangible social capital through increasing the shock and stress of fishing communities.

³⁵ There are many definitions of social capital. Coleman (1988) defined that social capital is anything that facilitates individual or collective action, generated by networks of relationships, reciprocity, trust, and social norms. Meanwhile, Putnam (1995) referred that social capital is the collective value of all social networks and the inclinations that arise from these networks to do things for each other. And Fukuyama (2001) argued that social capital is an instantiated informal norm that promote co-operation between two or more individual. In this thesis, social capital is communities' capability in building relationship and interaction which is built through tangible (social or public facilities) and intangible assets (trust, network, relationship) for livelihood development.

³⁶ According to Coleman (1988), physical capital is wholly tangible, human capital is less tangible, and social capital is less tangible yet. Hanifan (1916) also promoted that social capital could be classified into those tangible substances. This means that social capital largely refer to intangible assets, but it also consists of tangible assets, in particular social facilities (communities meeting hall, praying hall, and recital communities hall), public infrastructure (school), and fisheries infrastructure (fish landing, fishermen meeting hall, traditional fish market) into social capital. Those physical facilities has a function to support and retain the social structure such as trust, reciprocity, social network, and marketing channel link in fishing communities.

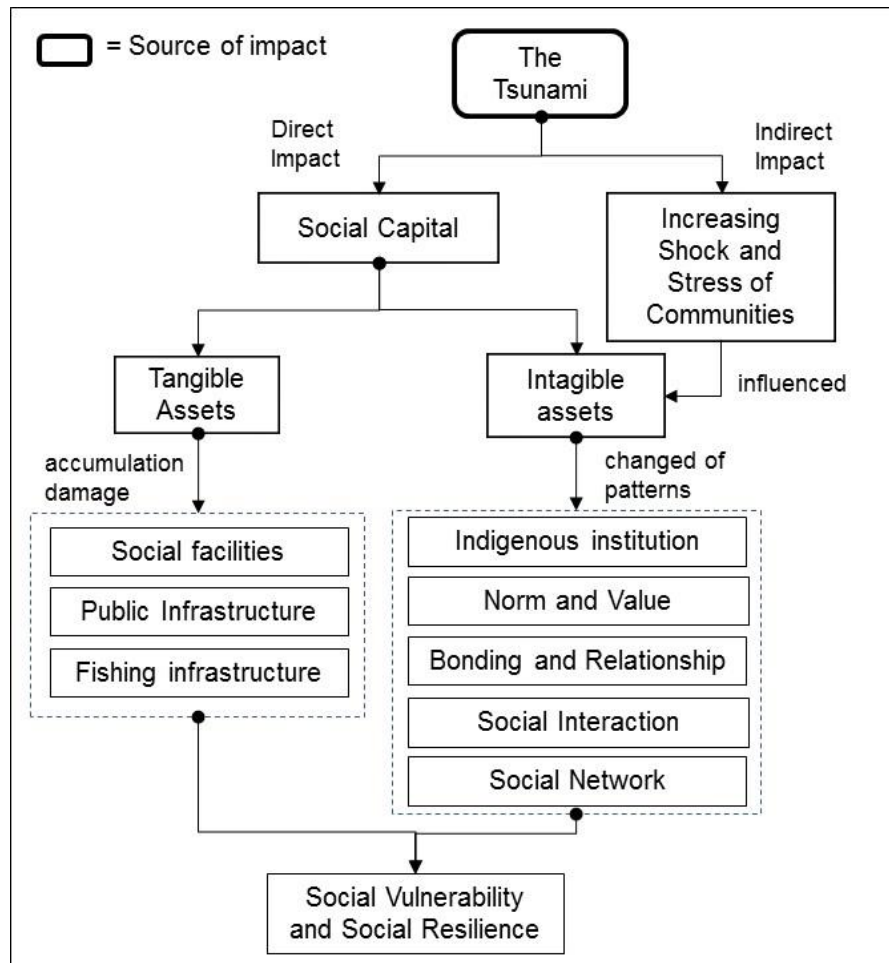


Figure 23. The tsunami impact to social capital and communities in Krueng Raya Bay (Field survey, 2012)

In this case, the fishing communities in four villages have not shifted from the genuine institution, PLL, into a new one. Indeed, most of the donor agencies always consulted with this institution to decide which fishermen could be chosen as beneficiaries. In reality, this indigenous institution did not define the criteria how to select suitable fishermen on fisheries aid delivery. As consequence, disharmony emerged between PLL and the fishermen who did not get enough aid, thus agitating social interaction, bonding and relationship among them. Sometimes, other villages' except Meunasah Kudee Village also assumed that this institution always distributed fisheries aid in Meunasah Kudee Village. Not naturally, such conflicts and gaps might be great obstacle to the restoration of intangible social capital.

7.2. Social vulnerability and resilience in fishing communities

Birkman et al. (2009) explained that reducing the impact of a stressor often needs vulnerability approach, focusing mainly on assets and resources. This is why social vulnerability became an important factor in mitigating the impact of disaster to community within sustainable livelihood development and social resilience. Bogardi (2006) argued that social vulnerability and social resilience have an orthogonal relationship and they might be affected on community capacity.

Because of difficulties in quantifying the social vulnerability, many scholars have used “Social Vulnerability Index (SoVI)”, in order to allocate the necessary resources to the right targets at the right location. Cutter et al. (2003) proposed the construction of SoVI as a basis for planning and action on disaster response. To simplify this concept, Indonesia’s National Agency for Disaster Management (Badan Nasional Penanggulangan Bencana) (2012) suggested that SoVI can be measured with consider to population density (population/km²), sex ratio, poverty ratio, disable population ratio, and age population ratio. The result of SoVI in eight villages in Krueng Raya Bay is around 0.6007-0.8460. Moreover, social resilience index (SRI) can be calculate using invers of SoVI. The result of SoVI and SRI in 2003 as can be seen in Table 30.

Table 30. The result of SoVI in eight villages in Krueng Raya Bay

Village	SoVI	Category			SRI	Category		
		Low (<0,25)	Moderate (0,25-0,50)	High (>0,50)		Low (<0,25)	Moderate (0,25-0,50)	High (>0,50)
Ruyung	0.7888	No	No	Yes	0.2112	Yes	No	No
Paya Kameng	0.7070	No	No	Yes	0.2930	No	Yes	No
Beurandeh	0.6978	No	No	Yes	0.3022	No	Yes	No
Meunasah Kulam	0.7936	No	No	Yes	0.2064	Yes	No	No
Meunasah Keudee	0.8460	No	No	Yes	0.1540	Yes	No	No
Meunasah Mon	0.7850	No	No	Yes	0.2150	Yes	No	No
Ie Seu Um	0.6007	No	No	Yes	0.3993	No	Yes	No
Lam Reh	0.6425	No	No	Yes	0.3575	No	Yes	No

Sources: Data Analysis (2012)

The four villages selected, i.e. Ruyung, Meunasah Keudee, Meunasah Kulam, Ruyung, Meunasah Mon showed a highest SoVI, which were in range 0.7850 – 0.8460, because these villages are located nearby sea and flat area. Other villages located in coastal zone area were also high SoVI categories. If SoVI was high, social vulnerability in Krueng Raya Bay might be high. This means, if this area would be struck by any disaster, it would

take huge cost on recovery of community to steady condition. Bogardi (2006) argued that social vulnerability was measured in how much cost is needed and how many people will be affected. Meanwhile, social resilience is gauged by time; how long community takes time to recover, self-organize, and incorporate lesson learned to normal condition. SRI in the study area was in range 0.1540 – 0.2150. It would take long time for restoration in fishing communities.

7.3. Role of Social capital in fishing communities

Social capital in Krueng Raya Bay has established and developed through both indigenous and formal institutions that bond the coastal community due to social network, rule, norm, sanction, and relationship of trust before the tsunami event (Table 29). DFID (1999) remarked that social capital was developed through networks and connectedness, membership of formalized group, and relationship of trust. While Green and Haines (2002) added that social capital in commonly is an emphasis on aspect of social structure, trust, norm, and social network to facilitate coordination and cooperation for mutual benefit. Putnam (1995) suggested that social capital refers to connections among individuals, social networks, norms of reciprocity, and trustworthiness.

In capture fisheries of Krueng Raya Bay, the indigenous institutions who have a role to govern fishermen directly are Panglima Laot Lhok and Toke Bangku. On the other hand, others genuine organization such as Tuha Peut (four members) and Tuha Lapan (eight member) have facilitated fishermen for solving social problems. Meanwhile, LGU has not arranged to govern fishermen who inhabitant within a village administrative. However, among the indigenous institution and LGU, both normative and structure aspect of social capital have been tied into bond, bridges and social network. Berkes (2006) stated that “the role of cross scale institution is significant to provide a means to bridge the divide between processing take place at different level”.

Table 31. Indigenous institutions role engagement on the developing of social capital accordance to four boundaries administrative authority in Krueng Raya Bay

Local Institution ¹ and Boundaries ²	Social Capital Development ³		
	Network and connectedness	Membership more formalized group	Relationship of trust, reciprocity and exchange
Local Region			
Panglima Laot Lhok	<ul style="list-style-type: none"> • Establish patron-client fishermen system; • Increase trust among fishermen; • Social networking development; and • Can access to Panglima Laot and Fisheries Office in district and provincial level 	Fishermen as membership can accept rule, norm and sanction	<ul style="list-style-type: none"> • No transaction cost; and • Create cooperation among fishermen to reduce poverty
Toke Bangku (financial trader)	<ul style="list-style-type: none"> • fishermen and both provider operational cost and marketer system; • Create huge trust between fishermen and operation cost provider; • Establish patron-client between fishermen and toke bangku • Social networking development; and • Can access to local and regional market 	No rule, norm and sanction to role fishermen as un-register membership to Toke Bangku	<ul style="list-style-type: none"> • Create transaction cost; • Create cooperation between fishermen and Toke Bangku to produce fish • Provision loan to fishermen without collateral
Fish Processing Association	<ul style="list-style-type: none"> • Create professional relationship; • Create trust among the fish processor; • Can access to local and regional market 	No rule, norm and sanction to role fish processing ownership	<ul style="list-style-type: none"> • No transaction cost; and • Create cooperation for arranging price of fish processing product
Village			
Local Government Unit	<ul style="list-style-type: none"> • Establish to rule social networking in village level; • Create trust for social problem solving; and • Can access to sub district and district government level 	No rule, norm and sanction due to religion	<ul style="list-style-type: none"> • Transaction cost for administrative arrangement; and • Encourage community cooperation for social action

Table 31. Continue...

Local Institution ¹ and Boundaries ²	Social Capital Development ³		
	Network and connectedness	Membership more formalized group	Relationship of trust, reciprocity and exchange
Tuha Lapan	<ul style="list-style-type: none"> • Establish relationship among the community in village level; • Informal representative to create trust with head of village for social problem solving; and • Can access to Local Government Unit in Village Level 	No rule, norm and sanction to role community but it evolve religion rule	<ul style="list-style-type: none"> • No transaction cost; and • Increase cooperation for working together in village level
Sub Village			
Tuha Peut	<ul style="list-style-type: none"> • Establish relationship among the community; • Social networking development; • Can access to Tuha Lapan to solve social problems; 	No rule, norm and sanction to role community but it evolve religion rule	<ul style="list-style-type: none"> • No transaction cost; and • Increase cooperation for working together in sub village level
Head Sub Village Institution (Dusun)	<ul style="list-style-type: none"> • Establish social networking; • Create trust among community to solve social problems; Can access to others institutions in village level 	No rule, norm and sanction	<ul style="list-style-type: none"> • No transaction cost; • Increase cooperation for working together in sub village level

^{1,2} Source : UNDP and Consortium CCMRS-LEIMA (2006), ³ Data Analysis (2012)

7.4. Lesson learnt from the strengthening of social resilience

Fisheries livelihood recovery project (FLRP) was not only physical treatments, but also used comprehensive approach in order to obtain a livelihood strategy and livelihood outcome. It provided fishing boats, livelihood materials, and integration financial into social capital, human capital and natural capital. Moreover, it was implied the modification of Sustainable Livelihood Analysis DFID (1999) which was called Fisheries Livelihood System Analysis.

According to Consortium CCMRS-LEIMA (2007), FLRP could be classified and facilitated to four activities, namely: developing fishing boat and capture equipment supply, mobile market and fish processing, construction and fisheries aggregating device, and non-fisheries livelihood and institutional capacity building. The total budget

allocation for all livelihood activities was around USD 1,129,293 (72.64% of total project budget). In addition, the remaining these budget, about USD 403,562 (25.96%) and USD 21,834 (1.40%) respectively, which were allocated both for operation and overhead cost of program (Figure. 24).

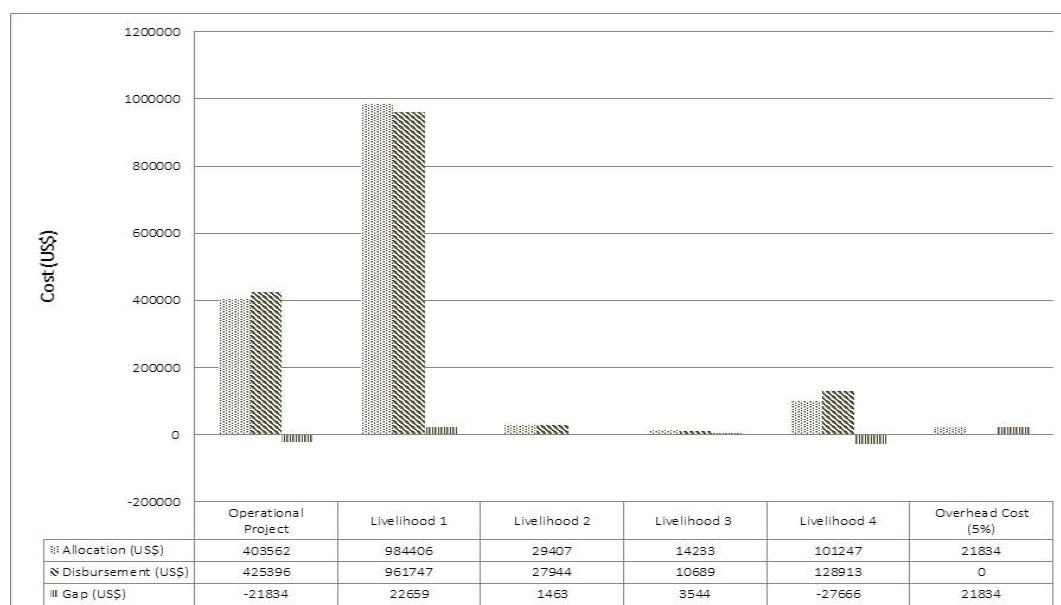


Figure 24. The proportion of budget allocation, disbursement and gap on FLRP in Krueng Raya Bay in period 2005-2007

Shown in Figure 24, the budget was allocated not only to livelihood 1 but also need to spent amount money for livelihood 2, 3 and 4. Indeed, FLRP had reallocated budget around USD 144,887 (9.32%) to cover non capture fisheries, including for conducting institutional capacity building. As a result, it must be changed the financial strategies on stage of implementing through re-balancing budget; the contingency budget (5% of total budget) need to disburse on covering operational cost.

