

**Community-based Shrimp Aquaculture
in Northwestern Sri Lanka**

by

Eranga Kokila Galappaththi

A Thesis Submitted to the Faculty of Graduate Studies of
The University of Manitoba
in Partial Fulfillment of the Requirements for the Degree of

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FACULTY OF GRADUATE STUDIES**

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Abstract

This thesis investigates small-scale community-based shrimp aquaculture (CBSA) in northwestern Sri Lanka. The objectives are to explore: (1) community-based shrimp aquaculture; (2) commons institutions and application of commons rules; and (3) policy implications (i.e., as an alternative to large-scale operations in ensuring sustainability). Data were gathered from three communities in northwestern Sri Lanka, through participant observations; semi-structured interviews; focus group discussions; and key informant interviews.

Presence of small-scale community-based institutions is evident. Arguably, commons in this context are social-ecological systems, including the interconnected natural water body. Main characteristics of the existing resource governance system are multi-level commons institutional structure; zonal crop calendar system; collaborative/participatory management approach; and better management practices. A SWOT (strengths, weaknesses, opportunities, threats) analysis proves the viability of existing CBSA. This thesis recognizes CBSA as an alternative approach to large-scale aquaculture operations to ensure sustainability in the long run.

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Acronyms

- BMP:** Better Management Practices
- BOBLME:** Bay of Bengal Large Marine Ecosystem
- CFC:** Ceylon Fisheries Corporation
- CFHC:** Ceylon Fishery Harbor Corporation
- DFAR:** Department of Fisheries and Aquatic Resources
- EJF:** Environmental Justice Foundation
- FAO:** Food and Agriculture Organization
- IASC:** The International Association for the Study of the Commons
- IISD:** International Institute of Sustainable Development
- MBV:** *Monodon Baculo Virus*
- M&E:** Monitoring and Extension
- MFAR:** Ministry of Fisheries and Aquatic Resources
- MFARD:** Ministry Of Fisheries and Aquatic Resources Development
- NAQDA:** National Aquaculture Development Authority
- NARA:** National Aquatic Resources Research and Development Agency
- NIFNE:** National Institute Of Fisheries and Nautical Engineering
- NSF:** National Science Foundation
- PCR:** Polymerize Chain Reaction
- PL:** Postlarvae
- SEMBV:** Systemic Ectodermal and Mesodermal Baculo Virus
- SLADA:** Sri Lanka Aquaculture Development Association
- SWOT analysis:** Strength, Weaknesses, Opportunities, and Threats analysis
- UNEP:** United Nations Environment Program
- WCED:** World Commission on Environment and Development
- WSS:** White Spot Syndrome
- YHV:** Yellow Head Virus

Glossary

Samithiya: In local language, *samithiya* refers to a cooperative, association, or society. This is a collective group of people working towards achieving the same goal(s). The plural term is *Samithi*.

Crop calendar: A system of assigning specific shrimp culturing periods of the year among shrimp farming communities.

Zonal system: A system of geographically demarcated boundaries designed by considering natural shrimp disease-spreading patterns. This system divides the northwestern shrimp farming area into five zones and 32 subzones.

Better management practices: A set of operational guidelines/practices introduced to shrimp farmers to minimize the risk of shrimp diseases and to increase the shrimp harvest. These guidelines are formulated by shrimp aquaculture experts.

Common water system: A system of interconnected water bodies available in the northwestern area. Three lagoons, rivers, and a natural canal system are interconnected by a man-made large canal called the “Dutch Canal”.

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CHAPTER 1: INTRODUCTION



Plate 1.1: *Maha* river, southern coastal border of the northwestern area



Plate1.2: Shrimp harvesting using drag-nets

1.1 Introduction

This chapter will focus on describing the study context, followed by the study purpose and objectives; the research methods; country and sector profiles; history and overview of the shrimp industry; theoretical background and significance of the study; and the thesis plan and outline.

Based on the history and development of the shrimp aquaculture sector in Sri Lanka, the impacts (social, economical, and ecological) of commercial large-scale shrimp aquaculture are comparatively higher than small-scale shrimp aquaculture (Dahdouh-Guebas et al., 2002; Munasinghe et al., 2010). Despite lucrative profit margins (Galappaththi, 2010), large-scale aquaculture often is a threat to the sustainability of the sector as well as the social-ecological systems (Huitric et al., 2002). Collapse of unsustainable large-scale aquaculture systems led to the emergence of a large number of small-scale shrimp aquaculture operations. There is a significant contribution from the small-scale shrimp producers to the country's total shrimp production (Galappaththi, 2010; MFARD, 2011).

Collective management and/or community-based management could be an alternative approach (or part of an alternative approach) in ensuring long-term sustainability. In Sri Lanka, there is evidence of the existence of collective groups called *Samithi*, translated as cooperatives/societies. For example, there are community associations in the communities of *Muthupanthiya*, *Wairankattuwa*, and *Pinkattiya* in northwestern Sri Lanka. These associations take decisions on stocking time period, selling process, feed buying process, etc. (Tennakoon, 2009).

Community-based management has the potential to address major issues related to the tragedy of the commons, such as excludability and subtractability (Berkes, 2009; Berkes et al., 2001; Feeny et al., 1990; Feeny et al., 1996; Ostrom et al., 1999). The Sri Lankan

Government recognizes and supports community-based organizations such as *Samithi*, which are important for co-management for the fishery and aquatic sector (Ten-year development policy framework of the fisheries and aquatic resources sector: 2007–2016). Moreover, fisheries and aquatic resources Act number two of 1996 supports the bottom-up development approach of managing the sector.

Therefore, it is worthwhile to investigate collective management and/or community-based management as an alternative approach. So far, published studies on community-based management in small-scale shrimp aquaculture in Sri Lanka seem to not be available.

1.2 Purpose and objectives

The purpose of this study is to understand how shrimp aquaculture can be carried out by community-based institutions as an alternative approach to large-scale commercial aquaculture operations, to ensure the sustainability of the industry. This does not mean that large-scale shrimp production operations could be totally replaced by the community-based institutions, but rather the latter is a potential approach to building sustainability in the future. It should be noted that the small-scale farmers who form the bottom layer of the cultured shrimp supply chain in Sri Lanka (Galappaththi, 2010) also make a significant contribution towards the total shrimp production. It is worthwhile to explore the potential of community-based aquaculture as an alternative management model and propose it as a model for ensuring sustainability in the future.

The specific objectives of the study are:

1. To understand the operation of community-based shrimp aquaculture in northwestern Sri Lanka.

Under this objective, existence of community-based shrimp aquaculture in the study area is confirmed. Background information on individual shrimp farmers (their profiles) and any affiliations to community-based organizations are documented. The basic shrimp operation system is described, including shrimp grow-out ponds, special requirements needed, inputs used, and seasons of production. Moreover, presence of integrated

production (e.g., shrimp and vegetable production) is investigated. The physical characteristics of the system are documented, such as where water comes from and where it goes; drainage and/or disposal of waste food in the pond, etc. In addition, basic economics of the system, such as where inputs are purchased from, costs incurred, where the yield is sold, etc. are explored. Data are qualitatively analyzed and findings are presented using narratives and descriptive statistics.

2. To explore any commons institutions in the aquaculture system and how small-scale aquaculture operations can be connected through commons rules into community operations, as well as how these fit into an overall governance system. This objective investigates the system at two levels: collective aspects of aquaculture operations (*samithiya*=association) and the government institutions level (including co-management/participatory management). To investigate how each level works as part of a commons governance system, the scope of decisions made by each level is identified. In particular, rules relating to subtractability and excludability (Ostrom et al., 1999) are analyzed. The scope (horizontal spread), scale of operation, influential power, level of establishment/evolution (number of years since incorporation, presence of procedures/processes, organizational structure, etc.) are studied. In addition, the nature of member-cooperative relationships, such as information sharing and compliance are studied. Relationship diagrams, tables, and matrices are used in this analysis.

3. To explore the policy implications of community-based shrimp aquaculture as an alternative approach to large-scale commercial operations to improve sustainability.

Objective Three deals with a variety of policy-related matters. The ultimate goal of this objective is to document if the community-based aquaculture is viable (or not). There is no assumption that large-scale shrimp production could be totally replaced by community-based operations; rather the thesis explores a potential approach for building sustainability for the future. Strengths, weaknesses, opportunities, and threats related to the practices were identified through a SWOT analysis. This captures the desired policy

direction of the sector/country. Application of community-based shrimp aquaculture as an alternative approach to large-scale operations is explored.

1.3 Methods

The research paradigm applicable to this study was largely participatory, as the research attempted to understand collaborative empowerment issues of the shrimp farming sector in Sri Lanka. Since this research is also centered on real world problems, it also showed characteristics of a pragmatic paradigm to a certain extent. The research design was qualitative, as much of the work was related to exploration and understanding of the contextual background. In order to obtain an understanding of the context, the case study approach was adopted as the research strategy.

The major source of data for this study was primary data and the data from the writer's previous research. Primary data collection methods included participant observations and semi-directive interviews. Moreover, focus group discussions and key informant interviews were conducted to explore the common institutions as well as to validate the data gathered through participant observations and semi-directive interviews. In addition, basic statistics collected by the ministry and line authorities became a secondary data source. The primary data collection took place during April–August 2012 in the northwestern area of Sri Lanka.

Considering the nature of the shrimp aquaculture sector in Sri Lanka, the sampling method used was the non-probabilistic snowball sampling. Sample size was determined based on a thorough analysis of the population involved in the sector. Data related to the first objective was qualitatively analyzed and was supplemented by descriptive statistics (e.g., percentages, frequencies) and graphical representations. The second objective was accomplished through an analysis of institutional mapping and a matrix. Analyses of strengths, weaknesses, opportunities, and threats (SWOT analysis) were conducted to fulfill the third objective.

1.4 Background: Sri Lanka and shrimp aquaculture

Sri Lanka is a tropical country consisting of various climatic and topographical conditions within a relatively small land area. Sri Lanka is also considered to be a global biodiversity hot spot with many plant and animal species which are recognized as being distinct at high taxonomic levels (Bocxlae et al., 2009). Table 1.1 shows the socio-economic profile of Sri Lanka. The country is an island with a land area of 65,610 km² including an inland water area of 2,905 km². The coastal belt around the country is 1,340 km long. It has a population of 21 million. The population is comprised of 74% Sinhalese, 18% Tamils, 7% Muslims, and 1% other ethnic groups. As of 2010, Sri Lanka's unemployment rate was 5.8% and the literacy rate of the population over 15 years old is 91.3%. The GDP at market prices in 2010 was 49.55 billion in local currency.

Table 1.1: Profile of Sri Lanka (Source: Anon, 2010)

Description	Statistics (2010)
Land area (including inland water area)	65,610 km ²
Inland water area	2,905 km ²
Coastal belt	1,340 km
Population	21 million
Ethnic composition	Sinhalese: 74%; Tamils: 18%; Muslims: 7%; Others: 1%
Unemployment rate	5.8%
Literacy rate (15 years and older)	91.3%
GDP at market prices (in Sri Lankan rupees)	49.55 billion

In terms of production volume and technology, the Sri Lankan aquaculture sector is still in an infant stage compared to other Asian countries (Anon, 2007; MFARD, 2011). The Sri Lankan aquaculture sector is composed of coastal shrimp aquaculture, inland fishery, and ornamental fish culturing (Anon, 2007). Among these, the most dominant aquaculture operation is coastal shrimp aquaculture (Anon, 2007). The most common shrimp species cultured is the black tiger shrimp (*Penaeus monodon*). In addition, small-scale projects have recently started to cultivate freshwater giant shrimp (*Macrobrachium rosenbergii*) and white-leg shrimp (*Penaeus vannamei*) in eastern areas of the country (MFARD, 2011).