Although there was no budget providing for non-fisheries livelihood activities at the beginning of the implementation, FLRP had to set up of budget for the activities of agriculture, livestock, small businesses, and institutional capacity building due to consideration of the village planning process, in order to strengthen social resilience.

According to Davis (2005), the communities' favorable conditions are needed to cope hazard reduction at various levels, in order to increase the resilience of community at risk to absorb disaster shocks, bounce back following their impact and adapt during disaster

recovery. As consequence, it might be changed the logical framework and program result in Krueng Raya Bay with consider to adaptive management. (Table 32)

Table 32. The changing of planning and output on FLRP in Krueng Raya Bay

Logical Framework			Program Performer	
Bottleneck	Objective and Activities	Target Group	Output	Impact
Collapse of fisheries asset and capital to generate income for sustainable fisheries livelihood development	Objective : Local economic and livelihood recovery after earthquake and tsunami disaster for coastal community			The fishermen returning to fishing with the potential of generating income around Rp.30,000-Rp.60,000/person daily
	Fisheries Livelihood 1:			
	Developing lift net, line, beach seine mini purse seine fishing fleet and equipment supply	31 lift net, 10 line, 4 beach seine, and 3 purse seine packets of fishing fleet	24 lift net, 10 line, 4 beach seine, and 3 purse seine packets of fishing fleet	
	Fisheries Livelihood 2:			To help the increasing income of coastal community outside of fishing activity and to reduce poverty
	- Mobile market	10 packages	10 packages	
	- Fish processing Unit	10 unit	1 packages	
	Fisheries Livelihood 3:			Fishermen can harvest fish that conditioned in the fishing ground areas, which is relatively close to fishermen's residential
	- Fish Aggregate Device Reconstruction	6 packages	3 packages	
	Objective and Activities	Target Group	Output	
	Objective: Recovery and reduce poverty of non-fisheries livelihood on coastal community			
	- Agriculture	No target	3 packages	
	- Livestock	No target	3 packages	
	- Home made	No target	3 packages	

Table 32. Continue...

Logical Framework			Program Performer	
Lack of trust, norm and network would be weaken social resilience	Objective: To develop and improve the capacity of local people in managing the assets and facilities produced by the project through development of social and institutional capital			Capacity building of economic and social capital toward strengthening social resilience
	- Village planning development	3 packages	4 packages	
	- Regional Development Committee (RDC)	No target	1 packages	
	- Institutional capacity building	No target	1 packages	
	- Technical assistance	No target	1 packages	
	- Microfinance development	No target	1 packages	
	- Social grant	No target	3 packages	

Sources: Data analysis (2012) due to Consortium CCMRS- LEIMA

According to the field survey conducted in 2012, various changes of the target group have been consulted to Regional Development Committee which was established by the village planning (Duek Pakat) of three villages. These changes were also coordinated and consulted with various local (internal systems, see Table 32), international (UNDP), national institutions (BRR NAD-Nias, CCMRS and LEIMA Foundation) as an external institution system. Both groups were interested parties in the implementation FLRP. With reference to the UNDP and Consortium CCMRS-LEIMA (2006) and field survey (2012), the stakeholder analysis has been carried out for Krueng Raya Bay (Table 33).

Table 33 shows that, in Krueng Raya Bay, stakeholders, including formal and informal institutions, who concern to relief the affected fishermen, has involved fisheries recovery process. According to Ostrom (1990), institutions had both the formal legal rule and informal social norm that govern the behavior and shape how the individual and organization to interact one each other's.

Table 33. Stakeholder's analysis on FLRP in Krueng Raya Bay

Stakeholders	Stakeholder's Interest	Perception of Problem	Mandate
UNDP	Contribution to recovery livelihood post tsunami the Aceh Emergency Response and Transitional Recovery Program	Collapse of livelihood on coastal community who live in affected area of tsunami on 24 December 2004	Provision budget, controlling, monitoring and evaluation program
BRR NAD-Nias	Build back better	Aftermath tsunami was affected to Aceh's economics	Coordination and implementing agency for rehabilitation and reconstruction program
Consortium CCMRS-LEIMA	Conduct need assessment, design, and implementing fisheries livelihood recovery	Damage of fisheries resources was created un sustainable fisheries livelihood	Implementing, facilitating, and assisting coastal community
Panglima Laot Lhok	Facilitation external institution agency to delivery aid to fishermen	Fishing fleet, equipment and infrastructure fisheries damage by tsunami hit	Management of fishermen due to ecological and local region boundaries
Fishermen	Beneficiaries of fishing fleet and equipment delivery	Fishing fleet destroy and lack of financial capital on recovery of livelihood	Actor of capture fisheries livelihood and user of fish resources (no mandate)
Toke Bangku	Beneficiaries of financial and marketing support to get asset and capital to recovery their livelihood	Loss their asset and capital because of tsunami and no return modal from fishermen	Actor of financial support marketing for fishermen (no mandate)
Fish Processor	Beneficiaries of fish processing to obtain unit fish processing, financial capital and assistances	Unit fish processing damage and lack of financial capital	Actor of fish processor to increase the fish value added (no mandate)
Fish trader	Beneficiaries of fish trader to get financial capital and equipment	Equipment loss and lack of financial capital	Actor of fish trader to sale fresh and salty fish to consumer (no mandate)
Farmer	Beneficiaries of agriculture and livestock to obtain financial capital	Damage and lost land farm and livestock	Actor of agriculture and livestock to produce vegetable and meat (no mandate)
Mosque Family Board	Rehabilitation of mosque facilities	Severe damage of mosque facilities	Actor of social and religion aspect
Local Government Unit	Rehabilitation and reconstruction of housing, social infrastructure and administration system	Damage and loss of housing, social infrastructure and administration system	Actor to govern the community in tsunami affected area
Tuha Lapan	Informal institution to facilitate community in village level on recovery process	Tsunami impacted to social capital	Actor to govern social capital in village level
Tuha Peut	Informal institution to facilitate community in sub village level on recovery process	Tsunami impacted to social capital	Actor to govern social capital in sub village level

Table 33. Continue...

Stakeholders	Stakeholder's Interest	Perception of Problem	Mandate
Arisan Group	Informal organization to arrange women to get financial capital	Tsunami impacted to financial capital	Actor to indirectly govern women in financial lottery
Meunasah Committee	Informal religion leader to assist delivery aid from donor agency	Tsunami impacted to social capital	Actor to govern social capital in village level
Community Village Committee for Security	Community representative to facilitate aid delivery	Tsunami impacted to administration and village development	Actor to connect donor institution to LGU
Head Sub Village Institution (Dusun)	Social infrastructure reconstruction	Tsunami impacted to social infrastructure	Actor to facilitate aid in sub village level
Wirid (recital) group	Capacity building assistance relate to religion aspect	Tsunami impacted to social capital	Actor in social capital in village level (no mandate)

However, a prominent role has performed by Panglima Laot Lhok because it has a vertical relationship with its members and tied to the value system that has become a tradition among the fishermen. Nurasa et al. (1993) stated that Panglima Laot Lhok has system to lead and guide the local fishing communities, resolve conflict and dispute among fishermen, responsible in determination of taboo in fishing activities, and impose penalty against violators.

There were a few changes in the role of Panglima Laot Lhok aftermath the tsunami with additional functions. Panglima Laot Lhok became an assistant for donor agency. It also played a significant role in determining the beneficiary of fishermen and distributing of aid. In the context FLRP, Panglima Laot Lhok also became a guarantor of quality fishing boats built after improvement by the fishermen group (Consortium CCMRS-LEIMA, 2007). Changes in the functions and roles performed by it were a part of the adaptations strategies by local institutions in the face of pressure and stress to achieve and return to normal conditions. It would had a relationship to social resilience in society who affected by disaster. Cacioppo et al. (2011) stated that social resilience would be effective to smaller unit which was related to nearly all form of human association, from dyads all of types, families, small group, neighborhood, community and culture. According to Sapirstein (2006), the adaption process is needed to ensure that people are dealing with the situation at hand, rather than romanticizing an idealized past or harboring anger and

resentment at perceived failures of government. Gibbs (2009) argued that resilience, on couple of social ecological system, is linked to social process both on individual and community level and intangible factors, i.e. social cohesiveness, for underpinning adaptive capacity.

Another indigenous institution, Toke Bangku (TB, financial trader), plays a significant role to reinforce social resilience on recovering capture fisheries livelihood. He or she has close relationship with fishermen. According to research (2012), the pattern of relationship between TB and fishermen is personal bond, trust and mutual complement. In the process of the mutual cooperation, there is no legal commitment, TB provides operational funds to fishermen in order for them to fish, and in turn, the fishermen are obliged to sell their catch to TB. Moreover, they often borrowed money from Toke Bangku for the purpose of buying daily goods during off-fishing seasons. Even if fishermen could not afford to pay their debts, TB had rarely collected money.

These patterns of the relationship can built an emotional connection between fishermen and Toke Bangku. Garces et al. (2010) reported that Toke Bangku has substantial role in fish market channels. They mentioned that after the fish unloaded should be sold to Toke Bangku, and then sold it to Muge (mobile market) or to other local traders. Thus, Toke Bangku also has a social and market network³⁷. The marketing channel link which is established by Toke Bangku as can be seen in Figure 25.

According to Figure 25, Toke Bangku has relationship with boat owner and skipper. Toke Bangku also has wide relationship with the marketing channel link is not only in local fish market, but also regional market intra province and inter province. The are 6 flows of fish marketing which are handled by Toke Bangku: (1) Toke Bangku-fish processor, (2) Toke Bangku – Toke Bangku in local market, (3) Toke Bangku – retailer, (4) Toke Bangku – Mobile Market, (5) Toke Bangku – Toke Bangku in regional market,

³⁷ Marketing channel link was established by TB long time ago in Aceh. This market network can be classified as one of intangible assets in fishing communities. The tsunami was directly impacted to fish market network which supported fisheries livelihood, because physical marketing facilities and transportation were destroyed, and merchants were also dead). By using the previous collectors before the tsunami, TB revitalized marketing channel link to support fish marketing system and fisheries livelihood recovery.

and Toke Bangku – collector/exporter in regional market inter province in Medan, Sumatera Utara Province.

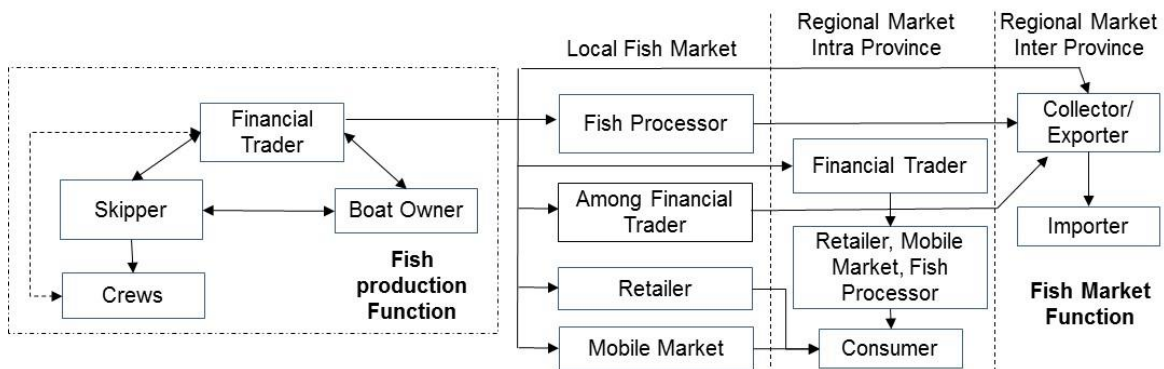


Figure 25. Toke Bangku function and its marketing channel link

In addition, Tuha Peut and Tuha Lapan (four member and eight member) had arranged the bridging, bonding, and networking between Panglima Laot Lhok, Toke Bangku and formal institution such as LGU and sub village. They played a significant for the strengthening foster the social resilience of fishing communities during the recovery of fisheries livelihood. According to Adger (2000), social resilience of a community depends on the institutional structure of that society: both modes of socialized behavior (informal institutions) and formal structures of governance or law (formal institutions).

7.5. Constrains and issues toward strengthening social resilience in Aceh

Based on the experience of FLRP in Krueng Raya Bay, we have learnt a lot of lessons that would be useful for strengthening social resilience from any disaster's shock. With reference to the program cycle management, Equal (2012) has developed the project cycle which consists of a number of stages, namely, defining the policy objectives, identifying the issues, developing a detail plan, implementing program, monitoring and evaluation, and establishing partnerships.

In case of FLRP, the planning and program formulation phase, was engaged fishing communities to design activities for fisheries livelihood recovery. The objective of these phase were to verify that activities were formulated by the need assessment and communities meeting (Duek Pakat) in each villages. According to DFID (1999), the

community's involvement in sustainable livelihood analysis is how to put people at the center of decision and development of livelihood program.

The result of verification indicated that there was a gap between activities proposed and community's needs. Initially, the program was highly prioritized according to the recovery process of fisheries livelihood, although there are many other livelihoods such as agriculture, livestock and other small enterprise. And then, the program should accommodate as community proposed. It was done to avoid a conflict among disaster victims that can undermine social resilience in Krueng Raya Bay.

Consortium CCMRS-LEIMA conducted meetings of villages planning development in which representatives of each of the formal and informal institutions in a village attended to re-design the activities proposed by the fishing communities of Krueng Raya Bay. . They determined the representative due to the agreement in Duek Pakat. The purpose of this meeting was to overcome the limitations of funds, formulated non-capture fisheries livelihood activities, established village development committees, formulate the criteria and mechanisms for livelihoods beneficiaries. This meeting agreed that the assistance provision would be channeled through economic institutions owned by the villages.

The fishing communities' passion in Krueng Raya Bay and their commitment had written and signed in a charter agreement. In this process, all the rules, norms and values would be unity in a society Krueng Raya Bay to avoid conflicts among the community for getting aid. In addition, the community engagement in FLRP was also performed on the stage of program implementation, monitoring and evaluation, and formulation of exit strategies of sustainability program. This collaborative process had gained the key factors successful for accomplishment program in Krueng Raya Bay (Table 34).

Collaborative actions have increased community's adaptability, bounding of community and local institution, and building mutual trust among institutions. It means that fishing communities shows the signs of response, self-organization, redundancy, learning, and adaptation to face the impact of disaster. These indications are the signs strengthening social resilience in coastal community aftershock of the disaster.