Table 1.2: Sector profile at a glance (Sources: Anon, 2007*; Jayasinghe, 1998**; MFAR, 2009)

Description	Statistics (2009)
Total aquaculture sector production	339,730 tons
Total shrimp production	16,684 tons
Total aquaculture shrimp production	3,550 tons
Sector contribution to GDP	1.7%
Annual export earnings	US \$183 million
Employment in sector (direct and indirect)*	1.05 million
Land area-shrimp farming**	5000 ha

Table 1.2 provides the shrimp sector profile at a glance. Accordingly, the total aquaculture sector production in 2009 was 339,730 tons, including a total shrimp production of 16,684 tons. Out of this, 3,550 tons were cultured shrimps. The sector's contribution to the country's GDP is 1.7%, with annual export earnings of US \$183 million. A little over one million people (1.05) are directly or indirectly employed in this sector. In total about 5,000 ha are shrimp farming lands.

1.5 Natural shrimp life cycle and aquaculture

To complete the natural life cycle of black tiger shrimp (Figure 1.1), both the coastal sea environment and lagoon/estuary environment are required. This is because the shrimp need water with varying levels of salinity in different stages of their life cycle. Their life begins in the coastal sea water and the initial stages (i.e., egg, Nauplius, Protozoa, and Mysis) are spent at the sea. A low saline lagoon or estuary environment is required for the next stage (i.e., Postlarvae). Postlarvae continue to grow in a low saline environment until they become juveniles. At the late juvenile stage, postlarvae move back to the coastal sea waters. These shrimps become adults and start producing eggs.

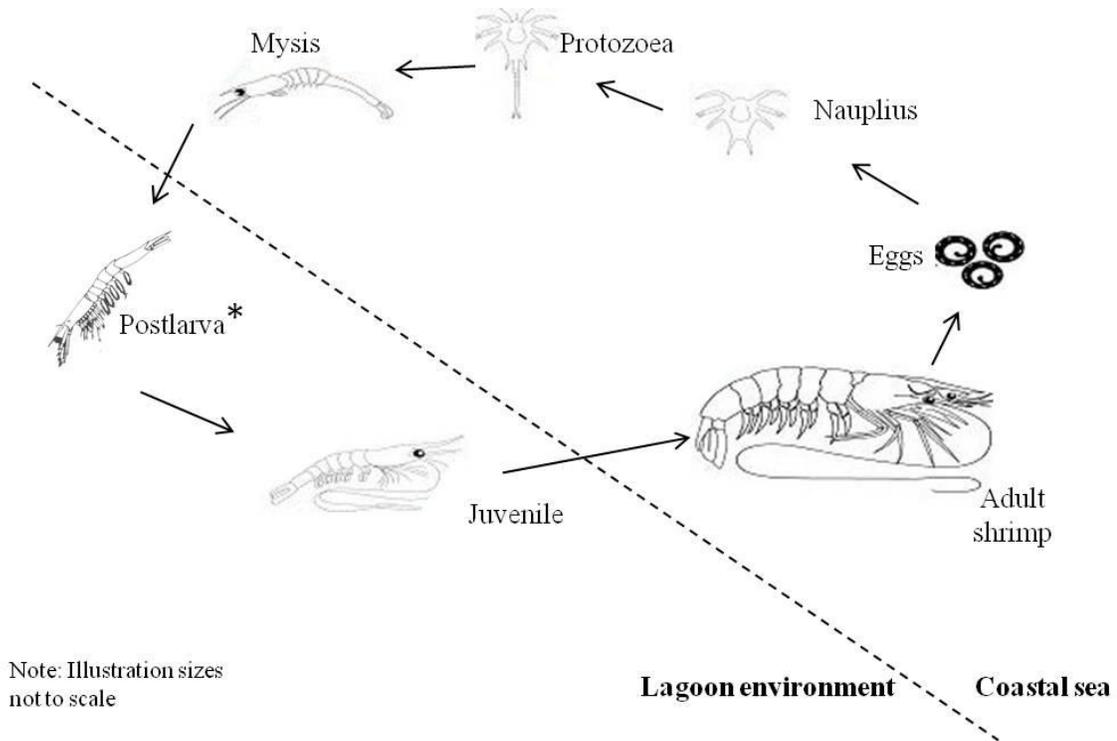


Figure 1.1: Natural life cycle of black tiger shrimp (*Penaeus monodon*)

*What farmers call “seed” is the postlarval stage.

When aquaculturing shrimps, essential living conditions (water salinity, water temperature, and other water quality parameters) required for each stage of the shrimp life cycle are artificially provided. The shrimps grown in the human-made aquaculture systems grow faster than natural shrimps due to the presence of optimal environmental conditions for growth and fewer constraints compared to the natural environment. Life cycle stages from eggs to postlarvae are produced in shrimp hatcheries. Postlarva is the stage suitable for stocking in shrimp farms, where they are then grown up to a marketable size. Adult shrimp for artificial breeding purposes are again caught from the sea. Table 1.3 provides a comparison of where the life cycle stages are spent under each system.

Table 1.3: Comparison of natural and aquaculture shrimp life stages

Stages in life cycle	In natural environment	In shrimp aquaculture
Eggs	Coastal sea	Produced in shrimp hatcheries
Nauplius	Coastal sea	
Protozoa	Coastal sea	
Mysis	Start moving in to lagoon and estuaries	
Postlarva	Lagoon and estuaries	
Juvenile shrimp	Moved back to coastal sea	Shrimp farms
Adult shrimp	Coastal sea	Caught from the sea and used for artificial breeding in hatcheries

1.6 Overview of actors and practices involved in the shrimp industry

As illustrated in Figure 1.2, there are several stages and players involved with the supply chain of the shrimp industry. The stages largely coincide with the life cycle of the shrimp. Parent shrimp (i.e., parent stock or brood stock), of sizes appropriate for breeding, are caught from the sea by fishermen. Then they are sold to breeding stock suppliers, who bring them down to shrimp hatcheries. The parents are kept in the hatcheries under controlled conditions (temperature, salinity, pH value, lighting, etc.) until the eggs are extracted. The eggs are kept in a separation tank until they spawn into a certain postlarvae (PL₁₅) stage. PLs are considered as one of the raw materials in shrimp farming and are sold by quantity to the farmers. The farmers culture these PLs in grow-out ponds until they grow up to a stage appropriate for processing (harvest). Then, depending on the quality, the harvest is sold either to seafood processing plants (if to be exported) or to village-level shrimp collectors/middlemen (if to be sold in the local market). If the harvest is good for processing for the export market, it is graded based on the quality and the prices are tagged based on the grades. On the other hand, if the harvest is going to be sold in the local market, it is given a single price as a bulk. The decision on which market to sell in (whether export or local) is made by the farmer based on the prevailing price levels and the quality of the harvest. The number of players involved in each stage of this cycle, lead times (time taken to complete a particular stage), and the approximate unit values are also given in Figure 1.2.

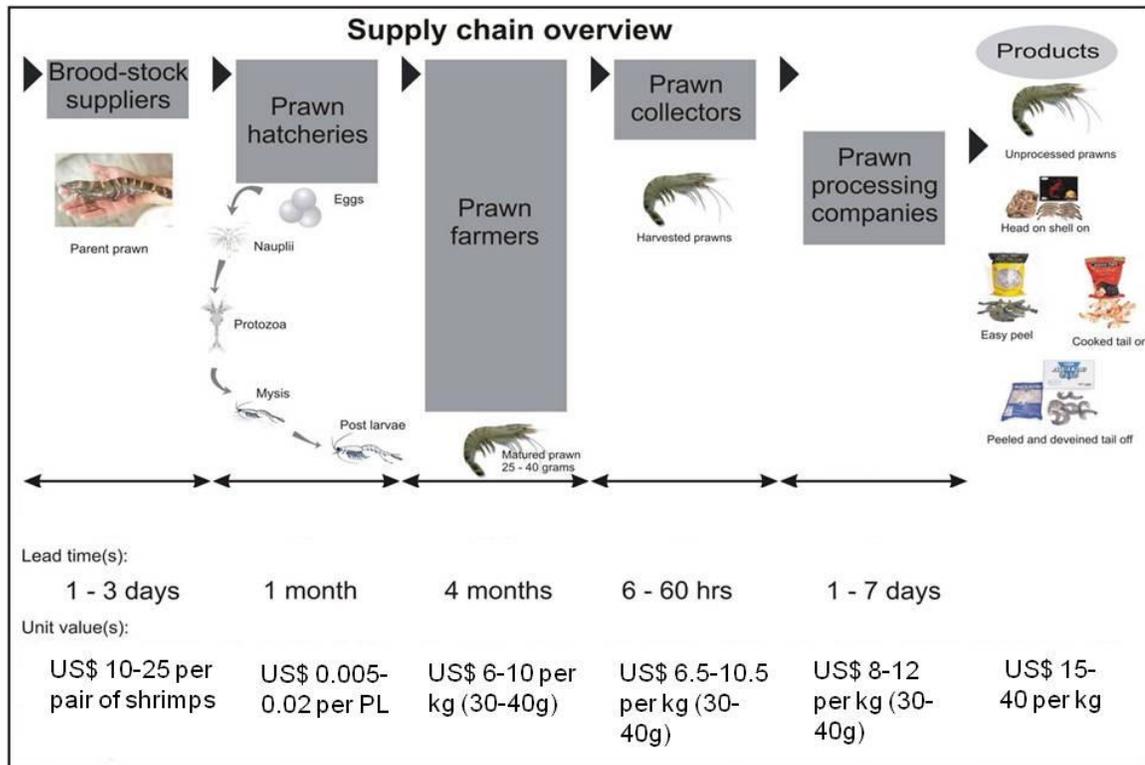


Figure 1.2: Overview of cultured shrimp supply chain (Source: Galappaththi, 2010)

In addition, there are several other large-scale businesses involved in the shrimp industry. These include input and support services such as:

- Postlarvae (PLs)
- Feed for PLs in hatcheries and adult shrimps in farms
- Antibiotics to prevent diseases
- Seafood processing plants
- Machinery rentals (e.g., paddle wheels, generators, water pumps)
- Money lending arrangements (e.g., banks, credit unions, money lenders)
- Land acquiring arrangements (e.g., family-owned, rentals, leasing arrangements, etc.)
- Middlemen/collectors, who buy yield from farmers and sell to processing plants
- Laboratory services to test the quality/diseases of PLs (e.g., PCR test)
- Advisory services to provide extension services/guidance/information on culturing, management practices, disease prevention, etc.