Table 34. Aspects and factor contribution to success of program

Aspect	Factor contribution to success
Program Management	<ul style="list-style-type: none"> • Solid vision and mission understood by implementing agency; • High spirit and team work; • Availability of management system (Financial and Technical System Operational Procedure, etc.); • Sufficient human resources in terms of qualities and quantities
Program Sustainability strategy/approach	<ul style="list-style-type: none"> • Intensive participatory facilitation • Credible commitment among stakeholders; • Establishment of local economic institution for accelerating livelihood recovery • Establishment of regional development committee board to facilitate the local three village leaders

Sources: Modified from Consortium CCMRS and LEIMA

In addition, the implementation of FLRP has an impact on the strengthening of economic capital and social capital. Of course, the recovery of economic assets, particularly for fisheries livelihood activities were expected to increase anchovy fish production. Unfortunately, it has no returned back to pre-tsunami production (Research, 2012). The number of fishing boats operated was almost the same as before the tsunami disaster, because donor agency, NGOs and GOI constructed new boats (Panglima Laot Lhok, 2012). In short term, the fishermen caught the reef fish species that they sold directly to local markets both in Banda Aceh (Peunayong Fish Market) and Aceh Besar District (whole market, Pasar Induk).

In the last quarter of 2011, in Krueng Raya Bay, the volume of catch increased comparing to five years after the tsunami. Indeed, the fish processors said that dry fish anchovy product had increased delivery to terminal markets such as Pasar Ikan Cemara, in Medan in early 2012 (Filed Survey, 2012).

Considering the socioeconomic improvement after recovery of fisheries livelihood, it can be said that strengthening social resilience would not guarantee to increase anchovy fish production because it also depends on the recovery of ecological systems. Adger (2000) explained that social resilience system has relationship and undefined to resilience of ecological system on which social system depends.

The restoration of social capital was mostly done by mediation, facilitation and assistance approach to society, beneficiaries and local institutions. Social capital in the context of FLRP implementation has been tended to increase, especially in terms of the improvement of the three village relationship in Krueng Raya Bay (Table 35).

Table 35. Qualitative impact on social capital

Item	Before the Program	After the Program
Krueng Raya Charter	There was relatively no communication between the village leaders regarding to the development plan	Krueng Raya Charter was initiated as an umbrella and agreed by the three local village leaders to cooperate and consolidate the regional economic development
Krueng Raya Regional Development Committee (RDC)	There was no such institution	Krueng Raya RDC was established to guarantee the facilitation of Koperasi Syariah Hidup Baru (KSHB) activities and village local leaders
Fisheries Group	Relatively few number of fishers group	Increasing capacity of fishers group both in terms of number of group as well as the management skill through training on management of fisheries business.
Local youth people	Relatively few number of people interested to the syariah-based cooperative	Increasing interests of the local people to involve to the management of the KSHB
Institutional capital	There was only one institution engaging the local micro-finance and economic institution namely Baitul Qirat.	New microfinance, KSHB was developed as the alternative for managing the economic activities of the local people

Sources: Modified from Consortium CCMRS and LEIMA

Finally the exit strategies were needed to be selected in order to maintain the sustainability of fisheries livelihood after accomplishment of fisheries recovery program. There were two exit strategies which were suggested by FRLP to community in Krueng Raya Bay, namely: assisted and facilitated the fishermen group and other local economic agents local university and/or NGOs through establishment of Krueng Raya Regional Development , including through; and increased maintained the capacity of local fishermen and of women group through KSHB or fisheries cooperative.

To sum up, the strengthening of social capital and the establishment of exiting strategies upon mutually agreement had indicated that the steps forward to the strengthening of social resilience has been done post recovery process. There are five indicators that can be used as a reference for the strengthening the social resilience of fishing communities,

namely: (1) prepared quick response to handle the mentality drop using the informal leader and formal as adviser and facilitator; (2) given the opportunities for fishing communities engagement in the decision process of fisheries livelihood recovery to encourage their participation for providing program and activities of fisheries livelihood recovery; (3) designed collaboration action in implementing of fisheries livelihood recovery by integration implementing agencies and local institution role on recovery of livelihood; (4) increased the capacity of fishing communities in self-organization to re-organize the fisheries livelihood capital; and (5) encouraged the fishing communities to get lesson learnt from their experience relief and adaption on recovery of the mentality and livelihood.

7.6. Summary

Social resilience has role to govern the local community and coastal fisheries resources toward sustainable fisheries development in tsunami affected area. This chapter describes the outcomes of this research, while focusing mainly on the impact of the tsunami disaster on the improvement of social capital which would be toward the strengthening of social resilience. The tsunami was impacted on social capital through destructed social facilities (housing, fishermen meeting hall, etc.), erupted intangible of social capital (such as trust, network, relationship, indigenous institution, rule and norm), and increased shock and stress of fishing communities. The four villages selected, i.e. Ruyung, Meunasah Keudee, Meunasah Kulam, Ruyung, Meunasah Mon showed a highest SoVI, which were in range 0.7850 - 0.8460, because these villages are located nearby sea and flat area.

Indigenous institution had a contribution and adaptable to rebound social resilience. The Panglima Laot Lhok (sea commander) had determined and adapted role on recovery of the fishing communities, particularly facilitated aid delivery to fishermen, as shown in anchovy fisheries relief case in Krueng Raya Bay. Toke Bangku (financial trader) had stimulated for reinforcement of advance payment and market channel. The other institutions supported upon linking and bridging connectivity among stakeholders. Collaborative governance can avoid conflict, reduce donor dependency and strengthen social resilience within fishing communities.

Toward the strengthening social resilience of fishing communities could be gain through: (1) revitalization of rule, norm, trust, network, and relationship using the social value and religious; (2) engagement of indigenous institution and local government unit on recovery process in designing program planning, decision making, monitoring and surveillance; (3) adoption of the sustainable livelihood approach by using fishing communities participation; (4) integration of management adaptive strategies for implementing fisheries livelihood program and activities; (5) collaboration action among the stakeholders and local institution capacity building in coping shock and crisis circumstance aftermath tsunami, (6) arranging exit strategies for fisheries and alternative livelihood development.

CHAPTER 8. CONCLUSION AND RECOMMENDATION

Conclusion and recommendation will provide the answer for four specific objectives. The contents of conclusion are expected to support and create the ideas toward the strengthening of social resilience in fishing communities through recovery and development processes of fisheries livelihood. To reduce their vulnerability and increase social resilience, this thesis will provide recommendations that may solve the problems which fishing communities have faced at present.

8.1. Conclusion

8.1.1. Factors affecting on changes of fisheries livelihood patterns

The tsunami absolutely gave huge negative impact to fisheries livelihood in Krueng Raya. DaLA is one of the analysis that can be used to measure damage and loss of tangible fisheries capital for estimation its recovery budgeted. However, it cannot be applied to predict how much intangible social capital of fishing communities (e.g., social bonding, interaction, and network) and their stress which are impacted by this tragedy. It is also difficult to measure how much this intangible capital is in both quantitative and qualitative terms has recovered after the tsunami. Definitely, this great disaster drives indirect conflict among fishing communities and indigenous institution when the system and schema of aid delivery are not transparent, fair, and accountable.

Factors changed, which are represented by the capital of fisheries livelihood (such as fishermen, operational cost, production cost of boat, number of boat and fisheries infrastructure), affected fisheries livelihood pattern in the study area. The factors constraints are increasing of production asset and operational cost. These factors' changes must be paid attention on recovery of fisheries livelihood during the recovery process. People and communities increased dependency on fish resources to retain their livelihoods. In a short term (emergency and relief phase), fishermen and their productive assets had to be restored first to improve fisheries livelihood; followed by fisheries infrastructure, indigenous institution, fish resources and coastal ecosystem in the medium and long term (reconstruction and development phase) to restore fishing communities.

Therefore, the fisheries livelihood factors changes can influence the existence of fishing communities in the future.

8.1.2. Factors contributing on changing of fish resources declining

A declining of marine capture fisheries production including anchovy was occurred in Aceh Besar District, in the period 1999-2004 and 2005-2011. It was indicated that anchovy production from Krueng Raya Bay was also dropped in the same period. Anchovy was identified as *Stolephorus commersonii* and it faced over exploited state during the period 1999-2004 and it had become the depletion state in the period 2005-2012.

There are several factors that caused overfishing of anchovy fisheries prior to the tsunami. The lack of knowledge about anchovy unit stock, increasing effort, non-selective mesh size, unlimited use of lighting, harvesting throughout the monsoon season were direct factors to bring the overfishing of anchovy. Anthropogenic factors definitely caused the degradation of coral reef and mangrove ecosystem, which were possibly indirect factors on the decline of anchovy fisheries prior to the tsunami.

Anchovy fisheries faced depletion due to CPUE of anchovy and average recent catch in MSY. Such a depletion had at least six scenarios, as follow: (1) anchovy resources suffered under extreme pressure during the critical years (2005-2006), (2) the direct factor contributed on anchovy resource declining during recovery process, (3) the destructive fishing operations threatened the coral reef ecosystem, (4) the anthropogenic factors lead to coral and mangrove ecosystem degradation, (5) tsunami impact compounds the degradation of coastal ecosystem; and (6) increase in population caused the increase of anthropogenic factors and dependency on anchovy resources. However, it is clear that the tsunami impact on anchovy resources may be lesser than the combined effects of destructive fishing and anthropogenic factors.

8.1.3. Integrate sustainable livelihood approach into fisheries livelihood recovery

Changes in fisheries household income and poverty levels were greatly affected by the tsunami strike. This natural disaster shifted the structure of fisheries household income from > IDR 1 million to IDR 0.5-1 million. Destruction of physical, fish resource, and financial capital were the main factors that caused a decreasing of fishing communities' income. Many fishermen substitutes their fishing boats from lift net boat to hand line boat in order to cope the decrease of income. On the other hand, a number of poor people increased almost double because after the tsunami disaster. After reconstruction program (2005-2009), a number of poverty people in fishing communities could be decreased to 50% of their number aftermath the tsunami (2005).

The characteristics of fishing communities could be the key factors on recovery of fisheries livelihood. The strong characteristics of the fishing communities can cope their shock and stress after the tsunami hit. However, they cannot restore fisheries livelihood without aids delivered by external institution. As a consequence, the aid dependency index of fishing communities became very high at the end of recovery process. Setting up a good criteria for aid delivery have to define first in order to neglect overlapping and conflict among the beneficiaries in the beginning of recovery process.

8.1.4. Toward the strengthening social resilience

The strengthening of social resilience in fishing communities, who are depend fish resources for their livelihood, are needed integrated effort to link social capital, financial capital, physic capital and human capital. Moreover, sufficient budget, human resources and various institutions are needed to restore fisheries livelihoods within social-ecological boundaries, like a bay. In fact, there are many recovery programs implementation on recovery of fisheries livelihood, but they are not focused directly on strengthening social resilience. Nevertheless, the implication of these program might have a positive impact for the strengthening of social resilience of fishing communities.

A lesson learnt of FLRP implementation was how to integrate the sustainable livelihood approach into recovery of fisheries livelihood. This program implications could reduce

the fishing communities' dependence on donor's support and it might enhance the capacity of local institution to organize fishing communities' relief.

The key to the success of strengthening social resilience is to enhance the capacity of a local facilitator, encourage fishing communities' involvement at every stage of program management, and build local institutions to control program implementation. Technical assistance and capacity building of indigenous institution, such as Panglima Laot Lhok, Toke Bangku, Tuha Lapan and Tuha Peut, may accelerate the speed of recovery. These indigenous institution were also needed in order to revitalize the social capital and adaptation capacity of fishing communities. Mutual trust among stakeholders, which were involved in recovery program of fisheries livelihood, played interesting role in strengthening of social resilience. Moreover, local institutional, such as Panglima Laot and Toke Bangku, should allow and combine with external institutions to facilitate and assist fishing communities to relief their shelf-organized of social resilience.

Those conclusions above shown that the declining of fish resources, the degradation of coastal ecosystem, and the changing of fisheries livelihood capital change were not only caused by the tsunami factor, but also by anthropogenic factor such as using destructive fishing gear. The tsunami has direct caused a decreasing of income, increasing of poverty people, rising of social vulnerability, declining of social resilience within fishing communities. It is naturally that one of the strategies adopted in the recovery process is to restore sustainable livelihood with strengthening social resilience of fishing communities.

8..2. Recommendation

8.2.1. Management factors of fisheries livelihood

There are several lessons learnt from how to cope disaster impact on fishing communities in the future. Economic valuation of ecosystem and resources is needed as baseline data. Other lessons learnt are to measure the vulnerability of fishing or coastal communities; and to mitigate sensitive areas in coastal zone. The most interesting program of fisheries livelihood recovery are to increase capacity and capability of indigenous institution. Instead, this genuine institution, such as Panglima Laot Lhok and Toke Bangku, could

continue to assist the fishing communities for improving and developing their livelihood after post rehabilitation and reconstruction phase.

Therefore, the related stakeholders need to pay attention for managing changing patterns of fisheries livelihood, as follow:

- Building self-inventory system to record tangible and intangible asset of fisheries livelihood by empowerment indigenous institution (i.e.: sea commander and financial trader) and Local Government Unit and collaborative with Marine Affair and Fisheries Office in district level.
- Preparing fisheries resources and mitigation disaster mapping based on community participation to provide information for recovery program by MMAF District level.
- Building community surveillance system to ensure fuel price in solar packet dealer and retailer is fit with government standard price.
- Establishment record data system of fish landing to provide reliable information of fish production by encourage sea commander and financial trader participation.
- Transforming wood boat material based to non-wood boat material base (i.e.: fiberglass) to decrease re-investment cost of asset production.
- Replicating traditional early warning and escape system to reduce a number of human capital affected by disaster through involvement of sea commander and Local Government System
- Strengthening social bounding to reduce stress and shock aftermath disaster by revitalization of social norm and religious value, and synchronize the function of social and religious institution.

8.2.2. Recovery of fish resources depletion and its ecosystem degradation

On a positive note, anchovy depletion can be turned around to avert another anchovy fisheries collapse in the future. To prevent such a bigger “tragedy of the commons” , the Government of Aceh Province (GOAP) needs to prepare “Good Governance of Anchovy Fisheries Management, GGAFM in the future. This concept can accommodated the action plan and implemented them into short run (1-5 years), middle run (5-10 years), and long run (> 25 years). Some action plan can be adopted for GGAFM as follow:

- Within a short run (1-5 years), the GOAP should conduct research on the unit stock to generate new baseline data of anchovy resources, information dissemination for preventing destructive and ecologically un-friendly fishing gear for anchovy catch, and the greater involvement of society in the management of coastal ecosystems for anchovy resources;
- Within a middle run (5-10 years) , the Zoning and Management Plan must be prepared by GOAP to integrate multi-purpose uses of the coastal zone of Krueng Raya Bay for the next 5-10 years;
- Within the long run (> 25 years), the most interesting scenario is to keep anchovy fisheries sustainable by integrating the indigenous institution (Panglima Laot Lhok) and district governments in managing fisheries resources by using social ecological approach and establishing Marine Protected Areas in the long run (25 years).

This recommendation will be useful to further conserve anchovy resources and its ecosystem; thus potentially contributing to an increase in income of fishing communities in Krueng Raya Bay.