Among the supply services, the feed business is the most dominant support activity. Container loads of shrimp feed are imported by independent agents from countries like Taiwan, Singapore, China, and India. Feed is sold to both the hatcheries and the farms. Most other support services tend to centre on the feed suppliers and, as a result, there are currently a few dominant companies in the industry who provide all of these inputs and services.

Even though the shrimp industry is highly attractive among businessmen due to the high profit margins and the relatively shorter crop life cycle, it is always entangled with a high level of risk. This is due to price fluctuations of the produce and its high susceptible nature for diseases (such as white-spot syndrome). In addition, wild catch (i.e., shrimp caught directly from the sea) from northern and eastern areas is also significant quantity-wise. The wild catch also goes through the same pathway and competes for better prices against the farm-produced shrimp.

Products

In general, shrimps to be sold at local markets do not undergo any value addition or processing. Before selling at foreign markets, the yield has to be processed to increase the shelf life and to add more value. Value addition is also done based on the requirements and guidelines set forth by the buyer. For example, head-on-shell-on, headless-shell-on, peeled and deveined, and tail-on are some of the ways shrimp can be processed. Certain products are partially processed based on specific requirements.

1.7 Environmental, social, and economical impacts from the shrimp industry

The impacts from shrimp aquaculture are diverse, especially in terms of environmental, social, and economic aspects. The extent of the level of impacts is also dependent upon factors such as (a) scale of production: commercial large-scale, medium-scale, small-scale, etc.; and (b) type of operation: farms, hatcheries, processing plants, etc. There is solid evidence to prove that the large commercial-scale shrimp aquaculture operations make significant adverse social-ecological impacts to the environment (EJF, 2003; EJF, 2004; Huong & Berkes, 2011; Muir, 2005; Nayak & Berkes, 2010).

The environmental impacts from the shrimp industry are often negative. For instance, mangrove deforestation is an issue in shrimp farming areas as mangroves serve as a base for socio-economic activities of the surrounding community. Mangrove ecosystems are also important for sustainability of the lagoon fishery in those areas (Munasinghe et al., 2010; Rönnbäck, 2001). Shrimp farming may lead to severe water pollution in nearby lagoons, canals, wells, and groundwater sources (Pa´ez-Osuna, 2001). For example, sometimes the waste water from the ponds is directly discharged into these natural water bodies, contaminating them with the chemicals used in shrimp aquaculture. As a result, the water becomes artificially nutrient-enriched leading to algae blooms and eutrophication conditions in surrounding water bodies (Cattermoul & Devendra, 2002; Rönnbäck, 2001). Release of water from the grow-out ponds also spreads diseases into the external natural environment (Cattermoul & Devendra, 2002; Pa´ez-Osuna, 2001), such as White Spot Syndrome (WSS) or Monodon Baculo Virus (MBV). Furthermore, cultured shrimps get mixed with the wild ecosystems, thereby creating an ecological imbalance (Galappaththi, 2010; Tennakoon, 2009).

The social impacts from the shrimp industry also directly affect the surrounding communities. There are many land ownership disputes between the shrimp farmers and the community land owners (Primavera, 1997; Tennakoon, 2009). Certain shrimp farming properties (lands) belong to the government and are used illegally (Munasinghe et al., 2010). Moreover, there are many unrecorded thefts, harassments, and socially unacceptable behaviours taking place in most of the commercial large-scale aquaculture operations in the world (EJF, 2003; EJF, 2004). Most of the shrimp farmers have to focus on protecting their harvest once the shrimp stocks are grown up to a marketable size (Tennakoon, 2009).

There is evidence to show that large-scale profit-oriented companies often unilaterally decide to leave the industry, leading to economic uncertainty (Cattermoul & Devendra, 2002). They also shift from place to place looking for better profit prospects. Shrimp farming is an operation consuming a large amount of resources (soil and water)

(Cattermoul & Devendra, 2002; Nirodhawardane et al., 2003; Primavera, 1997), making land and water unusable for any other economic activity such as rice farming, ornamental fish farming, etc. This is the reason companies tend to shift around looking for new lands (Galappaththi, 2010). These kinds of unethical business practices create economic instability in those communities, leading to unemployment and social issues (Cattermoul & Devendra, 2002; Rönnbäck, 2001). In addition, depending on the land-to-employment ratio, shrimp farms rate very low (Cattermoul & Devendra, 2002) compared to other income-generating activities such as textile factories. Large-scale shrimp aquaculture is generally not sustainable (Pa´ez-Osuna, 2001).

1.8 Theoretical background

“Tragedy of the commons” (Hardin, 1968) is a phenomenon which describes how the freedom for accessing the commons causes the whole system to fail (Feeny et al., 1990). Hardin’s metaphor for this is the divergence between individual and collective rationality (Feeny et al., 1990; Hardin, 1968). This rationality is explained using the concept of “Prisoner’s Dilemma” (Feeny et al., 1996). The “tragedy” starts in the aquaculture context due to overuse of environmental resources as inputs and the addition of pollutants to the environment as waste (Pa´ez-osuna, 2001). This tragedy could happen ecologically, socially, and economically (Cattermoul & Devendra, 2002). Solving this tragedy should start by addressing the two main problems related to the commons (common-pool resources), which are: excludability and subtractability (Berkes, 2009; Berkes et al., 2001; Feeny et al., 1990; Feeny et al., 1996; Ostrom et al., 1999). The excludability problem is in controlling access to the resources (Feeny et al., 1990; Ostrom et al., 1999). The subtractability problem is in formulating and enforcing rules and regulations among users to reduce their impact on one another directly or indirectly (Berkes, 2009; Berkes et al., 2001; Feeny et al., 1990; Ostrom et al., 1999).

Community-based natural resource management is one of the ways to address these two main problems (Berkes et al., 2001). Currently, there is an increasing worldwide trend of involving local communities in management of natural resources (Berkes, 2003; Feeny et al., 1990; Ostrom, 1990; Pomeroy & Rivera-Guieb, 2006). Community-based natural

resource management is based on the grounds that local populations have a greater interest in the sustainable use of resources than does the state and that they are more able to effectively manage those resources through local or “traditional” forms of access (Brosius et al., 1998; Nayak, 2006). Therefore, it is worthwhile to study the existing and potential applications of community-based resource management in the small-scale aquaculture industry in Sri Lanka.

Scholars have identified that collectively managed resources work better than totally government or privately managed resources (Ostrom, 1990; Ostrom, 2009), and “collective action” solves problems better than individual solutions (Ostrom, 2000). Sri Lanka has a history of managing resources collectively for many sectors, including fisheries, aquaculture, and agriculture (Amarasinghe, 2006; BOBLME, 2011). Most of these resources are managed by cooperatives (BOBLME, 2011). These cooperatives facilitate collective decision making regarding a particular resource (BOBLME, 2011; Degen, 1998). This thesis aims to study this tradition of cooperative (collective) decision making.

1.9 Significance of the study

The presence of community-based shrimp aquaculture operations is limited in the contemporary world. Existing operations seem to be undocumented. The purpose of the study is to investigate the existence of community-based shrimp management and to understand how shrimp aquaculture can be carried out by community-based institutions as an alternative approach to the corporate-based operations, to ensure the sustainability of the industry in the long run. First, the study helps to understand how community-based shrimp aquaculture management works in northwestern Sri Lanka, the extent of spread/establishment within the study area, etc. Secondly, the study explores the application of community-based management concepts and commons theory in the context of shrimp aquaculture in Sri Lanka. Thirdly, this study inspires us to think about application of the current resource management system as an alternative to any (usually) unsustainable aquaculture systems. Moreover, the study allows for comparative studies with other countries such as Vietnam, Thailand, India, and Bangladesh.

1.10 Structure and organization of the report

Figure 1.3 outlines the structure of this thesis. The next chapter elaborates the methodology. The third chapter, the literature review, summarizes relevant findings from research studies elsewhere. Chapter Four, Five, and Six discuss research findings. The seventh chapter provides the summary and conclusions of the study.

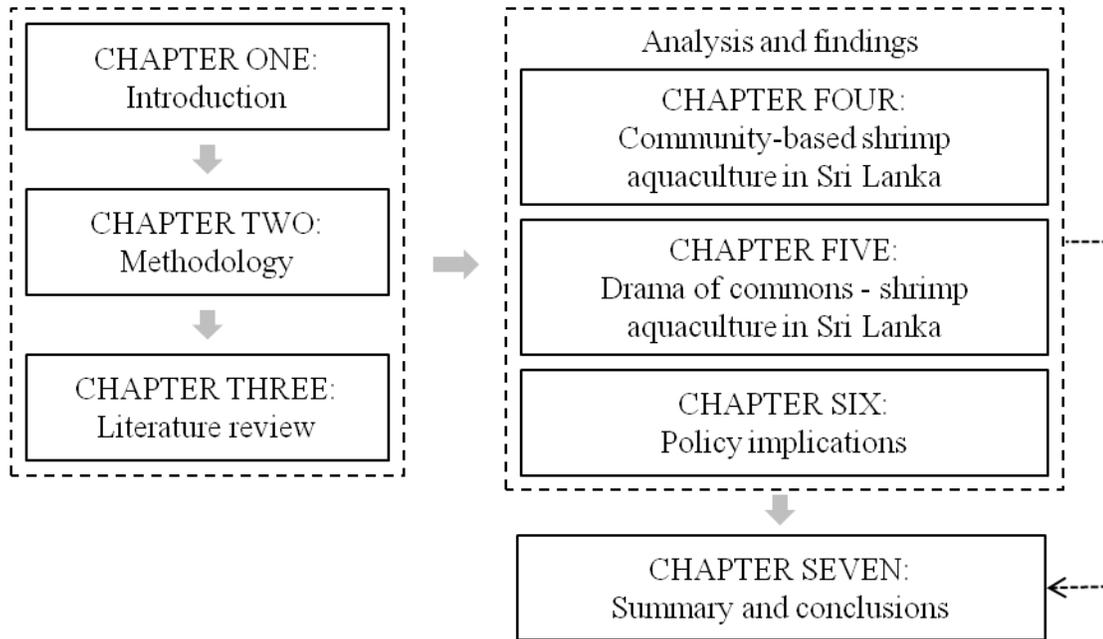


Figure 1.3: Structure of the thesis

CHAPTER 2: METHODOLOGY



Plate 2.1: Interviewing a leader of a shrimp farming association



Plate 2.2: Monthly meeting of a shrimp farmers' association

2.1 Introduction

The introductory chapter provided background on the research problem, justification for the research, research questions, research objectives derived from those questions, and the outline of the research methodology. This chapter provides a detailed description as to how the research was conducted. It discusses relevant philosophical worldviews, research design, research strategy, data types, data collection methods, sampling techniques and, finally, how the data was analyzed to accomplish each research objective. It also provides the reasons and justification for adopting such a methodology.

2.2 Philosophical worldviews

Empowerment, issue orientation, change orientation, collaborative nature, and political nature are the main features of the participatory worldview (Creswell, 2009). Since the main problem addressed through this research is to see if community-based shrimp aquaculture management can be proposed as an alternative to large commercial-scale aquaculture operations, this study displays change orientation. Moreover, it will empower the community-based institutions involved in shrimp production to better manage their own resource base. The study also calls for collaborative work with the stakeholders involved in the shrimp industry in northwestern Sri Lanka. In addition, political nature is inherent to any study that involves people. Hence, the research paradigm of this study is largely “participatory”. However, the pragmatic worldview can also be applied to a certain extent as this study is problem-centered and real world practice-oriented (Creswell, 2009).

2.3 Study area

Tiger shrimp aquaculture in Sri Lanka was expanded in the northwestern (Puttalam District) and eastern areas (Batticaloa District) (Galappaththi, 2010; Jayasinghe, 1998; Tennakoon, 2009). However, the industry in the eastern area was disturbed by the civil war that lasted for about three decades (1979–2009) as well as by the tsunami devastation which occurred in 2004 (Galappaththi, 2010; Tennakoon, 2009). Therefore, the only remaining shrimp farming is in the northwestern area of the island (Figure 2.1).

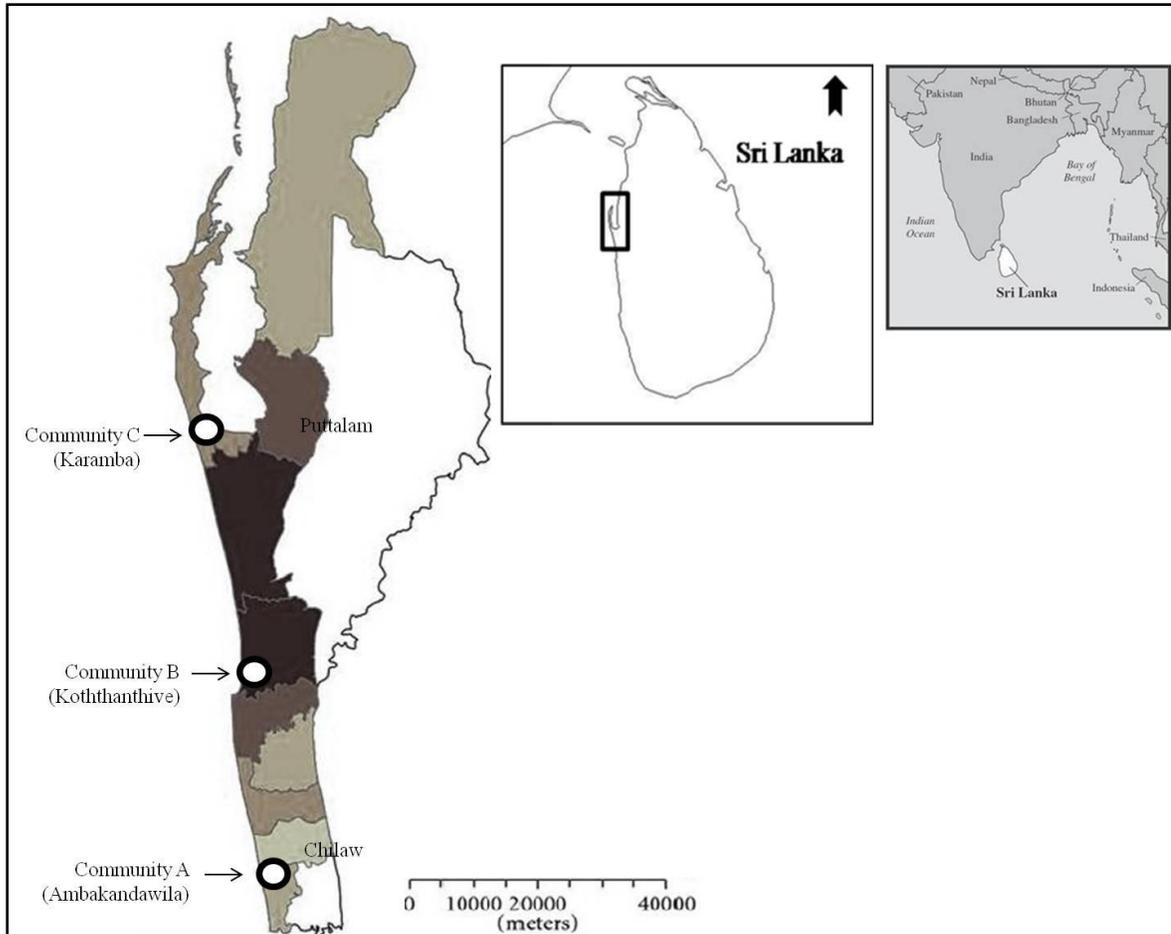


Figure 2.1: Map of the study area

(Adopted from <http://www.hindawi.com/journals/vmi/2010/679130/>)

2.4 Research design

The methodology of the research is clearly related to the research purpose and the objectives. The main aim of this study is to understand how shrimp aquaculture can be carried out by community-based institutions as an alternative to large-scale commercial aquaculture operations. Therefore, as the first step, evidence was searched to confirm the presence of community-based shrimp aquaculture in northwestern Sri Lanka. Secondly, commons institutions related to shrimp aquaculture were explored to identify how small-scale aquaculture operations can be connected through commons rules into community operations. Finally, it was investigated how community-based shrimp aquaculture can be

used as an alternative to large-scale commercial operations to ensure the sustainability of the industry and environment.

To meet the above-mentioned objectives and requirements, it was determined that qualitative research was the most appropriate form of research to be used in this study. Qualitative research can be defined as "any kind of research that produces findings not arrived at by means of statistical procedures or other means of quantification" (Strauss & Corbin, 1990, p.17). Qualitative research is also a naturalistic approach to understanding a particular context-specific setting (Golafshani, 2003). Qualitative research is capable of discovering the truth attached to a problem (Carr, 2008). Further, qualitative research fairly expresses a social phenomenon since the data occurs naturally and there is no need to have an experimental type of design (Hancock, 2002). It is about experiences, understandings, opinions, and feelings of the individuals of the study, which is a holistic perspective (Groenewald, 2004). Despite their pros and cons, both qualitative and quantitative research designs are valuable in discovering key findings. Such key findings are capable of unfolding the "the big picture" (Hancock, 2002).

Moreover, qualitative research helps in developing theoretical concepts and provides a better understanding of the social world (Golafshani, 2003). Woods (2006) identified five features of qualitative research: a) it focuses on natural settings; b) it has interest in meanings; c) it involves perspectives and understandings; d) it emphasises on process; and e) it involves concerns related to inductive analysis and grounded theory.

Each of these features of qualitative research can act as a strength and/or weaknesses of the design. For example, one criticism attached to qualitative research is the generalizability. The study results and lessons learned could be difficult to apply to a large population. This is due to the generally small sample group and selection of subjects on a non-random basis. However, most of the time, the original research question is narrowed to a specific area or subgroup of the population. In this case, generalizability is not the main aim of the research (Hancock, 2002).

2.5 Research strategy

This was an exploratory study. The research strategy adopted was the case study approach. A case study approach enables a rich understanding of the processes being executed within a given context and it has the ability to generate answers to the questions “why?”, “what?”, and “how?” (Yin, 2009). Researcher Yin (2009, p.18) defines the case study research method as an “empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used”.

There are strengths and weaknesses attached to the case study approach as a research strategy. The case study method helps to obtain a rich understanding on complex issues and/or objectives while strengthening the existing knowledge about theories (Soy, 1997). It also emphasizes “detailed contextual analysis of a limited number of events or conditions and their relationships” (Soy, 1997). In addition, better insights to the behaviour shaped by an issue/event/condition provide an opportunity for innovation (Stone et al., 2004). On the contrary, the case study method has less ability to give cause-effect conclusions (Stuart et al., 2002) and sometimes it is hard to generalize findings (Gerring, 2004).

2.6 Sampling technique

Based on the purpose and objectives of this research, the sampling technique used was non-probabilistic sampling. Non-probabilistic sampling does not involve a random selection process (Yin, 2009). However, this does not indicate that the non-probabilistic sampling method is not representative of a population (Doherty, 1994). The requirements of this research are best served by the non-probabilistic sampling method (Doherty, 1994).

Due to the absence of a proper sampling frame of the stakeholders involved in the shrimp aquaculture industry of Sri Lanka, a snowball sampling technique was used. There is evidence of snowball sampling being used commonly in qualitative research, primarily through interviews (Atkinson & Flint, 2001). This technique is often used to study hidden populations, which are difficult for the researcher to access and hence it is not possible to

develop a sampling frame for the population (Atkinson & Flint, 2001). Studying non-heterosexual women in social networks is an example. During the snowball sampling, one sample unit is located/tracked and that sample unit will reveal the details as to how to access a similar unit (i.e., the next sample unit). Likewise, the sample group appears to grow like a rolling snowball (Faugier & Sargeant, 1996; Golafshani, 2003). As a research data collection method, the snowball sampling method has many advantages. Snowball sampling is an informal and easy method to reach the target population (Atkinson & Flint, 2001) and to reach populations which are difficult to enumerate through descending methods such as household surveys (Atkinson & Flint, 2001; Faugier & Sargeant, 1996). Within the shrimp aquaculture sector in Sri Lanka, snowball sampling has been used for qualitative studies by Galappaththi (2010) and Tennakoon (2009).

2.7 Sample size and composition

In this setting, semi-structured interviews were conducted among the stakeholders of the shrimp industry in Sri Lanka. Each stakeholder was considered to be a unit of analysis. Sample size was determined based on a thorough analysis of the population involved. Accordingly, there were 38 individuals in the sample representing three different communities (community A: Ambakandawila; B: Koththanhive; and C: Karamba) in the northwestern part of Sri Lanka. This sample size was determined based on the repetitiveness of data— that is, the samples were collected until the researcher realized that addition of one more unit would not add a significant value or a knowledge-wise contribution. These shrimp farmers also represented community-level shrimp farmers' associations. Some of them were officers and leaders of these associations and some others represented sector stakeholders as they carried out multiple roles as hatchery owners and small community-level sellers.

2.8 Data sources

There is a very limited amount of secondary data available on this specific study and hence the major data source for the study was primary data. The Ministry of Fisheries and the line authorities (such as NAQDA, NARA) keep track of basic statistics related to this sector such as annual production, prices, numbers of registered community-based

cooperatives, numbers and names of registered farmers, etc. These sources become the secondary data sources.

2.9 Data collection methods

Data collection methods of this study were: a) participant observations; b) semi-directive interviews; c) focus group discussions; and d) key informant interviews. Focus group discussions and key informant interviews were conducted to explore the commons institutions as well as to validate the data gathered through participant observations and semi-directive interviews. The data collection tool used for semi-structured interviews is an open-ended question guide. A questionnaire was used as the tool to gather data from individual farmers.

Before going to the field to commence data collection, approval from the Joint Faculty-Research Ethics Board of the University of Manitoba (appendices) was obtained.

a) Participant observations

Participant observations were used during data collection as this method allows obtaining insights into the context, relationships, and behaviour of the sampled community (Mack et al., 2005). It can provide the researchers with previously unknown information that is crucial for research design, data collection, and interpretation. Moreover, some research methods (such as questionnaires) highlight the problem of the researcher not becoming "personally involved" with the respondent(s). This method, however, involves the researcher "getting to know" the people being studied by entering their world and participating either openly or secretly in that world. However, in the method of participant observations, the researcher has to maintain both a personal and a social distance between him/her and the individuals being researched.