8.2.3. Sustainable fisheries livelihood development

The sustainable fisheries livelihood development can be defined as the fishing communities' capabilities, assets and activities required for a means of their living while not undermining the fish resource base and its ecosystem. This approach is needed adoption by GOAP on recovery of fisheries livelihood. DFID formulated many strategies formulated within sustainable livelihood framework. However, according to the result of this research, two main strategies should be suggested, namely, implementation of alternative livelihood development and adoption of social-ecological approach. These strategies must be supported by the second and the tertiary level strategies, such as: (1) provided technical assistance, (2) integrated social, financial, human, physical, and natural capital, (3) engaged women in fisheries livelihood, (4) involved fishing communities in management system, (5) collaborative action, (6) strengthened bonding indigenous and LGU, and (7) increased capacity building of indigenous institution.

GOAP also needs to pay attention some requirements in managing fishing communities post disaster, as follow:

- Identifying income of fishing communities, fish resources, and coastal ecosystem existing before disaster by involvement of indigenous institution and local government unit. These baseline data would be useful on recovery of fisheries livelihood post disaster.
- Delivering fisheries aid to the right beneficiaries properly is main precaution to rebuild and re-finance asset production of fisheries livelihood by using indigenous institution assistance, self-monitoring, and competent authority coordination.
- Integrating local institution and their system value to recover fisheries livelihood by using disaster management based on community participation.
- Incorporating alternative livelihood development and social-ecological approach strategies are key factor on recovery of fisheries livelihood to be sustain by encouraging indigenous institution and women participation engagement; providing technical assistance for related stakeholders; implying collaborative action among stakeholders; and integrating human, physic, social, financial, and natural capital utilization.

8.2.4. Toward the strengthening social resilience of fishing communities

There are inappropriate information and data about how the fishing communities, cope their stress and shock post disaster strike. In the future, it is needed to conduct a research on how the affected community by disaster have coped shock and strengthen social resilience. The Government of Aceh Province (GOAP) needs to identify and inventory social resilience of fishing communities. Social resilience index can be used to evaluate how strong or weak the resilience of fishing communities in facing seasonal change of fisheries livelihood capital.

The further action is needed to implement by GOAP toward the strengthening social resilience of fishing communities, as follow:

- Conducting the training on social vulnerability and resilience based on local resources knowledge for fishing communities. This training objective is to increase capacity and awareness of fishing communities on safety live, hazard impact, and diversification of risk. District government establishes a community disaster management group;

- Providing entrepreneur skill on ecosystem services and non-fisheries resources for alternative livelihood development. These skills are useful to encourage fishing communities in increasing capacity how to cope fish resources degradation and diversifying livelihood by using local resources availability and their experiences;
- Promoting local disaster management system to prevent negative impact of disaster through establishing local body and providing good infrastructure to help people's evacuation or area;
- Revitalizing social bonding and network to maintain and increase fisheries communities' awareness of social capital for coping crisis based on social norm and religious value of local communities.

In the end part of this recommendation, it should be stressed that integrated sustainable livelihood based on community participation and recommendation are a key factor on recovery of fisheries livelihood to achieve self-social resilient of fisheries communities and cope fish resources depletion and ecosystem degradation through the roles of indigenous institution. However; these recommendations need further evaluation because it has an interesting role to get the implication of fisheries development and disaster management strategies toward social resilience in fishing community aftermath the tsunami in Aceh Province. The general conceptual framework toward the strengthening of social resilience in fishing communities may be adopted for those stakeholder who interest in disaster management in the future as can be seen in Figure 26.

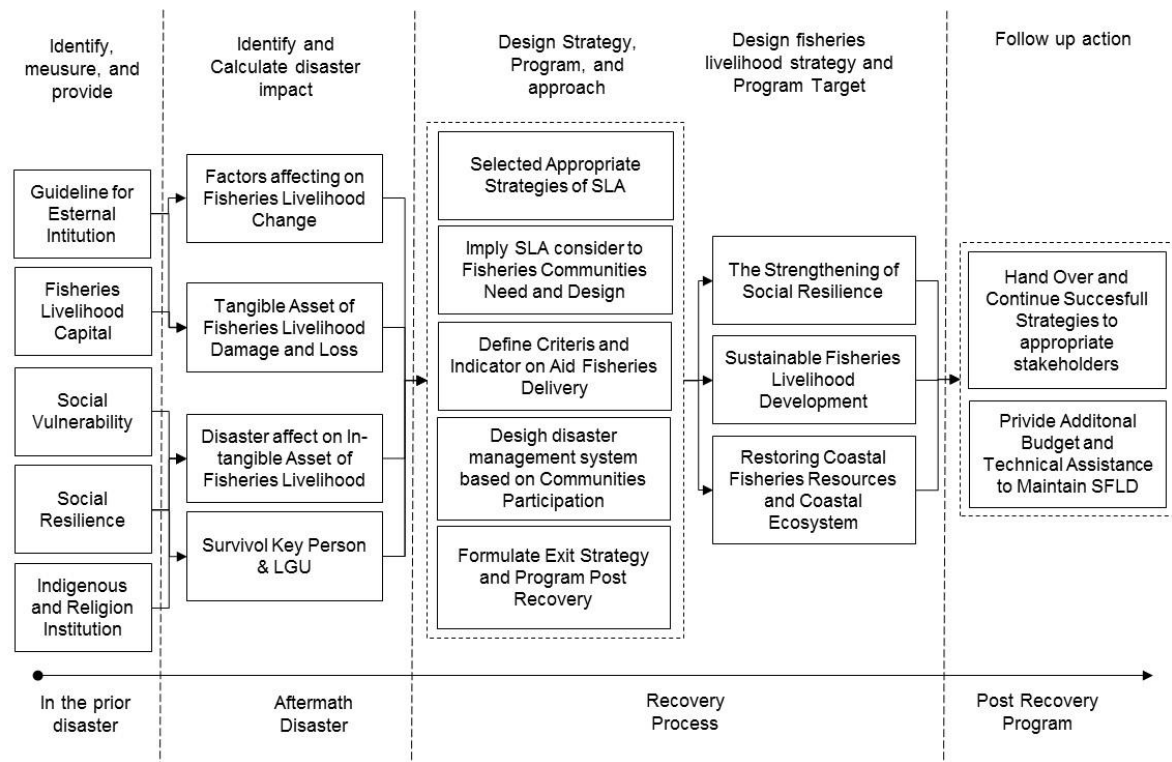


Figure 26. Conceptual framework toward the strengthening of social resilience on recovery of fisheries livelihood

This conceptual framework needs must be further examined whether it is effective and rationale for sustainable livelihood development and disaster management. It is also need to verify the availability of various guideline book on recovery of livelihood post disaster. It also could direct the recovery actors for implementing the program of fisheries livelihood aftermath disaster, in particular in handling the social resilience of fishing communities. It is still very hard for us to predict when natural disaster will be occurred; however, the strengthening social resilience could become an expectation to reduce shock and stress aftermath disaster.

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Appendix

Appendix 1. Semi structure questionnaire

Part 1. Demography Background

1. Name :(cannot write)
2. Gender : ☐ male ☐ female
3. Age :years old
4. Marital Status : ☐ single ☐ married ☐ widow ☐ divorce
5. Major Livelihood :(add any remark)
6. How long have you lived in this community?.....years
7. Where you come from ?
☐ In side Aceh Province ☐ out side Aceh Province
8. What is your race or ethnic identification?
☐ Aceh Pidie ☐ Aceh Utara ☐ Aceh Besar ☐ Melayu ☐ Java ☐ Others, mentioned.....
9. How many adults currently live in your home?.....Persons
10. How many children currently live in your home?
☐ 1 child ☐ 2 children ☐ 3 children ☐ more than 3 children
11. How many of the adults living in your home are older adults (65 years of age or older)?
☐ 1 person ☐ 2 persons ☐ 3 persons ☐ more than 3 persons
12. Is there somebody of your family members disable conditions? ☐ Yes ☐ no

Part 2. Fisheries Livelihood Recovery

1. Other than you, how many people in your household are employed?
☐ 1 person ☐ 2 persons ☐ 3 persons ☐ more than 3 persons ☐ others,.....persons
 (please write down more information in table below)

No.	Name of Family Member	Relation to the Head ¹⁾	Sex ²⁾	Type of Occupation ³⁾	Level of Education ⁴⁾	Condition ⁵⁾	Time to Start ⁶⁾			
							1	2	3	4
1.					2	3				
2.										
3.										

Remark:

1) Fill : 1=head, 2=wife, 3=child, 4=father, 5=mother, 6=others

2) Fill : 1=male, 2=female

3) Fill : 1: a=government official, b=staff of company, c=military, d=owner of company, e=others

2: a=Capture fisheries, b=Aquaculture fisheries, c=fish processing, d=marine culture, e=fish trader, f=CF labour, g=Aq labour, h=FP labour i=MC labour, j=T labour, k=others

4) Fill : 1=healthy; 2=sick; 3 disable

5) Fill : 1=yes, 2=no, 3=partime job

6) Fill : 1=before tsunami, 2=emergency phase, 3=reconstruction phase, 4=present

2. Information about the total of household income

Time	Question				
	Monthly household income (IDR)	Monthly consumption (IDR)	Saving money a month (IDR)	Any debt	Percentages fishery income of total household income
Before Tsunami (2003 or 2004)	<input type="checkbox"/> < 500,000 <input type="checkbox"/> 500,000-1,000,000 <input type="checkbox"/> >1,000,000	<input type="checkbox"/> < 500,000 <input type="checkbox"/> 500,000-1,000,000 <input type="checkbox"/> >1,000,000	<input type="checkbox"/> Yes: a. Bank, b. Coop, c. At home, d. Family, e. Others..... <input type="checkbox"/> No	<input type="checkbox"/> Yes: a. Bank, b. Coop, c. Baitul Qirad, d. Family, e. Toke Bangku, f. Others..... <input type="checkbox"/> No	<input type="checkbox"/> <25%; <input type="checkbox"/> 25-50% <input type="checkbox"/> 51-75%; <input type="checkbox"/> 76-100%
At present (2009-2012)	<input type="checkbox"/> < 500,000 <input type="checkbox"/> 500,000-1,000,000 <input type="checkbox"/> >1,000,000	<input type="checkbox"/> < 500,000 <input type="checkbox"/> 500,000-1,000,000 <input type="checkbox"/> >1,000,000	<input type="checkbox"/> Yes: a. Bank, b. Coop, c. At home, d. Family, e. Others..... <input type="checkbox"/> No	<input type="checkbox"/> Yes: a. Bank, b. Coop, c. Baitul Qirad, d. Family, e. Toke Bangku, f. Others..... <input type="checkbox"/> No	<input type="checkbox"/> <25%; <input type="checkbox"/> 25-50% <input type="checkbox"/> 51-75%; <input type="checkbox"/> 76-100%

3. General information of fishing fleet and gear

Information	Before Tsunami (2003 or 2004)	Reconstruction Phase (2005- 2009)	At present (2009-2012)
Fishing Fleet			
• Type of fishing fleet ¹⁾			
• Status of ownership ²⁾			
• Year of purchase or aid accepted			
• Capital sources ³⁾			
• Technical life (year)			
Number of unit fishing gear			

Remark:

- 1) Fill 1=Lift Net Boat; 2=Beach Seine Boat; 3=Fishing Boat; 4=Boat Without engine
 2) Fill 1=private ownership; 2=group ownership; 3=not ownership (if fill point 3, the question no 3-9 not necessary to answer)
 3) Fill 1=private; 2=formal credit (bank); 3=informal credit; 4= government program; 5=aid program (a. National NGO; b. International NGO; c. Private Sector; d. Others)

4. Fishing activities

a. Please mention the duration of west and east season

Fishing Operation	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
East season												
• Before Tsunami (2003 or 2004)												
• Reconstruction (2005-2012)												
West season												
• Before Tsunami (2003 or 2004)												
• Reconstruction (2005-2012)												

- b. Is there any change of peak, low and off season for fish catch in before and after the tsunami? ☐ Yes ☐ No; if yes, please write down.

Time/fishing season	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Before the tsunami (2003 or 2004)												
• Peak season												
• Low season												
• Off season												
Reconstruction-present (2005-2012)												
• Peak season												
• Low season												
• Off season												

- c. Do you catch fish for whole year? ☐ Yes ☐ No

- d. If your answer “Yes”, how many time do you go for fishing within a month in both west and east season?

Season	Before the tsunami (< 2004)	Reconstruction-present (2005-2012)
East	<input type="checkbox"/> < 10 days <input type="checkbox"/> 10-15 days <input type="checkbox"/> 15-20 days <input type="checkbox"/> 20-26 days <input type="checkbox"/> others, mention.....days	<input type="checkbox"/> < 10 days <input type="checkbox"/> 10-15 days <input type="checkbox"/> 15-20 days <input type="checkbox"/> 20-26 days <input type="checkbox"/> others, mention.....days
West	<input type="checkbox"/> < 10 days <input type="checkbox"/> 10-15 days <input type="checkbox"/> 15-20 days <input type="checkbox"/> 20-26 days <input type="checkbox"/> others, mention.....days	<input type="checkbox"/> < 10 days <input type="checkbox"/> 10-15 days <input type="checkbox"/> 15-20 days <input type="checkbox"/> 20-26 days <input type="checkbox"/> others, mention.....days

- e. If you just do one day fishing trip, how many hour do you do a day? (Please chose your answer regarding the table below)

Season	Before the tsunami (< 2004)	Reconstruction-present (2005-2012)
East	<input type="checkbox"/> < 5 hours <input type="checkbox"/> 5-8 hours <input type="checkbox"/> Others, mention.....hours/day	<input type="checkbox"/> < 5 hours <input type="checkbox"/> 5-8 hours <input type="checkbox"/> Others, mention.....hours/day
West	<input type="checkbox"/> < 5 hours <input type="checkbox"/> 5-8 hours <input type="checkbox"/> Others, mention.....hours/day	<input type="checkbox"/> < 5 hours <input type="checkbox"/> 5-8 hours <input type="checkbox"/> Others, mention.....hours/day

- f. How many kilogram your fish catch in before and after the tsunami? (Please write down in table below)

Time	Fish Production (kg)/Season			
	Minimum		Maximum	
	East	West	East	West
Before the tsunami (2003 or 2004)				
Reconstruction-present (2005-2012)				

- f. How much your gross income do earn for once time fishing in in before and after the tsunami? (Please write down in table below)

Time	Gross Income IDR/fishing			
	Minimum		Maximum	
	East	West	East	West
Before the tsunami (2003 or 2004)				
Reconstruction-present (2005-2012)				

5. Please mention kind of fish species, deal with who and rank

No.	Local Name/Bahasa Name	English Name	Deal with ¹⁾	Grade ²⁾

Remark:

- 1) Fill 1=Fishermen; 2=Fish Trader; 3=Fish collector; 4=others, mentioned.....
- 2) Fill 1=grade A; 2=grade B; 3=grade C

6. Please mention how much do you spend money for operational cost/fishing?

No.	Item	Before Tsunami (2003-2004)	After Tsunami (2005-2010)	Present (2011-2012)
1.	Fuel			
2.	Food			
3.	Water			
4.	Others			

7. How many time per year do you need for fishing boat maintaining? How much do you spent your money for each fishing boat maintaining?