Woods (2006, p.10) identified the advantages of the participant observation method as "it blends in with natural activity; it gives the researcher access to the same places, people and events as the subjects; it gives access to documents relevant to the role, including confidential reports and records; it facilitates the use of mechanical aids, such as tape

recorders and cameras; it provides personal first-hand experience of the role and thus improves the understanding; and it makes a worthwhile contribution to the life of the institution”. In the same article, Woods (2006) also explains the disadvantages of this method. There is the potential for conflicts between the roles of the researcher and the participants, which could affect the research (Woods, 2006); there is also the danger of “going native” (Creswell, 2009; Woods, 2006). Another applicable weakness of this method is that it is time consuming (Mack et al., 2005).

b) Semi-directive interviews

Interviews can be categorized as unstructured, semi-structured, and highly structured (Hancock, 2002). Highly structured interviews are more or less similar to questionnaires. These types of interviews might narrow down the scope of data and the interviewee might not give their own natural answers to the questions (Creswell, 2009). On the other hand, unstructured interviews—sometimes referred to as in-depth interviews—ask a limited number of questions and frame the question based on the interviewee’s previous response (Hancock, 2002). Moreover, during semi-directive interviews the interviewee is guided by the interviewer but the scope of the interview is allowed to follow the associations identified by the participant. Huntington (1998) specifies that “there is no fixed questionnaire, nor is there a preset limit on the time for discussions, although a list of topics may be a useful reference, helping the interviewer cover important areas while allowing the participants to add or skip topics depending on their interest and expertise”. These interviews should be fairly informal, since interviewees should not feel uncomfortable during the discussion, thus facilitating them to talk freely (Woods, 2006). Semi-structured interviews are generally based on a series of open-ended questions based on the research area that the researcher wants to cover (Hancock, 2002). Major insights to the qualitative research come through face-to-face interviews, where the interviewer empathizes and wins the interviewee’s confidence (Woods, 2006).

c) Focus group discussions

The purpose of focus group discussions is to gain knowledge on a particular topic or need, by interviewing a group of people directly affected by the issue (Creswell, 2009). As a result, focus group data can be used to explore the depth and gravity of opinions regarding the subject; understand differences in perspectives; understand what factors

influence opinions or behaviour of the community; evaluate reactions to proposed services; and learn about participants by observing their interactions (Hancock, 2002). Moreover, focus group discussions provide depth over breadth of the subject (Hancock, 2002). This type of data collection method is more suitable for relatively smaller samples and it enables the researcher to ask a variety of questions and explore the answers as they arise (Hancock, 2002; Mack et al., 2005). It is also a good method to validate findings of a study while collecting qualitative data.

Hancock (2002) identifies the number of people that should be included in a focus group as 6 to 10, in order to have an effective group discussion. Moreover, he suggests having more than one focus group during data collection for a better representation.

In this study, focus group discussions were used to explore the commons institutions and understand how small-scale aquaculture operations can be connected through commons rules into community operations. Moreover, focus groups were used to validate the data gathered through participatory observations and semi-directive interviews.

d) Key informant interviews

Key informants are the individuals, or a group of people, who possess specific skills, knowledge, experience, and/or specialized background on the research project or project participants (Sofaer, 2002). They can also be someone who can effectively represent the target research sample (participants) and their activities to the researcher (Mack et al., 2005). According to Mack et al. (2005), key informant interviews can be carried out individually or as focus group. Based on NSF (1997), a strength of the key informant interview method is its ability to provide insider information, which is difficult to obtain by other qualitative methods like participant observations. Moreover, only selected required information, and less unnecessary data, is given by the key informants (NSF, 1997). However, NSF (1997) also identifies some drawbacks of this method. It requires considerable time and effort to identify and select the correct key informants. Further, the relationship between researcher and key informant can influence the type of information

obtained. Moreover, it can result in disagreements among individuals, leading to frustration in analysis.

2.10 Field data collection process

Primary data collection took place during April–August 2012 in the northwestern area of Sri Lanka. Prior to the arrival in Sri Lanka, several persons involved in the shrimp farming sector were contacted to figure out a method to enter the field. As a result, the study area was first approached through these previously arranged contacts. The government institution related to shrimp farming (i.e., NAQDA) made arrangements to properly approach the shrimp farming communities for research data collection purposes. Initially, the plan was to stick to one community for data collection. However, after observing the diverse nature of the farming operations and management systems, three communities were chosen for collecting data. Three research assistants helped to administer questionnaires and also in gathering some institutional data (in addition to their help in finding and approaching local contacts, providing directions, etc.).

Criteria used in selecting communities

The communities A, B, and C (Ambakandawila, Koththanhive, and Karamba, respectively) were included in the sample. There were two considerations in selecting these three communities. The first consideration was to capture the entire process of shrimp farming within the available limited timeframe. Different communities were in different stages of the shrimp farming/production process. For example, during the month of May, community A was in the middle of farming; community B was in the harvesting stage, and community C was in the pond preparation stage (Figure 2.2). The management activities and focus of the community-level shrimp farmers' associations also varied according to the production stages of farmers in the community. For example, the main concern of community C was to finish PL stocking prior to the deadline. On the other hand, community A—which was in the middle of the shrimp farming stage—focused on the shrimp diseases.

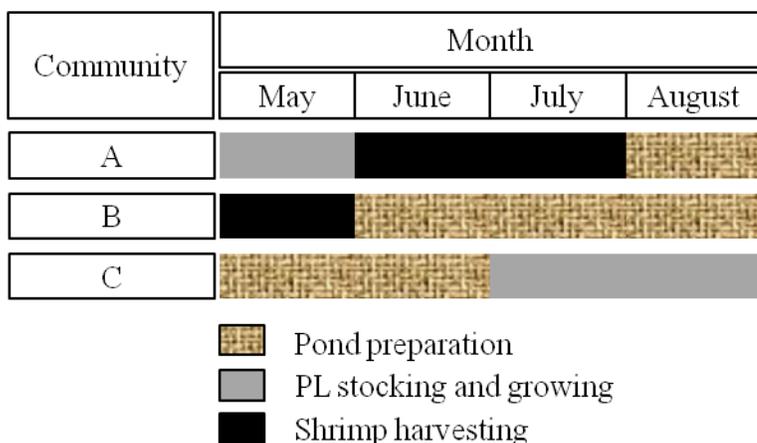


Figure 2.2: Different sampled communities in different production stages

The second selection criterion for consideration was the diverse cultural and ethnic background of each community. Community A was 100% Sinhalese; B was 100% Tamil; and community C comprised a mix of Sinhalese, Tamil, and Muslim people. Selected communities were geographically located in three different parts of the northwestern area.

Participant observations

Participant observation was the major data collection method. The response from the shrimp farming communities regarding the research study was fairly positive. The data from participant observations helped to get a better contextual understanding on the shrimp farming areas. Some community associations, which did not belong to the study sample, also contacted me and invited me to visit their community association meetings. Details on the meetings I participated in are illustrated in Table 2.1. Accordingly, 12 community-level meetings and five national-level meetings were observed.

Table 2.1: The meetings attended as an observer

Type of meeting	No. of meetings attended	Description
Community-level association meetings (zonal and sub-zonal level)	12	These were the monthly or special meetings of the small-scale shrimp farmers' community associations. In addition to three sampled communities (community A, B, and C), another three communities were visited because of their

		invitations.
National-level meetings	5	These were the meetings organized by the government institution and the national sector association. They were: crop calendar meeting, technical committee meeting, and other special meetings for decision making related to the development of the sector.

Farmer interviews, focus groups and key informant interviews

Table 2.2 shows the numbers of other types of interviews conducted. Accordingly, 38 semi-directive interviews, three focus groups, seven key informant interviews, and 28 other short interviews were conducted.

Table 2.2: Numbers of farmer interviews, focus groups and key informant interviews

Method	Number of interviews conducted	Description
Case studies based on questionnaire	38	The questionnaire was offered to farmers on an individual basis after getting to know them. (Number of farmers from each community: A=13; B=11; and C=14)
Focus group discussions	3	Focus group discussions were arranged towards the end of the data collection period in each community.
Key informant interviews	7	The most experienced and knowledgeable people in the industry were purposely interviewed. E.g., Co-founder of the current management system, past officers, current officers, some responsible government officers
Other short meetings/interviews	28	These unplanned spot interviews were conducted throughout the data collection period.

2.11 Methods of data analysis

Data gathered through participant observations and semi-directive interviews were documented immediately in the field. Analysis of these data began after labeling and coding each and every piece of data. This helped to distinguish the differences and similarities. The contextual understanding obtained from the field helped to develop mind maps and diagrams on some concepts, management processes, etc. Insights and

experiences gained through the participant observations also helped the researcher to simplify the analysis process.

Descriptive statistics (e.g., frequencies, percentages, average values) were used to investigate the first objective (i.e., the background on community-based shrimp aquaculture in northwestern Sri Lanka). The data from completed questionnaires were entered into Microsoft Excel 2007® software program and used in developing tables and graphs. Exploration on commons institutions was done by mapping the relevant institutions. Venn diagrams were developed to understand how small-scale aquaculture operations can be connected through commons rule into community operations (second objective). Strengths, weaknesses, opportunities, and threats (SWOT) analysis (Gupta, 2001) and matrixes were used to assess the viability and identify the strategic direction of the existing governance system. Moreover, comparisons were carried out to explore the option of community-based shrimp aquaculture as an alternative to large-scale commercial operations (Objective Three). Environmental costs and benefits were essentially factored in during these analyses based on social, ecological, and economical aspects.

2.12 How the findings were derived

Table 2.3 illustrates how the findings under Objectives One and Two were derived based on each data collection method/approach (i.e., participant observations, semi-directive interviews, key informant interviews, and focus groups).

Table 2.3: Methods used for objectives one and two

	Data collection method			
	Participant observations	Semi-directive interviews	Key informant interviews	Focus groups
Objective One:				
Profiles of individual shrimp farmers	√	√		
Existence of community-based management	√		√	√
Scale of shrimp farming	√		√	
Better management				

	Data collection method			
	Participant observations	Semi-directive interviews	Key informant interviews	Focus groups
practices				
Annual zonal crop calendar	√	√	√	√
Basic shrimp operations	√	√	√	√
Social-ecological systems of shrimp aquaculture	√		√	√
Objective Two:				
Commons applications	√	√	√	√
Development and evolution of commons management	√	√	√	√
Existing commons institutions	√	√	√	√
Resource governance process	√		√	√
Decision making in shrimp aquaculture management	√	√	√	√
Effective information sharing for shrimp aquaculture management	√	√	√	√

Figure 2.3 shows the methods used to derive findings under Objective Three. Only the first key area under this objective was derived based on the data collected, whereas the rest was synthesized based on the first key finding.

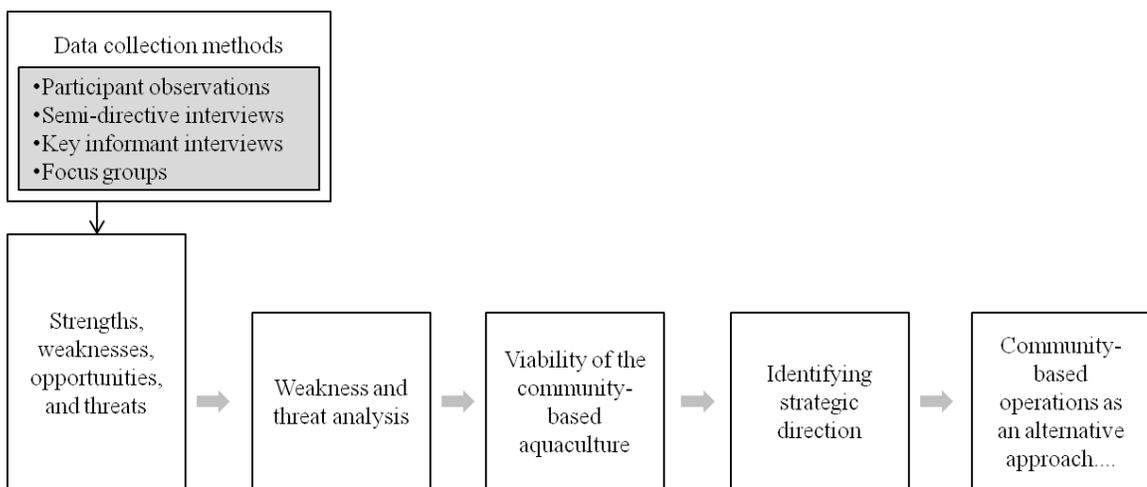


Figure 2.3: Deriving findings under Objective Three

2.13 Validity and reliability of the study

Validity in research explains to what extent research findings meet the reality (Cohen & Crabtree, 2008; Golafshani, 2003). According to Joppe (2000, p.1), “validity determines whether the research truly measures what it was intended to measure or how truthful the research results are. In other words, does the research instrument allow the researcher to hit ‘the bull’s eye’ of your research object? Researchers generally determine validity by asking a series of questions”. The validity of this study was ensured by adopting the following strategies:

- 360° approach of data collection—that is, the use of several data collection methods (participant observations, semi-directive interviews, focus group discussions, and key informant interviews);
- Draft findings were shared with the respondents for validation purposes and their feedback was obtained;
- Sample size was determined in the field during data collection to ensure a strong representativeness of the population involved;
- Samples were collected from three different communities in the northwestern part of Sri Lanka.

“Reliability” is also a tool to evaluate the quality of research (Golafshani, 2003). If someone repeats the same study (following the same methodology), the extent to which it repetitively demonstrates the same findings is explained as research reliability (Cohen & Crabtree, 2008; Golafshani, 2003). Reliability of this study was ensured by properly documenting the entire methodology and by maintaining a consistent approach during the research project.

2.14 Summary

In this chapter, the research methodology was described in detail. The research was conducted in the form of a qualitative analysis, where the case study approach was adopted as the research strategy. Mainly primary data was collected through participatory observations, semi-directive interviews, key informant interviews, and focus group

discussions. Sampling was done using the snowball sampling technique. Chapter Three provides the review of literature relevant to the study.

CHAPTER 3: LITERATURE REVIEW

3.1 Introduction

The first chapter provided a detailed description of the study context, research purpose, and objectives. The second chapter described the detailed methodology of the study. This chapter will summarize the relevant findings from other research studies conducted so far. It will describe the aquaculture industry in the global context as well as within Sri Lanka. Then it will illustrate the existing fisheries and aquaculture governance structure in Sri Lanka. Further, it will outline the theories and concepts related to the commons, tragedy of the commons, community-based management, co-management, social-ecological systems, and sustainable development.

3.2 Aquaculture

The history of aquaculture dates back to 2000 BC in China (Rabanal, 1988). The world aquaculture industry has significantly expanded during last 50 years, volume-wise, from less than one million tons to more than 50 million tons produced per year in 2006 (De Silva & Davy, 2010). The role played by the aquaculture industry is vital due to exponential world population growth and the resulting consistent increase in world food demand. The aquacultural food production mainly is for human consumption (FAO, 2010). Currently, aquaculture contributes more than 50% of the world seafood supply (De Silva & Davy, 2010; Muir, 2005), of which more than 90% comes from the Asian region (Muir, 2005).

Aquaculture provides direct and indirect sources of income for millions of people, especially in rural communities (De Silva & Davy, 2010). In certain Asian countries, the aquaculture sector serves as a main source of foreign exchange earnings and contributes to strengthening food security and alleviating poverty as well (De Silva & Davy, 2010). As a result, aquaculture is considered to be a successful primary food sector on a global scale (De Silva & Davy, 2010).

There are diverse definitions for aquaculture. Among them, this definition from the Food and Agriculture Organization of the United Nations is detailed and recognized worldwide: “Aquaculture is the farming of aquatic organisms: fish, molluscs, crustaceans, aquatic plants, crocodiles, alligators, turtles, and amphibians. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated. For statistical purposes, aquatic organisms, which are harvested by an individual or corporate body, which has owned them throughout their rearing period contribute to aquaculture; while aquatic organisms, which are exploitable by the public as a common property resource, with or without appropriate licences, are the harvest of capture fisheries” (FAO, 2011, p.86). However, country to country and province to province, based on the political visions, etc., the definitions vary.

The legal definition of aquaculture in Sri Lanka is, "the husbandry of aquatic plants and organisms ranging from the propagation of aquatic organisms under human control to the manipulation of at least one stage of an aquatic organism's life for the purpose of increasing production" (Fisheries and Aquatic Resources Act, No. 2 of 1996 of Sri Lanka, Section 66 p.21). The same Act defines "aquaculture enterprise" as “any area, enclosure, pond, impoundment, premises or structure set up or used for the cultivation of aquatic plants or organisms for commercial purposes and includes any cultivated pearl oyster or other shellfish bed, or raft or other structure used for cultivation of pearl oyster or other shellfish” (Anon, 2011).

3.3 Governance system in Sri Lanka

The primary fisheries legislation of Sri Lanka is the Fisheries and Aquatic Resources Act, No. 2 of 1996 (Anon, 2011). The Ministry of Fisheries and Aquatic Resource Development (MFARD) is the accountable and authoritative ministry for fisheries and aquaculture resource management. MFARD comes under the Cabinet, which is directly responsible for the Parliament of Sri Lanka. The Cabinet of Sri Lanka is a council of cabinet ministers appointed by the President under the advice of the Prime Minister of Sri

Lanka (Lowry & Wickramaratne, 1987). The Cabinet is chaired by the President. As a result, the portfolios of the ministries are often subjected to changes depending on the political party in power (Lowry & Wickramaratne, 1987). See Appendix A for the structure of the current MFARD (MFARD, 2011). There are eight line departments/institutions falling under the MFARD and each of these are mandated for different activities in the fishery sector (MFARD, 2011). Table 3.1 shows the origin and the roles of each of these departments in managing fisheries and aquaculture.

The National Aquaculture Development Authority (NAQDA) was specifically established for the development of aquaculture and the inland fisheries of Sri Lanka. The mandate of NAQDA is to contribute to the improvement of the socio-economic conditions of rural societies and to alleviate poverty by way of increasing freshwater and brackish water fish production, as well as introducing new technologies for utilization of aquatic resources for small-, medium-, and large-scale enterprise development (NAQDA, 2011).

Table 3.1: Departments/ institutions under MFARD, Sri Lanka (Adopted by: MFARD, 2011)

Institution	Established by	Role
Department of Fisheries and Aquatic Resources	Fisheries Ordinance in 1940 and upgraded by Fisheries and Aquatic Resources Act , 1996	Oversees the development of the fisheries industry of Sri Lanka and assists fisher community in uplifting their socio-economic aspects
Department of Coastal Conservation	The Coast Conservation (Amendment) Act, No. 64 of 1988	Coastal conservation, regulation, and management
National Aquatic Resources Research and Development Agency (NARA)	The National Aquatic Resources Research and Development Agency Act, No.54 of 1981	Research and development related to fisheries and aquatic resources
National Institute of Fisheries and Nautical Engineering (NIFNE) ¹	The National Institute of Fisheries and Nautical Engineering Act, No.36 of 1999	Acts as higher education, training, and consultation provider for the sector

¹NIFNE is currently working under a different ministry but still performs towards the same goals.

National Aquaculture Development Authority (NAQDA)	The National Aquaculture Development Authority Act, No. 53 of 1998	Fresh water, aquaculture and inland fisheries management
Ceylon Fisheries Corporation	State Industrial Corporations Act, No.49 of 1957	Management of fish selling and marketing process
Ceylon Fishery Harbour Corporation	Ceylon Fishery Harbour Corporation, 1972	Fisheries infrastructure development and management: e.g., Harbours
Cey-Nor Foundation	Public Companies Act, No. 23 of 1987	Production and supply of fishing gear, boats, and other accessories

3.4 The Commons

Commons are resources owned and/or shared by a group of people. Problems relating to the governance of commons are currently expanded to the economical (Stavins, 2010), social, and ecological environments. Katharine Coman highlighted the first issue in her article called “Some Unsettled Problems of Irrigation” in *American Economic Review* in 1911 (Stavins, 2010). Later, Garrett Hardin’s influential article “The Tragedy of the Commons” was published (Hardin, 1968). Hardin (1968) mentioned “freedom in the commons brings ruin to all” and named it as a “tragedy of the commons”. According to him, the tragedy of the commons is a dilemma arising from the situation in which multiple individuals, acting independently and rationally consulting their own self-interest, will ultimately deplete a shared limited resource, even when it is clear that it is not in anyone's long-term interest for this to happen (Hardin, 1968). The main areas of focus in this article are overpopulation, overexploitation, carrying capacity, and common property resource management (Feeny et al., 1990; Hardin, 1968). Hardin’s metaphor on pasture lands identified the divergence between individual and collective rationality (Feeny et al., 1990; Ostrom et al., 1999). He proposed privatization or government regulation as solutions to the tragedy of the commons (Hardin, 1968; Ostrom et al., 1999).

Current scope of the commons is broad (Berkes, 2009; Hess, 2008; Hess & Ostrom, 2007; IASC, 2012), based on how the commons are defined. During the time when the

tragedy of the commons theory was brought forward, the application of commons were mostly restricted to agriculture, forestry, fisheries, and a few other areas (Feeny et al., 1990; Hardin, 1968). However, currently there are various published definitions on this theory resulting in a broad range of literature (Hess, 2008; Hess & Ostrom, 2007). Charlotte Hess (2008) has identified evolving types of commons as “new commons”. These are mapped and categorized into six categories: 1) cultural commons, 2) medical and health commons, 3) neighbourhood commons, 4) knowledge commons, 5) markets as commons, and 6) global commons (Hess, 2008). Here, ownership is the main co-factor in determining the type of commons. In addition to ownership, the other two basic characteristics (Feeny et al., 1990) which led to the segregation of commons into different types are excludability and subtractability problems (Berkes et al., 2001).

The first characteristic is *excludability*, which means controlled access (Berkes, 2009; Berkes et al., 2001; Feeny et al., 1990; Ostrom et al., 1999). This is the control of access to the resource physically by the potential users (Feeny et al., 1990). This is problematic when it comes to moving resources like off-shore fisheries, wildlife, large bodies of water, global atmosphere, radio frequency bands, etc. It is less problematic for resources like forestry, range lands, etc. because of the static nature of these resources.