Type of maintaining	Before tsunami (<2004)	Reconstruction-present (2005-2012)
Boat maintaining/doking	.....time/year Cost estimation: IDR.....	.....time/year Cost estimation: IDR.....
Regular maintenance	.....time/year Cost estimation: IDR.....	.....time/year Cost estimation: IDR.....
Fishing gear maintenance	.....time/.....year Cost estimation: IDR.....	.....time/.....year Cost estimation: IDR.....
Change of fishing gear	.....time/.....year Cost estimation: IDR.....	.....time/.....year Cost estimation: IDR.....
Engine maintenance	.....time/year Cost estimation: IDR.....	.....time/year Cost estimation: IDR.....
Change of engine	.....time/.....year Cost estimation: IDR.....	.....time/.....year Cost estimation: IDR.....

8. Have you ever change your livelihood or work in before and after the tsunami?

☐ Yes ☐ No; if your answer “Yes”, what kind of livelihood or work?

Type of livelihood or work	Before tsunami (<2004)	Reconstruction-present (2005-2012)
Work within fisheries ¹⁾		
Other work		

9. Sources and ownership of others economic capital

Type of capital	Before Tsunami (<2004)		Reconstruction-Present (2005- 2012)	
	Sources ¹⁾	Ownership ²⁾	Sources ¹⁾	Ownership ²⁾
Farm Land				
Land				
House				
TV				
Parabola				
DVD				
Refrigerator				
Motor Cycle				
Car				
Bicycle				
Cell Phone				
Gold				
Others				

Remark:

1) Fill : 1=personal purchase; 2=legacy; 3=government grant; 4=Aid of Donor Agency; 5=family charity; 6=private donation; 6=others

2) Fill : 1=personal; 2=shared; 3=rental; 4=private; 5=government; 6=foundation; 7=customary

10. What problem do you face in fisheries livelihood recovery aftermath tsunami?

Mention three of them based on priority.

Problems	Priority scale				
Low of fish catch	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Illegal fishing	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Rigid rule of fish catch	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Boat quality	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Over capacity of boat	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
High investment	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Skill for fishing gear operation	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Low law enforcement	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Sea pollutant	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Lack of fisheries infrastructure	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Lack of financial support	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Conflict among fishermen	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Mangrove degradation	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Coral reef ecosystem degradation	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Beach damage	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1

Fill : 1=Strongly disagree; 2=disagree; 3=neither disagree nor agree; 4=agree; 5=strongly agree

11. How do you assess the recovery of social, economic, financial, infrastructure, and natural resources/ecology after the tsunami?

Type of Recovery	Phase ¹⁾			Duration Time ²⁾
	Emergency Phase (Jan-April 2005)	Reconstruction Phase (2005-2009)	At present (2009-2012)	
Social Capital				
• Personal life (psychist, ect)				
• Family life				
• Social life				
• Sea commander				
• Four Member (Tuha Peut)				
• Eighth Member (Tuha Lapan)				
• Local Government Unit				
Economic Capital				
• Formal micro finance				
• Finance trader				
• Fisheries livelihood				
Infrastructure				
• Public infrastructure				
• Fish market				
• Religious facilities				
• Education facilities				
• Health facilities				
Natural Resources/Ecology				
• Fish resources				
• Mangrove ecosystem				
• Coral reef ecosystem				
• Estuary				
• Beach				

Remark :

1) Fill : 1=less than before disaster (a. 75-100% b. 50-75 c. 25-50% d. <25%); 2=equal before disaster (100%) 3=more than before disaster (>100%)

2) Fill : 1=<2 years; 2=2-5 years; 3=5-10 years; 4=>10 years

12. Which is/are interesting capital to ensure fisheries livelihood sustainability in the future?

- ☐ Social capital
 ☐ Economic capital
 ☐ Human capital
 ☐ Infrastructure capital
 ☐ Natural capital
- ☐ Integration of social and economic capital
- ☐ Integration social, economic and human capital
- ☐ Integration of social, economic, human and infrastructure
- ☐ Integration of social, economic, human and infrastructure and natural capital

12. What is your opinion about fisheries livelihood recovery? Please response your opinion base on the following statement

Statement

Response

• Fishermen involve on fisheries livelihood recovery during planning, implementing, and monitoring phase	1	2	3	4	5
• Fishermen/fish processor/trader can relief their livelihood by themself					
• Recovery of fisheries livelihood has been done by external aid and instution	1	2	3	4	5
• Panglima laot Lhok has a significant role on fisheries recovery	1	2	3	4	5
• Financial trader has contribution on facilitate operational cost and market chain on fisheries livelihood recovery	1	2	3	4	5
• Tuha Peut and Tuha Lapan has function to connect fishermen and to Panglima Laot Lhok on recovery of fisheries livelihood	1	2	3	4	5
• Collaborative action is needed on recovery of fisheries livelihood	1	2	3	4	5
• Among indigineous institution and local government has strong bounding on recovery of fisheries livelihood	1	2	3	4	5
• Fisheries livelihood recovery was needed capacity building of indigenous institution	1	2	3	4	5
• Fishermen/fish processor/trader was needed technical assistance on recovery of fisheries livelihood	1	2	3	4	5
• Depedency of donor aid for fisheries livelihood recovery can reduce through self financial and self organizer	1	2	3	4	5
• Mutual trust and bounding among fishing society were key factor on recovery of fisheries livelihood	1	2	3	4	5

Fill : 1=Strongly disagree; 2=disagree; 3=neither disagree nor agree; 4=agree; 5=strongly agree

Part 3. Social Capital Assesment

1. To assess level of trust to non organizer of social capital (family, neighbor, friend, and colleque). How frequence to contact non organizer social capital

Name of non organisation	Frequency of Contack Before Tsunami (<2004)			Frequency of Contack After Tsunami (Jan 2005-Sept 2012)		
	Week ¹⁾	Month ²⁾	Year ³⁾	Week ¹⁾	Month ²⁾	Year ³⁾
.1.						
• Family						
• Neighbor						
• Friend						
• Colleague						

1) Fill : 0=no contact; 1=one time a week; 2=two time a week; 3=three time a week; 4=more than three time a week

2) Fill : 0=no contact; 1=one time a month; 2=two time a month; 3=three time a month; 4=more than three time a month

3) Fill : 0=no contact; 1=one time a year; 2=two time a year; 3=three time a year 4=more than three time a year

2. To assess level of trust to voluntary organizations

Are you as a member in following organizations ? ☐ Yes ☐ No (if yes, please complete table bellow)

Name of organization	Frequency of Contack Before Tsunami (<2004)			Frequency of Contack After Tsunami (2005-2012)		
	Week ¹⁾	Month ²⁾	Year ³⁾	Week ¹⁾	Month ²⁾	Year ³⁾
• Sea Commander (Panglima Laot Laot)						
• Financial Trader (Toke Bangku)						
• Fish Processing Association						
• Religious Organization in Village Level						
• Religious Organization in Region Level						
• Cooperative						
• Cultural Association						
• Youth Group						
• Trade Association						
• Sport Group						
• Recital Association (Dahlail)						

Remark:

- 1) Fill : 0=no contact; 1=one time a week; 2=two time a week; 3=three time a week; 4=more than three time a week
 2) Fill : 0=no contact; 1=one time a month; 2=two time a month; 3=three time a month; 4=more than three time a month
 3) Fill : 0=no contact; 1=one time a year; 2=two time a year; 3=three time a year 4=more than three time a year

3. Do you know how many percent the member active in following organization ?

☐ Yes ☐ No (if yes, please complete the table bellow)

Name of organization	% of member, participated ¹⁾	Name of organization	% of member, participated
Sea Commander (Panglima Laot Laot)			
Financial Trader (Toke Bangku)			
Fish Processing Association			
Religious Organization in Village Level			
Religious Organization in Region Level			
Cooperative			
Cultural Association			
Trade Association			
Recital Association (Dahlail)			

Remark:

Fill: 1=0-20%, 2=20-40%, 3=40-60%, 4=60-80%, 5=80-100%

4. Standard of generalized trust

Generally speaking, do you believe that most people can be trusted or can't you be too careful in dealing with people ?

Statement	Before Tsunami (<2004)	After Tsunami (Jan 2005-Sept 2012)
Most people can be trusted	<input type="checkbox"/> Not at all <input type="checkbox"/> Low <input type="checkbox"/>	<input type="checkbox"/> Not at all <input type="checkbox"/> Low <input type="checkbox"/>
	<input type="checkbox"/> Fair <input type="checkbox"/> High <input type="checkbox"/> Very high	<input type="checkbox"/> Fair <input type="checkbox"/> High <input type="checkbox"/> Very high
You can't be too careful	<input type="checkbox"/> Not at all <input type="checkbox"/> Low <input type="checkbox"/>	<input type="checkbox"/> Not at all <input type="checkbox"/> Low <input type="checkbox"/>
	<input type="checkbox"/> Fair <input type="checkbox"/> High <input type="checkbox"/> Very high	<input type="checkbox"/> Fair <input type="checkbox"/> High <input type="checkbox"/> Very high

5. Trust in institutions

How much confidence do you have in the following institution?

No.	Institution	Before Tsunami (<2004)					After Tsunami (2005-Sept 2012)				
		1	2	3	4	5	1	2	3	4	5
1.	Fisheries Office in District Level										
2.	Local Government Unit										
3.	Tuha Lapan (Eighth Members)										
4.	Tuha Peut (Four Member)										
5.	Legal System										
6.	The Police										
7.	Sea Commander (Panglima Laot Laot)										
8.	Financial Trader (Toke Bangku)										
9.	Fish Processing Association										
10.	Religious Organization in Village Level										
12.	Cooperative										

Response

1= A great; 2= Quite a lot; 3=Not very much deal; 4= None at all; 5= Hard to answer

6. Loan question

Do you think that in the fishing society generally trust each other in matters of lending and borrowing ?

☐ Do trust ☐ Do not trust ☐ Don't know/not sure ☐ No answer

7. Networks

Suppose your neighbor suffered an economic loss, say (harvest failure, shoulder season, low season, job loss). In that situation, who do you think would assist your financially? (Record first three mentioned)

Answer	Option	Answer	Option
No one would help		Family court judge	
Family		Patron/employer/benefactor	
Neighbors		Political leader	
Friends		Mutual support group to which s/he belongs	
Religious leader or group		Assistance group to which s/he belongs	
Community leader		Other.....	
Business leader		Don't know/not sure	
Police		No answer	

8. People here look out mainly for the welfare of their own families and they are not much concerned with village/neighborhood welfare. Do you agree or disagree with this statement?

☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree ☐ Don't know/not sure

9. Please tell me whether in general you agree or disagree with the following statements.

Statement	Response				
Most people in this village/neighborhood are basically honest and can be trusted	1	2	3	4	5
People are always interested only in their own welfare	1	2	3	4	5
Members in this village/neighborhood are always more trustworthy than others	1	2	3	4	5
In this neighborhood one has to be alert or someone is likely to take advantage of you	1	2	3	4	5
If I have a problem there is always someone to help you	1	2	3	4	5
I do not pay attention to the opinions of others in the village/neighborhood	1	2	3	4	5
Most people in this village/neighborhood are willing to help if you need it	1	2	3	4	5
This village/neighborhood has prospered in the last five years	1	2	3	4	5
I feel accepted as a member of this village/neighborhood	1	2	3	4	5
If you drop your wallet in the neighborhood, someone will see it and return it to you	1	2	3	4	5

Fill : 1=Strongly disagree; 2=disagree; 3=neither disagree nor agree; 4=agree; 5=strongly agree

10. What do you opinion about institution on the following statement of aftermath tsunami?

Institution	Has a role on delivery of aid for fishermen	Engaged on emergency action	Has changed function	Give Assistance for fishermen	Can cope and adapt the condition
Sea commander	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know
Financial trader	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know
Tuha Peut	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know
Tuha Lapan	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know
Local Government Unit	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know
Nation NGO	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know
International NGO	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know
District Government	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know
Province Government	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know
Center Government	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know

Part 4. Ecological Capital and Society Knowledge

1. Do you know the ecosystem coral reef, mangrove and sea grass, and estuary ?

☐ Yes ☐ No ☐ don't know

2. Do you know what is general coastal problem ?

Coastal ecosystem problem	Answer
Mangrove, coral reef, sea grass, and estuary destroyed before tsunami	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Fish resources had decreased both before and after tsunami	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Sea pollution has occurred both before and after tsunami	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Coastal zone conversion for various use decreased the function of ecosystem	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Mangrove destroyed because of conversion, fuel and building material	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Coral reef ecosystem destroyed because of by using destructive fishing gear	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
House hold, industry, and harbour sewage has polluted sea water	<input type="checkbox"/> Yes <input type="checkbox"/> no <input type="checkbox"/> don't know

3. Do you know what is the function of coral reef ecosystem?

Coral reef function	Answer
Coral reef are important to protect coastal villages from disaster	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Coral reef has function for nursery ground	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Coral reef has function for spawning ground	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Coral reef has function for feeding ground	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Coral reef has function for protection of fish resources	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Coral reef has function for nutrient supply	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Protection of coral reef will ensure fish resources in the future	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know

4. Do you know what is the function of mangrove ecosystem?

Mangrove ecosystem function	Answer
Mangrove is important to protect beach from disaster	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Mangrove has function for nursery ground	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Mangrove has function for spawning ground	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Mangrove has function for feeding ground	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Mangrove has function for protection of fish resources	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Mangrove has function for nutrient supply	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Protection of mangrove will ensure fish resources in the future	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know

5. Do you know what is the function of sea grass ecosystem?

Sea grass ecosystem function	Answer
Sea grass is important to protect beach from disaster	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Sea grass has function for nursery ground	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Sea grass has function for spawning ground	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Sea grass has function for feeding ground	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Sea grass has function for protection of fish resources	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Sea grass has function for nutrient supply	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Protection of sea grass will ensure fish resources in the future	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know

6. Do you know what factor cause a decrease of harvesting fish ?

Factor of decreasing fish harvesting	Answer
Over harvesting of fish by fishermen	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Mangrove ecosystem damage	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Coral reef ecosystem damage	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Sea grass ecosystem damage	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Using destructive fishing gear	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Sea water pollutant	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Illegal fishing	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Increasing of fishing fleet	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know
Disaster	<input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know

7. How do you assess the condition of the following ecosystem before and after tsunami ?

Ecosystem	Condition before tsunami					Condition after Tsunami				
	Heavy damage	Damage	Mode-rate	Good	Very Good	Heavy damage	Damage	Mode-rate	Good	Very Good
Beach										
Estuary										
River										
Coral reef										
Mangrove										
Sea grass										

8. Who will take most responsibility on recovery of the ecosystem?

- ☐ Fishing society
 ☐ Sea commander
 ☐ Local government unit
 ☐ Fisheries Office
 ☐ NGO
 ☐ Fishermen
☐ Legal Office
 ☐ The Police
 ☐ Private Sector
 ☐ Other,.....

9. What is your opinion about social ecological system will ensure the sustainability of fish resources?

- ☐ Strongly agree
 ☐ Agree
 ☐ Disagree
 ☐ Strongly disagree
 ☐ Don't know/not sure
 ☐ No answer

Part 5. Fishing Communities Resilience

1. The following statement are possible description of your society after disaster.
Please circle one response for each statement.

Statement

Response

People in my society feel like they belong to the society	1	2	3	4	5
People in my society are committed to the well being of the society	1	2	3	4	5
People in my society have hope about the future	1	2	3	4	5
People in my society help each other	1	2	3	4	5
My society has effective leaders	1	2	3	4	5
My society work with organization & agencies outside the society	1	2	3	4	5
People in my society communicate with leaders who can help improve the society	1	2	3	4	5
People in my society work together to improve the society	1	2	3	4	5
My society looks at its successes and failure so it can learn from the past	1	2	3	4	5
My society tries to prevent disaster	1	2	3	4	5
My society actively prepare for future disaster	1	2	3	4	5
If a disaster occur, my society provides information about what to do	1	2	3	4	5
People in my society trust public official	1	2	3	4	5
People in my society trust informal leaders or institution	1	2	3	4	5

Remark:

Fill : 1=Strongly disagree; 2=disagree; 3=neither disagree nor agree; 4=agree; 5=strongly agree

2. The following statements are possible descriptions of you and your relationship to your community (Optinal Items). Please circle one response for each statement

Statement

Response

I live in good housing	1	2	3	4	5
I can get the services I need.	1	2	3	4	5
I work with people in my society to solve our problems.	1	2	3	4	5
My family and I have a disaster plan.	1	2	3	4	5
I have friends in my society.	1	2	3	4	5
I would get involved in trying to improve my society.	1	2	3	4	5
I would like to become a leader in my society.	1	2	3	4	5
Good housing is available for people who live in my society.	1	2	3	4	5
Necessary health care services are available to people in my society.	1	2	3	4	5
People in my society have friendships with their neighbors.	1	2	3	4	5
Leadership opportunities are available to people who live in my society.	1	2	3	4	5

Remark: Fill : 1=Strongly disagree; 2=disagree; 3=neither disagree nor agree; 4=agree; 5=strongly agree

3. What do you response the following statement about institution engagement on livelihood recovery after disaster

Statement

Response

PLL laot has role and involment on recovery of capture fisheries livelihood.	1	2	3	4	5
Toke Bangku has role on recovery of capture fisheries livelihood.	1	2	3	4	5
Processing Association has role on recovery of fisheries livelihood.	1	2	3	4	5
Local Goverment Unit has role on recovery of fisheries livelihood.	1	2	3	4	5
Tuha Peut has role and involment on recovery of capture fisheries livelihood.	1	2	3	4	5
Tuha Lapan has role and involment on recovery of capture fisheries livelihood.	1	2	3	4	5
External Institution has role and involment on recovery of fisheries livelihood.	1	2	3	4	5
Religious Institution has role and involment on recovery of fisheries livelihood.	1	2	3	4	5

Remark: Fill : 1=Strongly disagree; 2=disagree; 3=neither disagree nor agree; 4=agree; 5=strongly agree

Part 6. Strategy on recovery of fisheries livelihood

1. Which strategies do you recommend on recovery of fisheries livelihood?

Optional strategies	Score				
Fishing communities involve in planning, implementing, and monitoring phase (S1)	1	2	3	4	5
Collaborative action (S2)	1	2	3	4	5
Strengthening bonding of indigineous institution and local government unit (S3)	1	2	3	4	5
Increasing capacity building of indigenou (S4)	1	2	3	4	5
Provided technical assistance for fisheries communities (S5)	1	2	3	4	5
Integrated social, finance, human, physical and nature capital building (S6)	1	2	3	4	5
Implementation of social ecological system approach (S7)	1	2	3	4	5
Women empowerment on micro enterprise (S8)	1	2	3	4	5
Alternative livelihood development (S9)	1	2	3	4	5

Fill : 1=Very low; 2=low; 3=moderate; 4=high; 5=very high

Appendix 2. Open structure questionnaire

Questions for Key Informant Interviews and Society Conversations

(Head of Village, Panglima Laot Lhok, Toke Bangku, Tuha Peut, Tuha Lapan, Fish Processing Association, Sub District and Others)

Part 1. General Questions on Society Resilience

1. How long have you lived in this society?.....years
2. We are interested in fishing society. What comes to mind when you think of a fishing society?
3. What about your fishing society?
4. How long your fishing society have been established in this region?
5. Society resilience is the capacity to foster, engage in, and sustain positive relationship and to endure and recover from life stressor and social isolation. Do you agree or disagree for this definition ?
6. Society resilience is important factor on recovery livelihood after disaster hit in fishing society. Do agree or disagree for this statement.
7. If society resilience strong in your fishing society, it would be fast on recovery of their livelihood. Do you agree or disagree.

Part 2. Questions on Connection and Caring

1. What factors contribute to the long term connectedness and caring of a fishing society? Why/how are these factors important?
2. Is there establish of the same value in your fishing society on connectedness and care one each others?
 - What are the dominant values in your fishing society on connectness and caring one each others?
 - Do members of your fishing society share similar values with each other?
 - Is there member of fishing society disagreement about important values on connectedness and caring? If so, which values? What evidence is there of disagreement?
 - What effort should be done to bring member of fishing society to understand about connectedness and caring?
 - How does sharing of values contribute to the long term connectedness and caring of a fishing society?
3. We are interested in your thoughts about connectedness in your fishing society.
 - Tell me about how fishing society members are connected with the fishing society. Please share a few examples of connectedness.
 - Are there members or groups within the fishing society who may feel left out?

- What could be done to help them to feel more connected?
- 4. Are members of your fishing society committed to the well-being of the fishing society?
 - How is this commitment expressed?
 - Are there individuals or groups who do not feel a commitment to the fishing society? Do you know why?
 - What could be done to increase their feeling of commitment?
 - How does commitment to the well-being of a fishing society contribute to the long term health and vitality of the society?
- 8. Do members of your fishing society have hope about the future?
 - If so, what is the source of this hope?
 - What is the fishing society hope due to your opinion?
 - If not, why are fishing society members not hopeful about the future?
 - What evidence is there of hopefulness or lack thereof?
 - Would the type of disaster (earthquake and tsunami) affect hope?
 - The fishing society want to recover their livelihood an equal condition on before tsunami. Do you agree or disagree?
 - The fishing society want to recover their livelihood are better than before tsunami. Do you agree or disagree?
- 5. Let us move on to participation. Are there opportunities for children and families to learn about and participate in disaster readiness, response, and recovery?
 - Describe their participation.
 - How do they find out about opportunities to participate?
 - Are there members or groups who do not participate? Do you know why?
 - Is it possible to engage them? How?
- 9. Does your fishing society help people in need?

Concern to help due to leader request.

- Are fishing society members' concerns being heard by their leaders? Why or why not?
- If not, what could be done to get the attention of leaders?
- Are the concerns of fishing society members being addressed by leaders? Why or why not?
- If not, how might leaders be encouraged to address these concerns?
- What evidence is there to support your impressions?

Helping after disaster

- Is there help for people during and after a disaster? Are there individuals or groups who do not receive help? What evidence is there to support your impressions?
- What could/should be done to increase assistance to these individuals or groups?

Treatment people after disaster

- Does your fishing society treat people fairly?
- What evidence is there to support your impressions?
- If people are not treated fairly, what are the consequences of a lack of fairness?
What, if anything, could/should be done to encourage the fair treatment of everyone?
- Does fair treatment affect people's sense of society? How?

Part 3. Questions on Resources

1. Let us talk about resources. These could be natural resources (fish, mangrove, coral reef), physical infrastructure (fish landing, fish market, ice plant, access road), equipment (fishing fleet, fishing gear), the workforce and leadership, and productive social connections.
 - Does your fishing society have natural resources? If yes, what kind of natural resources? Please mention various natural resources!
 - Does your fishing society have social resources? If yes, what kind of social resources? Please mention various social resources!
 - Does your fishing society have physical resources? If yes, what kind of physical resources? Please mention various physical resources!
 - Does your fishing society have financial resources? If yes, what kind of financial resources? Please mention various financial resources!
 - Does your fishing society have human resources? If yes, what kind of human resources? Please mention various human resources!
2. Do you think resources in your fishing society are adequate for disaster readiness, response, and recovery?
 - How well could your fishing society's resources withstand the stress of a disaster without loss of function?
3. What resources would improve the ability of your fishing society to address disaster readiness, response, and recovery?
 - How could your fishing society develop these resources?
 - Would your fishing society support any of these measures to develop resources?
 - What could be done to get your fishing society to support these measures?
4. Are roles and responsibilities for disaster management clearly defined in your fishing society?
 - Please share some examples.
 - To what extent is there overlap and/or redundancy in roles and responsibilities? Is this helpful or problematic?
 - What, if anything, could/should be done to clarify roles and responsibilities for disaster management?
5. Does your fishing society have effective leaders?
 - Do members recognize that they have powerful leadership in fishing society?
 - If so, what evidence is there to support your impressions?

6. Are members of your fishing society able to get the services they need? Please give some examples.
 - What services are lacking?
 - Are there individuals or groups who are unable to get services that are generally available to others in your fishing society? Who are these individuals or groups? Why are they unable to get these services? What could/should be done to change this situation?
 - Are there individuals or groups who are unable to get services that they really need which are not generally available in your fishing society? Who are these individuals or groups? What unavailable services do they need? What could/should be done to change this situation?
7. Are disaster response and recovery services available in your fishing society?
 - Are they available to all members of your fishing society?
 - If not, what individuals or groups are not served? Why? What could/should be done to ensure that these individuals receive services?
 - Are there deficiencies in your society's disaster response and recovery services? If so, what are they?
 - How could your fishing society improve response and recovery services given your fishing society's resources?
8. Communication is a major issue in addressing disasters. Do members of your fishing society communicate effectively with each other?
 - How do members of your fishing society communicate with respect to disasters?
 - Is this communication effective?
 - How could this communication be improved?

Part 4. Questions on Transformative Potential

1. Does your fishing society collect information about its history, status, and/or progress?
 - What kind of information?
 - How is this information gathered?
 - Who has access to this information?
 - How is this information used?
 - What kind of information should be collected? What should you do to encourage the collection of information?
2. Does your fishing society have or collect information that would improve its ability to adapt to and learn from crises?
 - If so, what type of information?
 - How is this information collected?
 - Who has access to this information?
 - How is this information used?

- What type of information should be collected? Why is this information not collected? What could/should be done to encourage the collection of such information?
3. What have you learned from the past fishing society crises that might help you to respond to and recover from future crises?
 - Have others in your fishing society also learned from these crises?
 - How can this knowledge be communicated to others in the fishing society so that there is widespread benefit?
 4. How does your fishing society establish goals and priorities for facing crises after disaster?
 - Who generally makes the final decisions on facing crises after disaster? Who else is involved in the decision making?
 - Are you encouraged to participate on coping of crises situation?
 - Are individuals or groups left out of the process on coping of crises? If so, who?
 - Do you know why individuals or groups are not participating on coping of crises?
 - Does your fishing society want specific individuals or groups to be involved in establishing goals and priorities on coping of crises ?
 - If so, who? What could your society involve these individuals or groups on coping of crises?
 5. Are members of your fishing society aware of fishing society issues they might address together?
 - If not, what should be done to increase awareness of fishing society issues?
 - Do fishing society members come together to address fishing society issues?
 - If not, what should be done to bring them together?
 - If yes, who is and is not involved, how do they convene, and what issues do they address?
 - If fishing society members come together to address fishing society issues, are they generally successful? How do you determine success? Why are or are they not successful?
 - What benefits arise from the process itself (whether or not a specific issue is resolved)? That is, what benefits arise from fishing society members coming together to address fishing society issues?
 6. Are there opportunities for fishing society members to participate in problem solving with respect to fishing society issues?
 - What are some of these opportunities?
 - Who actually participates?
 - Are individuals or groups left out of fishing society problem solving?
 - Should these individuals or groups be encouraged to participate in fishing society problem solving?
 - If so, what could be done to involve them?
 7. Describe opportunities that exist to help fishermen to develop skills that would improve crisis response in your fishing society.

- Are individuals or groups excluded from these opportunities?
- If so, why?
- What should be done to include these individuals or groups?

Part 5. Question on Recovery of Fisheries Livelihood (Use FGD Method)

A lot of help came from various donor agencies for fisheries livelihoods recovery. We want to know how the process the group of beneficiaries defining, the distribution of aid, and the management of aid.

1. Is the group designing on the basis of ownership of boats and fishermen who worked on the boat before the disaster? If no, how to define the group of beneficiaries?
2. Is there criteria to be designed for the group of beneficiaries who can get the aid from donor agency? If yes, what kind of criteria?
3. How the mechanism of aid delivery to the group of beneficiaries?
4. Is relate indigenous institution (i.e. Panglima Laot Lhok, Toke Bangku, Fish Processing Association etc.) involve on delivery of aid?
5. How the group of beneficiaries to manage of aid?
6. Is group or individual the status of ownership of aid (for example fishing fleet) ?
 - If the group as ownership of the fishing fleet, how long the status was retaining?
 - If the status of ownership to be changed to individual ownership, how the mechanism establish among the member of group?
 - Is there any transaction among the member of group on transferring the status of ownership? If yes, what kind of transaction?
7. Is there any conflict among the member of group when transferring of group to individual ownership?

Part 6. Questions on Public Engagement

1. As you know, we are interested in public involvement in building fishing society resilience to disasters. What roles are appropriate for the general population? If it is helpful, think about volunteer roles associated with disaster prevention, preparedness, response, and recovery.
2. What types of activities are appropriate for each role?
3. What kind of preparation is needed to enable fishing society members to perform the identified roles/activities?
 - What kind of experience do fishermen need to perform these roles/activities?
 - What kind of training do fishermen need to perform these roles/activities?
4. Are there barriers that interfere with involving the public in building fishing society resilience? Again, if it is helpful, think in terms of disaster prevention, preparedness, response, and recovery.

- What are the barriers? Focus on barriers that limit our ability to get society members involved.
5. In general, how can we engage fishing society members in building fishing society resilience to disasters? Focus on what we can do to get society members engaged.
 - What should be the goals with respect to building society resilience to disasters?
 - Which of these goals are of the highest priority?
 - What strategies can be used to engage fishing society members (or members of a specific group) in reaching each specific goal?
 - What resources will be needed?
 6. We have talked about roles and activities that might be appropriate for the general public in building fishing society resilience to disasters. We have discussed preparation for, and some barriers to, their involvement and ways to engage them. Now as a final step, let us consider strategies that the general public can use to build fishing society resilience to disasters. These will probably be related to the roles and activities we have already identified.
 - What strategies can be used to build fishing society resilience to disasters?
 - What are the barriers to the implementation of these strategies by the general public?
 - What resources will be needed for each strategy?
 - Do we need to do anything specific to engage fishing society members in these activities? That is, do we need to do anything in addition to general strategies for engaging fishing society members? Please share some examples.

Appendix 3. Respondents and Key Informants

1. Fishermen



Appendix 3. Continue.....