The second characteristic is *subtractability* (Berkes, 2009; Berkes et al., 2001; Feeny et al., 1990; Ostrom et al., 1999). Subtractability means each user is capable of subtracting from the welfare of the other users (Feeny et al., 1990). The level of exploitation by one user affects the ability of another user to exploit the same resource. This is identified as a rivalry in the resources (Ostrom, 1990). This could happen as a result of the divergence between individual and collective rationality. For example, increasing the daily catch of a specific fish will decline the other fishermen’s unit catch at a fishing effort.

Based on those characteristics, Berkes et al. (1989:91) define common property resources as “a class of resources for which exclusion is difficult and joint use involves subtractability” (Berkes et al., 2001; Feeny et al., 1990). The same resources were identified as “common-pool resources” by Ostrom in 1986 using the same definition

(Feeny et al., 1990; Ostrom et al., 1999). This is because of the intrinsic nature of the resources, where the property rights regime belongs to which it is held.

Feeny et al.(1990) define four categories of property rights within the common property regime: 1) open access, 2) private property, 3) communal property, and 4) state governance (state property). Open access is the absence of well-defined property rights (Berkes, 2009; Ostrom et al., 1999); the resource is not regulated and can be accessed by everyone, such as unpolluted fresh air, fish stocks in international waters, etc.

Private property has the right to exclude others from the resource and the resource is regulated and owned by an individual or a group of individuals (Berkes, 2009; Feeny et al., 1990; Ostrom et al., 1999). A good example is private fishing companies, where ownership is managed as a corporation. In this case the corporations are legally recognized by the local government and/or internationally recognized by international agreements.

Communal property or common property (Berkes, 2009) rights are held by a specific identifiable community of independent users (Feeny et al., 1990). As a community, these users exclude others from using the resources while regulating the resource as a community. The rights are exclusive or transferable within the community (Feeny et al., 1990). Members of the community have rights of equal access and use. Often, these resources are regulated as cooperatives. For example, Negombo stake-net fishery in Sri Lanka has been managed by a cooperative for more than 250 years (Amarasinghe et al., 1997; Atapattu, 1987; Berkes, 2009; Gunawardena & Steele, 2008). Most of the inland freshwater aquaculture farms are also managed as cooperatives (Amarasinghe, 2010).

State governance (state property) rights are largely exclusive to the government (Berkes, 2009; Feeny et al., 1990). The government makes decisions regarding the level of access and the nature of exploitation (Feeny et al., 1990). For example, navigable water and fisheries belong to the federal government of Canada.

Application of the above four types of property rights regimes depends on various circumstances and no specific type of property right regime guarantees the sustainability of a particular resource (Berkes, 2009).

3.5 Community-based resource management

Community-based management is one way to solve the “tragedy of the commons” by addressing the excludability and subtractability problems (Berkes et al., 2001). Sajise (1995) has defined community-based resource management as “a process by which the people themselves are given the opportunity and/or responsibility to manage their own resources; define their needs, goals, and aspirations; and to make decisions affecting their well-being”. This is a people-centered management approach (Pomeroy & Rivera-Guieb, 2006), and a way to “control access to the resource and to make and enforce the regulations among users to reduce their impact to others” (Berkes et al., 2001, p.173).

For example, Berkes (2009) describes how a Cree fishery in the Cree Indian village of Chisasibi, James Bay (in the eastern sub-arctic of Canada) has been managed and sustained by the villagers for a long time period. This is a subsistence fishery carried out under no apparent rules or regulations and it operates outside the sphere of government regulations. Another successfully managed community-based fishery is the Negombo stake-net fishery in Sri Lanka (Amarasinghe et al., 1997; Berkes, 2009; Gunawardena & Steele, 2008). This fishery is mainly managed by rural fisheries societies based in the villages around the Negombo lagoon. These institutions (i.e., commons institutions) are playing a major role in terms of managing resources through a community-based management approach. These cooperatives decide the eligibility of the membership and obligations of the fishers. They use a lottery system to allocate turns and produce a rotation through all sites to give equal allocation to all members of the cooperative (Amarasinghe et al., 1997; Atapattu, 1987; Berkes, 2009; Gunawardena & Steele, 2008). The rules to control the access and address the subtractability problem may be made by the government, markets, communities themselves, or by any combination thereof (Berkes et al., 2001).

According to Korten (1987), community-based management has several elements: a group of people with common interests, a mechanism for effective and equitable management of conflict, community control and management of productive resources, local systems or mechanisms for capturing and using available resources, broadly distributed participation in control of resources within the community, and local accountability in management.

3.6 Co-management

Co-management is the collaborative approach to manage commons or the common-pool resources. Co-management is defined as “the sharing of power and responsibility between the government and the local resource users” (Berkes et al., 1991, p.12). The World Bank definition for co-management is “the sharing of responsibilities, rights and duties between the primary stakeholders, in particular, local communities and the nation state; a decentralized approach to decision making that involves the local users in the decision-making process as equal with the nation-state” (Carlsson & Berkes, 2005; World Bank, 1999, p.11). The central element of co-management is the community-based resource management (Berkes et al., 2001). The difference between community-based resource management and co-management is based on the level and timing of the government participation in the management process. In addition, community-based resource management is more people-centered and community-focused. Co-management is focused on these issues and additionally on the partnership arrangements of the government and local communities. Co-management is broader than community-based management in terms of the scope and the scale. Further, the government plays a major and active role in co-management and a minor role in community-based management (Berkes et al., 2001).

3.7 Community-based management and co-management in Sri Lanka

Sri Lanka has been practicing community-based management and co-management for a long time (BOBLME, 2011; Degen, 1998; Kularatne et al., 2009; Wijenayake et al., 2005). Culture-based fishery is one such example, where both community-based management and co-management is practiced (Amarasinghe & De Silva, 2001; Kularatne et al., 2009; Wijenayake et al., 2005). Under the jurisdiction of Agrarian Services

Department (Act No. 58 of 1979), it was required to establish a village farmers' organization for each inland reservoir and an aquaculture committee coming under each farmers' organization, which is responsible for the management of culture-based fisheries (Amarasinghe, 2006). These organizations are mainly responsible for day-to-day water management of small irrigation reservoirs (Amarasinghe, 2006). The Act was amended in 2000, to make provisions for community participation in aquaculture in non-perennial reservoirs. Moreover, culture-based fishery practices have enabled coordination at decision-making levels between the fisheries and agrarian sectors (Amarasinghe, 2006). The stake-net fishery in Negombo lagoon (Amarasinghe et al., 1997; Berkes, 2006; Gunawardena & Steele, 2008), shore (beach) seine fishery in western, southern, and eastern coastlines, and near shore shrimp fishery in western Sri Lanka are a few more examples of community-based and co-management applications (BOBLME, 2011). In conclusion, community-based management and co-management is currently practiced in the fisheries and aquaculture sectors of Sri Lanka.

3.8 Social-ecological systems

Jahn et al. (2009, p.2) and Glaser et al. (2008) provided a working definition for the social-ecological systems: "a social-ecological system consists of a bio-geo-physical unit and its associated social actors and institutions. Social-ecological systems are complex and adaptive and delimited by spatial or functional boundaries surrounding particular ecosystems and their problem context". Resilience Alliance defines social-ecological systems as "complex, integrated systems in which humans are part of nature" (Berkes & Folke, 1998). Anderies et al. (2004) defines ecological systems and social systems separately to provide better explanation for social-ecological systems. Accordingly, social-ecological systems are defined as systems intricately linked with and affected by one or more social systems. Further, ecological systems are identified as an interdependent system of organisms or biological units (Anderies et al., 2004). Social systems can be the interdependent systems of organisms (Anderies et al., 2004; Glaser et al., 2008). Units of both social and ecological systems interact interdependently and each may contain interactive sub-systems and overriding systems as well (Anderies et al., 2004).

Bush et al. (2010) identifies how social-ecological systems can be applied in the context of shrimp aquaculture. These authors identify shrimp aquaculture as complex social-ecological systems. Further, their paper focuses on resilience, uncertainty, and risk of the social-ecological systems to study four aspects of shrimp aquaculture: interaction between coastal landscape and shrimp farming; disease management of shrimp farming; decision making under uncertain situations; and resource governance related to shrimp farming.

3.9 Sustainable development and sustainability

“Our Common Future” (World Commission on Environment and Development [WCED], 1987), also known as the Brundtland Report, is considered to be the most important catalyst for worldwide appreciation of the idea of sustainable development (Sikdar, 2003; United Nations, 1987). In this report, sustainable development is defined as “the development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Spangenberg, 2002, p.1; WCED, 1987, p.43). Key ideas within this definition are the needs and the limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs (IISD, 2011).

In the literature, several definitions can be found for sustainable development as well as for the concept of sustainability. Table 3.3 presents the definitions found in a literature search and are organized under business, social, and ecological environments.

According to the definitions, it is evident that different disciplines have adapted the concepts of sustainable development and sustainability to meet the key aspects of focus under each of those. Moreover, there is no agreed upon definition for either of these concepts, resulting in ambiguity.

Table 3.2: Definitions: Sustainable development and Sustainability

Sustainable Development	Sustainability
Definitions focused on business context	
<p><i>World Business Council on Sustainable Development (2001)</i></p> <p>“Sustainable development is about ensuring a better quality of life for everyone, now and for generations to come. Thus it combines ecological, social, and economic concerns, and offers business opportunities for companies that can improve the lives of the world’s people” (Molnar & Morgan, 2001, p.13)</p>	<p><i>Envision Tools (2000)</i></p> <p>“Sustainability in corporate terms means a business approach that creates long-term shareholder value by embracing opportunities and managing risks deriving from economic, environmental and social developments.” (Molnar & Morgan, 2001, p.13)</p>
Definitions focused on a social context	
<p><i>International Council for Local Environmental Initiatives (1996)</i></p> <p>“Sustainable development is a program to change the process of economic development so that it ensures a basic quality of life for all people, and protects the ecosystems and community systems that make life possible and worthwhile” (Molnar & Morgan, 2001, p.18)</p>	<p><i>West London Friends of the Earth (2001)</i></p> <p>“Sustainability means living within the resources of the planet without damaging the environment now or within the future. It also means having an economic system that provides a genuine quality of life, rather than depending on increased consumption” (Molnar & Morgan, 2001, p.21)</p>
Definitions focused on ecology	
<p><i>Conservation International (2001)</i></p> <p>“Conservation International (CI) believes that the Earth’s natural heritage must be maintained if future generations are to thrive spiritually, culturally, and economically” (Molnar & Morgan, 2001, p.21)</p>	<p><i>The Wuppertal Institute (1994)</i></p> <p>“Sustainability: An ecological system is healthy and free from 'distress syndrome' if it is stable and sustainable, that is, if it is active and maintains its structure (organization) function (vigor) and autonomy over time and is resilient to stress” (Molnar & Morgan, 2001, p.24)</p>

3.10 Sustainable development vs. sustainability: a comparison

This is an analysis based on the key ideas that seem to be consistent across the above definitions/descriptions on sustainable development and sustainability.

- There are three pillars to sustainable development; namely, economic development, social development, and environmental protection (The United Nations World

Summit Outcome Document 2005). On the other hand, the constituents of sustainability are the economy, society, and environment.