2. Financial Trader

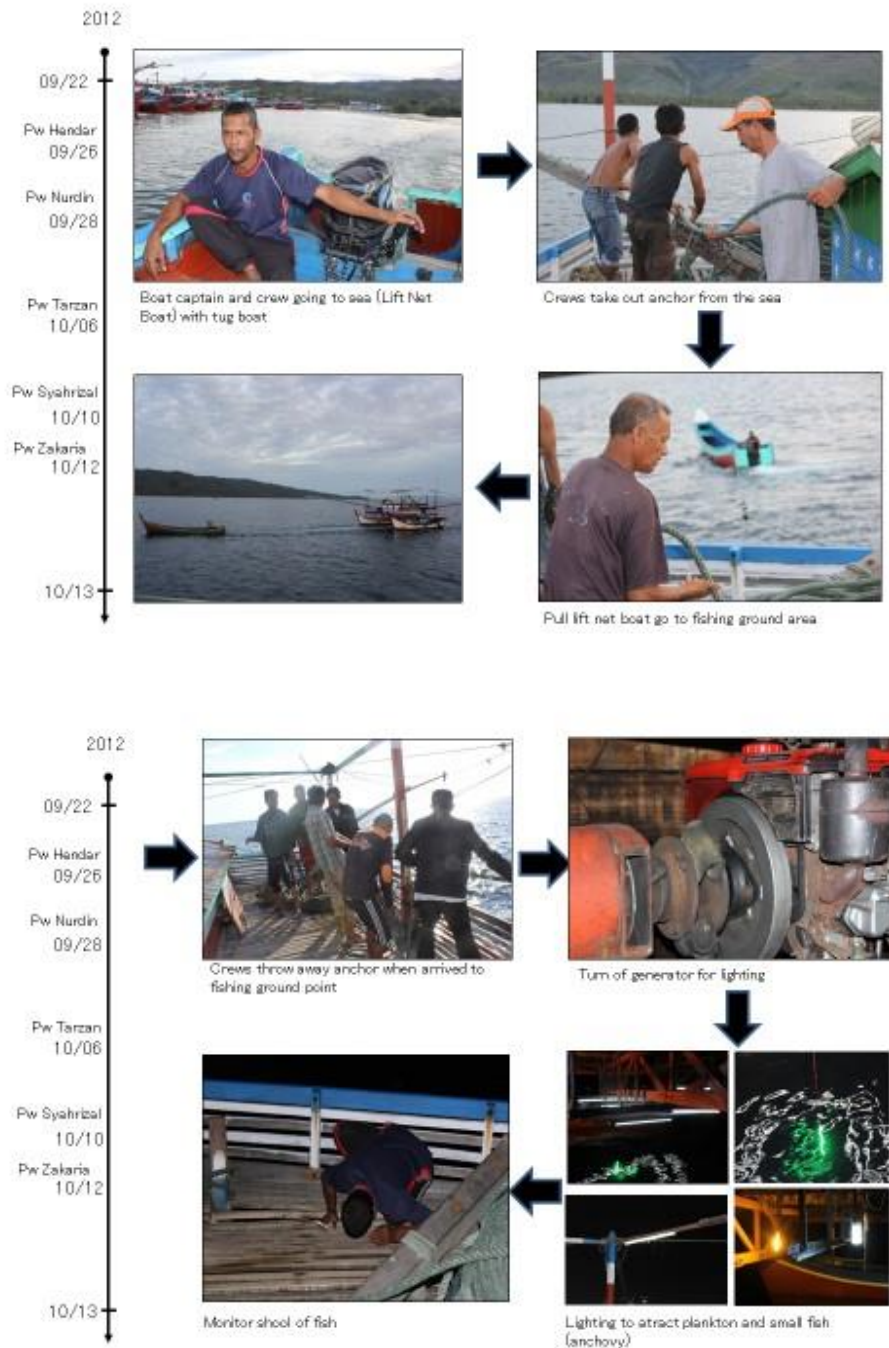


3. Key Informants



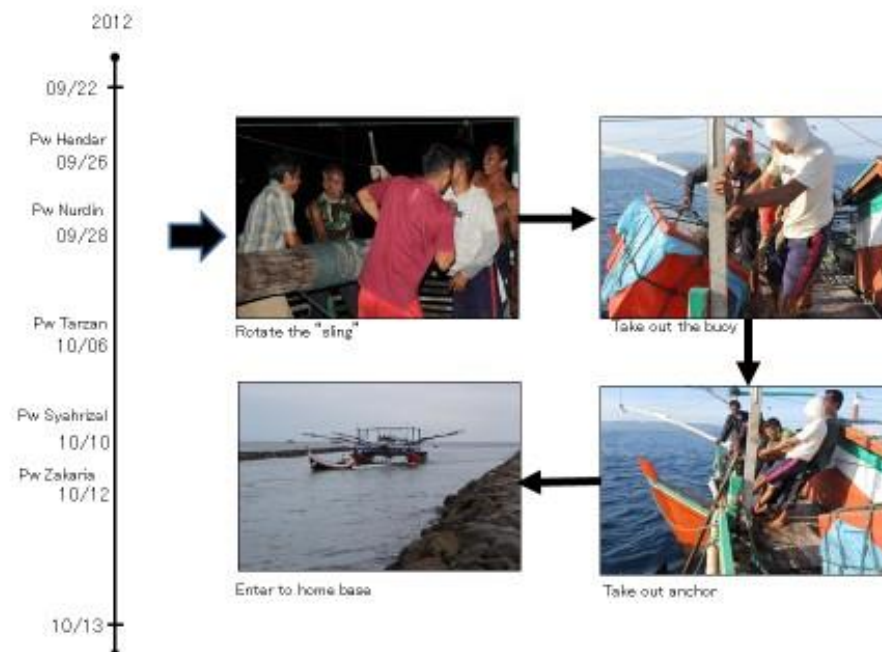
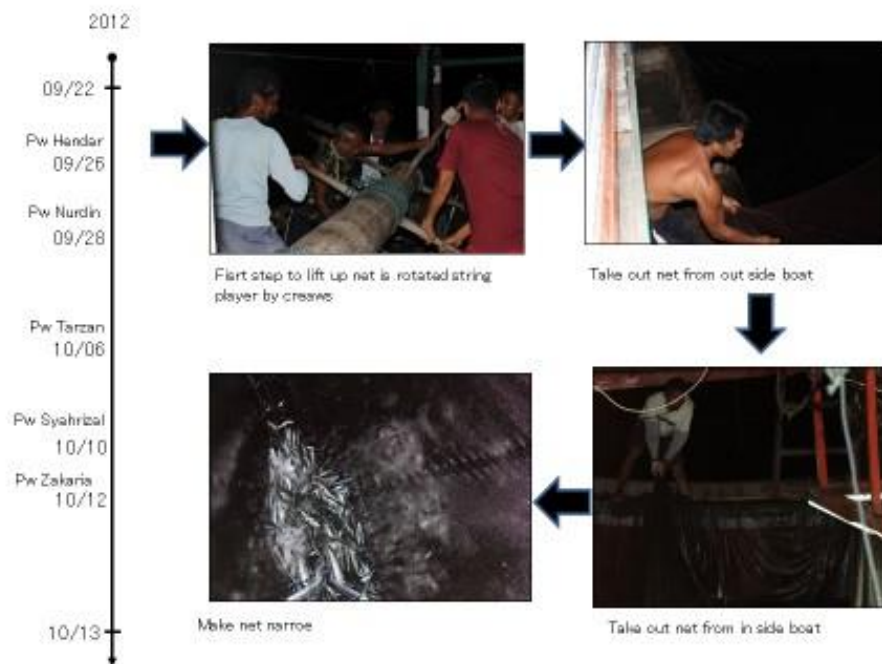
Appendix 4. Lift net boat operation and sampling

1. Lift Net Boat Operation



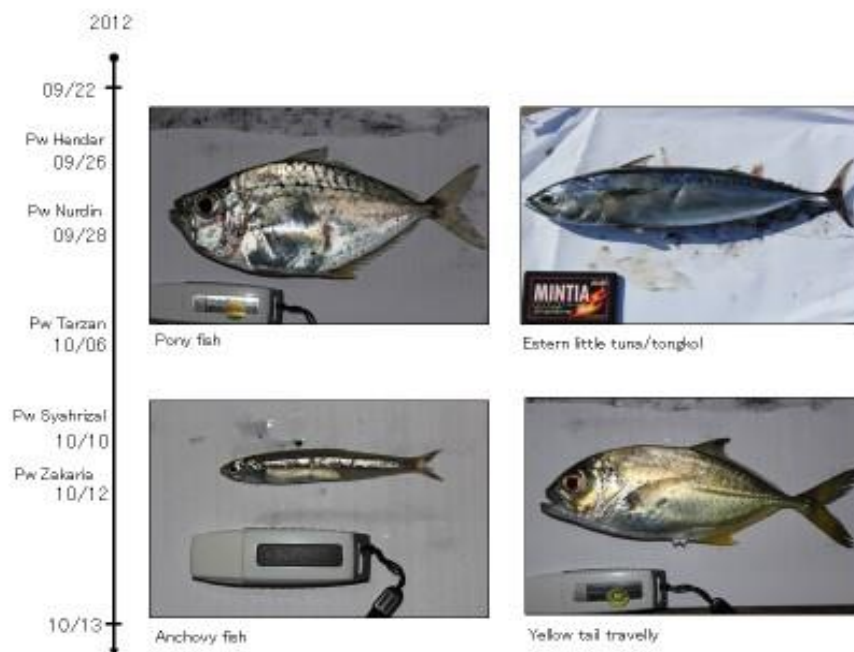
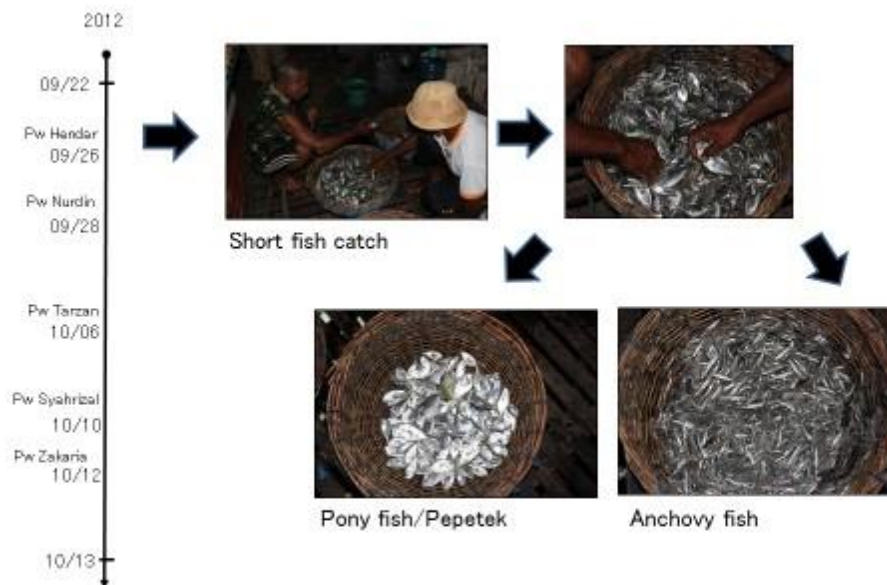
Appendix 4. Continue

Lift Net Boat Operation

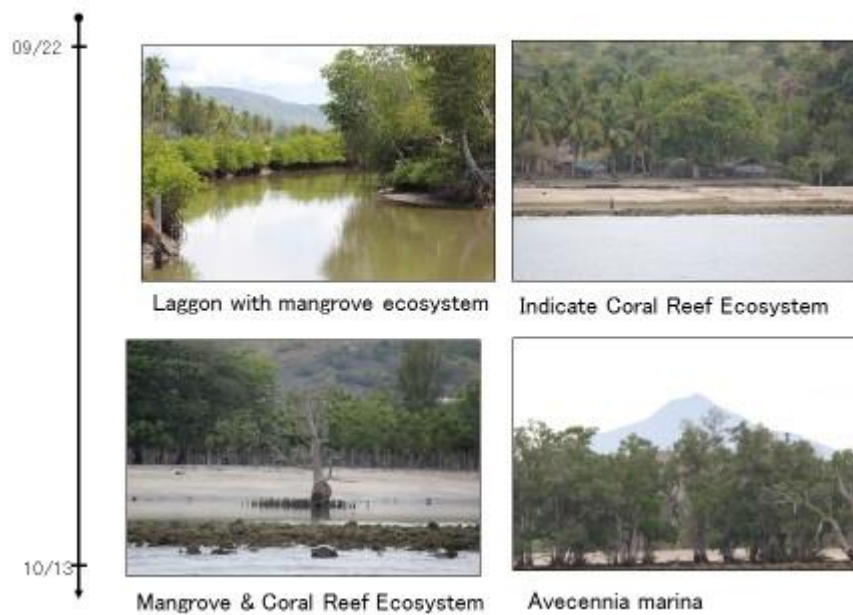


Appendix 4. Continue...

2. Sampling



Appendix 5. Ecosystem sampling and observation



Appendix 6. Marine capture fisheries production and a number of fishing boat (1999-2012) in Aceh Province and Aceh Besar District

Year	Production (Ton)		Growth (%)		Number of Boat (Unit)		Growth (%)	
	Aceh Besar	Aceh Province	Aceh Besar	Aceh Province	Aceh Besar	Aceh Province	Aceh Besar	Aceh Province
1989	8,808	82,676	-	-	1,304	14,584	-	-
1990	8,873	83,197	0.74	0.63	523	14,095	(59.89)	(3.35)
1991	8,919	86,602	0.51	4.09	599	13,704	14.53	(2.77)
1992	9,003	87,507	0.95	1.04	659	16,516	10.02	20.52
1993	9,147	89,468	1.60	2.24	609	16,994	(7.59)	2.89
1994	8,976	90,533	(1.88)	1.19	553	18,025	(9.20)	6.07
1995	8,988	99,627	0.13	10.04	520	17,723	(5.97)	(1.68)
1996	9,174	100,112	2.07	0.49	586	17,303	12.69	(2.37)
1997	9,430	110,927	2.79	10.80	603	13,687	2.90	(20.90)
1998	11,210	120,558	18.88	8.68	615	13,179	1.99	(3.71)
1999	10,619	111,686	(5.27)	(7.36)	633	14,581	2.93	10.64
2000	10,700	107,659	0.76	(3.61)	636	11,908	0.47	(18.33)
2001	11,577	102,842	8.19	(4.47)	822	11,288	29.25	(5.21)
2002	11,760	90,966	1.58	(11.55)	895	10,768	8.88	(4.61)
2003	11,239	134,077	(4.43)	47.39	1,109	16,070	23.91	49.24
2004	11,724	102,555	4.32	(23.51)	1,109	15,576	-	(3.07)
2005	4,059	81,163	(65.38)	(20.86)	241	15,703	(78.27)	0.82
2006	5,605	124,963	38.10	53.97	311	16,308	29.05	3.85
2007	6,986	127,640	24.62	2.14	447	16,656	43.73	2.13
2008	5,057	130,271	(27.60)	2.06	530	17,584	18.57	5.57
2009	5,159	140,408	2.01	7.78	584	16,519	10.19	(6.06)
2010	5,585	142,697	8.27	1.63	584	16,519	-	-
2011	6,999	145,834	25.32	2.20	584	15,995	-	(3.17)
Average Growth								
- Before Tsunami (1989-1998)			2.87	4.36			(4.50)	(0.59)
- Before Tsunami (1999-2004)			0.86	(0.52)			10.91	4.78
- After Tsunami (2005)			(65.38)	(20.86)			(78.27)	0.82
- Post Tsunami (2006-2011)			11.78	11.63			16.92	0.39

Sources: Aceh Province of Marine Affair and Fisheries (1990-2012)

Appendix 7. The volume and value of anchovy production in Aceh Besar District and Aceh Province during 2001-2010

Year	Aceh Besar		Aceh Province	
	Production (ton)	Prod. Value (IDR)	Production (ton)	Prod. Value (IDR)
2001	2788.4	12,156,750,000.00	7062.9	33,751,440,000.00
2002	912.7	3,262,400,000.00	3929.8	16,645,329,000.00
2003	1161.9	5,677,900,000.00	6918.5	29,748,725,000.00
2004	787	4,077,600,000.00	5516.7	28,130,610,000.00
2005	285	1,589,700,000.00	2355	16,449,888,000.00
2006	403	2,248,463,400.00	4139	25,880,625,900.00
2007	348	3,161,130,000.00	4445.4	34,150,282,300.00
2008	231	1,885,510,000.00	4223.2	27,480,738,700.00
2009	189	1,886,000,000.00	2342.2	24,304,600,000.00
2010	196	1,958,421,000.00	2396	24,593,530,400.00

Source: Aceh Province of Marine Affair and Fisheries (2011)

Appendix 8. The length and weight of anchovy interval data

Interval	Frequency	Composition (%)
Length		
68.0-72.0	29	15.43
72.1-76.1	21	11.17
76.2-80.2	12	6.38
80.3-84.3	23	12.23
84.4-88.4	44	23.40
88.5-92.5	27	14.36
92.6-96.6	21	11.17
96.7-100.7	11	5.85
	188	100
Weight		
5.20-5.60	23	12.23
5.61-6.01	17	9.04
6.02-6.42	11	5.85
6.43-6.83	26	13.83
6.84-7.24	41	21.81
7.25-7.65	33	17.55
7.66-8.06	25	13.30
8.07-8.47	12	6.38
	188	100

Sources: Field Survey (2012)

Appendix 9. The volume and value of anchovy production in Krueng Raya Bay

Year	Production (Ton/year)	% Growth	Value (USD)	Value (million USD)	% Growth
1999	1,905.6		1,073,303.0	1.1	
2000	1,855.5	(2.63)	754,181.1	0.8	-29.7
2001	1,833.1	(1.21)	766,287.7	0.8	1.6
2002	1,743.3	(4.90)	693,354.8	0.7	-9.5
2003	1,053.5	(39.57)	604,176.8	0.6	-12.9
2004	1,024.2	(2.78)	589,148.0	0.6	-2.5
2005	166.9	(83.70)	91,543.6	0.1	-84.5
2006	272.1	63.00	165,234.4	0.2	80.5
2007	182.3	(33.00)	175,006.2	0.2	5.9
2008	156.8	(14.00)	104,537.3	0.1	-40.3
2009	129.8	(17.20)	136,873.7	0.1	30.9
2010	136.3	4.97	150,882.4	0.2	10.2
2011	129.9	(4.70)	188,696.7	0.2	25.1
2012	126.6	(2.54)	202,933.7	0.2	7.5

Sources: Aceh Province of Marine Affair and Fisheries (2000-2012)

Appendix 10. Fish catch during field survey in Krueng Raya Bay

Date	Number of Vessel	Trip (unit)	Catch (Kg)	Fish Composition					Total (Kg)
				Anchovy	Sardine	Pony Fish	Mackarel	Travally	
15/09/12	26	26	650	300	100	125	125	0	650
16/09/12	26	26	675	375	175	125	0	0	675
17/09/12	27	27	700	400	175	125	0	0	700
18/09/12	27	27	725	425	175	125	0	0	725
19/09/12	28	28	750	375	275	0	100	0	750
20/09/12	28	28	725	425	100	75	125	0	725
21/09/12	Holiday								
22/09/12	28	28	750	400	200	0	150	0	750
23/09/12	28	28	725	325	150	100	0	150	725
24/09/12	22	22	750	350	250	150	0	0	750
25/09/12	21	21	450	325	75	50	0	0	450
26/09/12	21	21	375	300	25	50	0	0	375
27/09/12	20	20	450	275	100	75	0	0	450
28/09/12	Holiday								
29/09/12	9	9	250	100	150	0	0	0	250
30/09/12	9	9	375	250	125	0	0	0	375
01/10/12	9	9	275	225	25	25	0	0	275
02/10/12	7	7	250	150	50	50	0	0	250
03/10/12	20	20	500	350	100	50	0	0	500
04/10/12	16	16	400	300	50	50	0	0	400
05/10/12	Holiday								
06/10/12	29	29	750	200	300	200	50	0	750
07/10/12	29	29	775	225	150	100	0	300	775
08/10/12	26	26	625	275	225	125	0	0	625
09/10/12	28	28	750	325	275	150	0	0	750
10/10/12	29	29	750	350	150	100	0	150	750
11/10/12	28	28	725	325	150	100	0	150	725
12/10/12	Holiday								
13/10/12	29	29	800	425	150	100	0	125	800
Total	29	29	14950	7775	3700	2050	550	875	14950
Average	23	23	598	311	148	82	22	35	598
Minimal	7	7	250	100	25	0	0	0	250
Maximal	29	29	800	425	300	200	150	300	800
Percentage				52.01	24.75	13.71	3.68	5.85	
Rank				1	2	3	5	4	

Sources: Field Survey (2012)

Appendix 11. The length and weight of anchovy data measurement

Date of Sampling	Fish No	L (mm)	W (g)	Log L	Log W
26/09/201	1	70	5.6	1.845098	0.748188
	2	73	5.8	1.863323	0.763428
	3	71	5.7	1.851258	0.755875
	4	72	5.8	1.857332	0.763428
	5	85	6.6	1.929419	0.819544
	6	95	7.7	1.977724	0.886491
	7	87	6.8	1.939519	0.832509
	8	77	6.1	1.886491	0.78533
	9	74	5.9	1.869232	0.770852
	10	69	5.4	1.838849	0.732394
	11	88	6.8	1.944483	0.832509
	12	78	6.2	1.892095	0.792392
	13	97	8	1.986772	0.90309
	14	94	7.6	1.973128	0.880814
	15	81	6.2	1.908485	0.792392
	16	91	7.3	1.959041	0.863323
	17	92	7.4	1.963788	0.869232
	18	72	5.7	1.857332	0.755875
	19	71	5.7	1.851258	0.755875
	20	82	6.3	1.913814	0.799341
	21	93	7.5	1.968483	0.875061
	22	83	6.4	1.919078	0.80618
	23	88	7.1	1.944483	0.851258
	24	87	7	1.939519	0.845098
	25	83	6.4	1.919078	0.80618
	26	92	7.4	1.963788	0.869232
	27	82	6.3	1.913814	0.799341
	28	81	6.2	1.908485	0.792392
	29	76	6	1.880814	0.778151
	30	75	5.9	1.875061	0.770852
	31	77	6.1	1.886491	0.78533
	32	92	7.4	1.963788	0.869232
	33	99	8.1	1.995635	0.908485
	34	82	6.3	1.913814	0.799341
	35	88	7.1	1.944483	0.851258
	36	87	7.1	1.939519	0.851258
	37	89	7.3	1.94939	0.863323

Appendix 11. Continue...

Date of Sampling	Fish No	L (mm)	W (g)	Log L	Log W
28/09/2012	1	88	6.8	1.944483	0.832509
	2	99	8.1	1.995635	0.908485
	3	82	6.3	1.913814	0.799341
	4	94	7.6	1.973128	0.880814
	5	95	7.8	1.977724	0.892095
	6	91	7.3	1.959041	0.863323
	7	92	7.4	1.963788	0.869232
	8	72	5.7	1.857332	0.755875
	9	71	5.7	1.851258	0.755875
	10	70	5.6	1.845098	0.748188
	11	73	5.8	1.863323	0.763428
	12	71	5.7	1.851258	0.755875
	13	72	5.8	1.857332	0.763428
	14	85	6.6	1.929419	0.819544
	15	95	7.7	1.977724	0.886491
	16	87	6.8	1.939519	0.832509
	17	77	6.1	1.886491	0.78533
	18	74	5.9	1.869232	0.770852
	19	69	5.4	1.838849	0.732394
	20	89	7.2	1.94939	0.857332
	21	88	7.1	1.944483	0.851258
	22	98	8	1.991226	0.90309
	23	71	5.7	1.851258	0.755875
	24	87	7	1.939519	0.845098
	25	76	6	1.880814	0.778151
	26	69	5.3	1.838849	0.724276
	27	78	6.2	1.892095	0.792392
	28	72	5.6	1.857332	0.748188
	29	91	7.1	1.959041	0.851258
	30	94	7.5	1.973128	0.875061
	31	87	7	1.939519	0.845098
	32	88	7.1	1.944483	0.851258
	33	99	8.1	1.995635	0.908485
	34	92	7.4	1.963788	0.869232
	35	93	7.3	1.968483	0.863323
	36	85	6.4	1.929419	0.80618
	37	92	7.4	1.963788	0.869232
	38	99	8.1	1.995635	0.908485
	39	82	6.3	1.913814	0.799341
	40	88	7.1	1.944483	0.851258
	41	87	7.1	1.939519	0.851258
	42	77	6.2	1.886491	0.792392
	43	90	7.2	1.954243	0.857332

Appendix 11. Continue...

Date of Sampling	Fish No	L (mm)	W (g)	Log L	Log W
7/10/2012	1	87	6.9	1.939519	0.838849
	2	77	6.2	1.886491	0.792392
	3	74	5.9	1.869232	0.770852
	4	69	5.5	1.838849	0.740363
	5	88	6.8	1.944483	0.832509
	6	94	7.6	1.973128	0.880814
	7	92	7.5	1.963788	0.875061
	8	83	6.4	1.919078	0.80618
	9	95	7.7	1.977724	0.886491
	10	74	5.9	1.869232	0.770852
	11	69	5.4	1.838849	0.732394
	12	89	7.2	1.94939	0.857332
	13	88	7.1	1.944483	0.851258
	14	98	8.1	1.991226	0.908485
	15	71	5.7	1.851258	0.755875
	16	89	7.3	1.94939	0.863323
	17	87	7.1	1.939519	0.851258
	18	83	6.4	1.919078	0.80618
	19	92	7.4	1.963788	0.869232
	20	82	6.3	1.913814	0.799341
	21	81	6.2	1.908485	0.792392
	22	76	6.3	1.880814	0.799341
	23	87	7.1	1.939519	0.851258
	24	86	7.2	1.934498	0.857332
	25	99	8.1	1.995635	0.908485
	26	92	7.3	1.963788	0.863323
	27	93	7.3	1.968483	0.863323
	28	85	6.3	1.929419	0.799341
	29	88	7.1	1.944483	0.851258
	30	87	7.1	1.939519	0.851258
	31	75	5.9	1.875061	0.770852
	32	77	6.1	1.886491	0.78533

Appendix 11. Continue...

Date of Sampling	Fish No	L (mm)	W (g)	Log L	Log W
10/10/2012	1	73	5.6	1.863323	0.748188
	2	69	5.5	1.838849	0.740363
	3	87	6.8	1.939519	0.832509
	4	88	7.1	1.944483	0.851258
	5	85	6.6	1.929419	0.819544
	6	92	7.4	1.963788	0.869232
	7	92	7.3	1.963788	0.863323
	8	71	5.7	1.851258	0.755875
	9	82	6.3	1.913814	0.799341
	10	95	7.8	1.977724	0.892095
	11	93	7.5	1.968483	0.875061
	12	92	7.4	1.963788	0.869232
	13	91	7.3	1.959041	0.863323
	14	88	6.8	1.944483	0.832509
	15	75	6	1.875061	0.778151
	16	78	6.3	1.892095	0.799341
	17	94	7.6	1.973128	0.880814
	18	82	6.4	1.913814	0.80618
	19	94	7.6	1.973128	0.880814
	20	84	6.4	1.924279	0.80618
	21	69	5.4	1.838849	0.732394
	22	78	6.3	1.892095	0.799341
	23	87	7	1.939519	0.845098
	24	90	7.1	1.954243	0.851258
	25	70	5.3	1.845098	0.724276
	26	77	6.1	1.886491	0.78533
	27	73	5.6	1.863323	0.748188
	28	98	8.2	1.991226	0.913814
	29	88	7.1	1.944483	0.851258
	30	86	6.6	1.934498	0.819544
	31	95	7.8	1.977724	0.892095
	32	86	6.8	1.934498	0.832509
	33	72	5.6	1.857332	0.748188
	34	83	6.3	1.919078	0.799341
	35	94	7.5	1.973128	0.875061
	36	85	6.6	1.929419	0.819544

Appendix 11. Continue...

Date of Sampling	Fish No	L (mm)	W (g)	Log L	Log W
11/10/2012	1	72	5.8	1.857332	0.763428
	2	70	5.5	1.845098	0.740363
	3	75	6	1.875061	0.778151
	4	99	8.2	1.995635	0.913814
	5	82	6.3	1.913814	0.799341
	6	88	7.1	1.944483	0.851258
	7	93	7.6	1.968483	0.880814
	8	86	7.3	1.934498	0.863323
	9	94	7.7	1.973128	0.886491
	10	92	7.5	1.963788	0.875061
	11	82	6.3	1.913814	0.799341
	12	70	5.7	1.845098	0.755875
	13	87	6.8	1.939519	0.832509
	14	83	6.5	1.919078	0.812913
	15	99	8.3	1.995635	0.919078
	16	91	7.3	1.959041	0.863323
	17	95	7.6	1.977724	0.880814
	18	92	7.3	1.963788	0.863323
	19	83	6.5	1.919078	0.812913
	20	82	6.4	1.913814	0.80618
	21	68	5.3	1.832509	0.724276
	22	76	6.1	1.880814	0.78533
	23	92	7.4	1.963788	0.869232
	24	69	5.5	1.838849	0.740363
	25	74	5.8	1.869232	0.763428
	26	69	5.5	1.838849	0.740363
	27	92	7.5	1.963788	0.875061
	28	93	7.6	1.968483	0.880814
	29	85	6.3	1.929419	0.799341
	30	74	5.9	1.869232	0.770852
	31	81	6.2	1.908485	0.792392
	32	92	7.3	1.963788	0.863323
	33	75	5.8	1.875061	0.763428
	34	85	6.3	1.929419	0.799341
	35	88	7.1	1.944483	0.851258
	36	87	7.1	1.939519	0.851258
	37	76	6	1.880814	0.778151
	38	75	5.9	1.875061	0.770852
	39	87	6.9	1.939519	0.838849
	40	77	6.2	1.886491	0.792392

Sources: Field Survey (2012)