- Sustainable development is a pattern of resource use that aims to meet human needs while preserving the environment, so that these needs can be met not only in the present, but also for generations to come (Rajarithnam, 2010). It shows how both the economy and society are constrained by environmental limits and the capacity to endure (Scott Cato, 2009).
- Sustainability is an approach to decision making that considers the interconnections and impacts of economic, social, and environmental factors on today's and future generations' quality of life (Rajarithnam, 2010). It is a dynamic and evolving notion, and a process. It strives to be participatory, transparent, equitable, informed, and accountable (Molnar & Morgan, 2001).
- In comparison, sustainable development is the development (economic or otherwise) that incorporates the notion of sustainability into the decision-making process (Beddoea et al., 2009). Sustainability is mostly viewed as a state to be maintained or, if not, to be achieved in the future and hence it has the notion of a 'call to action'.
- All in all, sustainable development and sustainability become complementary concepts, where sustainability can be thought of as the goal and sustainable development as the process for achieving it (Clift, 2000). As a result, often times these notions can be used interchangeably.

These are some criticisms on the concepts of sustainable development and sustainability:

- The WCED Report (1987) discussed satisfying the needs of present and future generations. However, it should be noted that this report does not mention the fact that no generation fulfills all of its needs (Beckerman, 2002). This means the central economic concept of scarcity has been neglected.
- Finite resources and the market mechanism manage the supply and the demand of the resources (Beckerman, 2002). Quantitative declining of the resources supply leads to increased prices for that particular resource. For instance, diamond is a scarce resource and the prices are very high. Therefore, people limit the consumption and

use diamonds only for jewellery. According to the demand and supply theory, we will never run out of diamonds.

- According to Latouche (2004), on a planet where 20% of the population consumes 80% of the natural resources, a sustainable development cannot be possible for this 20%.
- The proponents of the de-growth concept also consider the term sustainable development to be an oxymoron (Treanor, 1997).

**CHAPTER 4: COMMUNITY-BASED SHRIMP AQUACULTURE IN
NORTHWESTERN SRI LANKA**



Plate 4.1: Growing shrimps found in the feeding tray



Plate 4.2: Harvested shrimps

4.1 Introduction

This chapter unfolds the analysis and results related to the first research objective by understanding the operation of community-based shrimp aquaculture in the northwestern communities of Sri Lanka. The chapter explores the existence of community-based shrimp aquaculture in the study area, and background information on individual shrimp farmers (their profiles) and any affiliations to community-based organizations is documented. The basic shrimp operation system is described in terms of the grow-out ponds, special requirements, and any other inputs used. The seasons of production—that is, the crop calendar—is described. Any type of integrated production (e.g., shrimp and vegetable production) is investigated here as well. Basic economics of the system such as where the inputs are purchased from, and costs incurred, are looked at. Finally, the chapter explores the social-ecological system within which shrimp farming is conducted. Data on the above aspects are qualitatively analyzed and findings are presented using narratives, descriptive statistics, and graphical representations.

4.2 Profiles of individual shrimp farmers

Demographic information

Demographic information such as age distribution, gender, highest level of education, and number of years of experience in the shrimp farming sector were analysed (Appendix B). Farmers of communities B and C had a similar type of age distribution. The majority (42%) of farmers were between 40 and 50 years old. In community A, there were 3 farmers (8%) who were less than 30 years old. Interestingly, 11% of the farmers were more than 60 years old. The oldest farmer was 68 years old. The sample interviewed included entirely male farmers. In terms of the industry experience (number of years) of farmers, all three communities were similar. Within a community, experience ranged from two years to more than 15 years, with the majority of shrimp farmers (66%) having more than 10 years of experience. The most experienced shrimp farmer I met had 26 years of farming experience. There were only 5% of farmers with less than two years of experience. Data on the highest level of education of shrimp farmers from all three communities followed more or less a normally distributed bell curve. The majority (37%) of farmers had some level of high school education while 26% of them had graduated

high school, 16% had completed post-secondary education, and 8% had less than junior high level education.

Farming-related information

The majority (53%) of the shrimp farmers used government-owned lands while 37% of farmers used their own lands, and the remaining farmers (11%) used rented lands (Appendix B). Among the communities, the majority of farmers from community B carried out farming in government-owned lands. In terms of types of business operations that the sampled farmers engaged in, 42% farmers carried out their farming activities on their own, while 39% farmers carried out farming activities as family-owned businesses, and 11% were in partnerships. The percentage of farmers who operated the businesses as private limited companies was 8%. The general practice of farmers was to employ a minimum number of employees to reduce input costs. The majority (47%) of farmers employed two to five people, whereas 24% of farmers had less than two employees, and 29% of them had employed five to eight people. Involvement of family members in the farming operation was a very common phenomenon. It seemed that this was mainly due to the high input cost of farming, which limited the ability to hire more people in the farm. The majority (74%) of shrimp farmers said they receive the support and involvement of their family members and/or relatives. The rest (26%) did not have any involvement of family members/relatives. Among the three communities, community C had the least involvement of family members in farming operations compared to the other two communities. In regard to the power sources for shrimp farming operations, only 47% of shrimp farmers used electricity power while the remaining (53%) farmers had no electricity available to their farms and totally relied on diesel generators. Dependency on diesel generators varied among the communities. Farmers of community A heavily relied on electricity whereas the farmers of communities B and C relied more on diesel generators. Other income-generating activities of these farmers (other than shrimp farming) was also probed into. It was discovered that 58% of the farmers were engaged in secondary income-generating activities in addition to shrimp farming. The majority of such farmers came from community B. Community C had the minimum number of farmers with a secondary income-generating activity. Some of these activities were

related to aquaculture while the rest were non-aquaculture type activities. Types of aquaculture-related activities were: shrimp PL production; feed selling; and integrated shrimp and fish farming.

4.3 Existence of community-based management

During the field data collection period, the researcher had the opportunity to participate in different types of meetings as an observer and to work closely with the shrimp farmers' associations at the community, zonal, and national levels. It was interesting to witness how complex resource governance systems are organized and maintained by the community-based institutions in the shrimp aquaculture sector in the northwestern part of Sri Lanka. Discussions with the relevant government institutions also confirmed the existence of community-based institutions and their significance in terms of the overall resource governance system of the shrimp aquaculture sector of the country. It was observed that the entire shrimp farming community area in the northwestern part of Sri Lanka is currently heavily dependent on this resource governance system.

Community-based institutions (called *samithiya* in local language) serve as the bottom level, self-organized community entities within the hierarchy of existing shrimp farmers' associations (community to national level). Existing community-based institutions belong to clearly defined geographical boundaries, which are known as zones and sub-zones (five zones and 32 sub-zones). These community-based management institutions are well organized and inter-connected through overriding zonal-level associations. Community-level shrimp farming associations formulate and implement their own rules to manage community-level resources. The statement given below is an example showing an association's criterion for becoming a member.

“No one can enter shrimp farming without getting community association's permission. Before the permission they have to visit our meetings at least for six months and then only we consider for our membership”.

Secretary (Community Association C)

Figure 4.1 illustrates a map of zonal and sub-zonal community associations. During the field data collection period, I had the opportunity to participate as an observer in the

meetings of these community associations. Therefore, the existence of community-based organizations, as a part of the existing shrimp aquaculture resources management system, is evident.

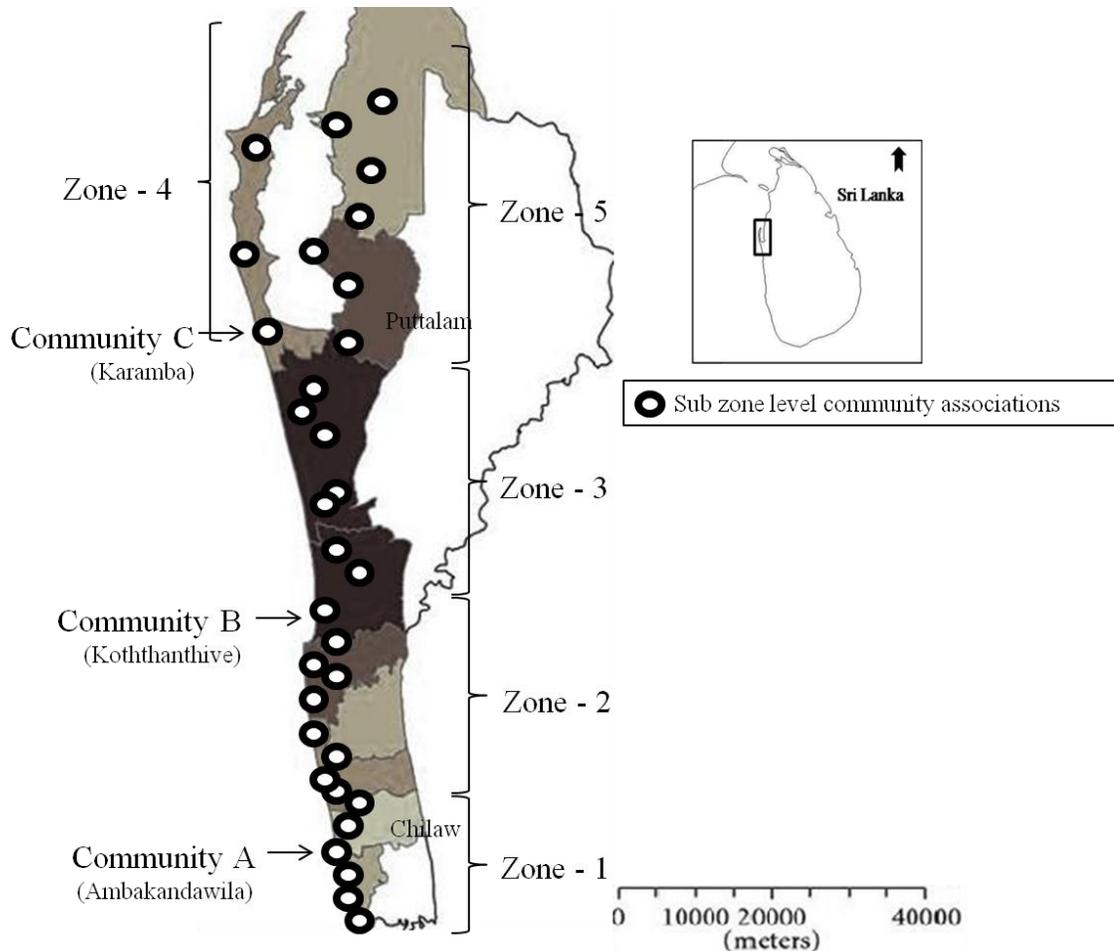


Figure 4.1: Location and distribution of shrimp farming communities

4.4 Scale of shrimp farming: small, medium, or large

The number of ponds operated in a farm can be considered as an indicator of the scale of shrimp farming. In 2011/12, the majority (37%) of the sampled farmers operated two to five ponds, whereas 11% operated just one pond (Appendix B). Twenty-nine percent and 18% of shrimp farmers operated five–ten and ten–fifteen ponds, respectively. Only 5% of farmers had more than fifteen ponds. The size of the smallest pond observed was about 0.2 hectares whereas the largest was about 0.8 hectares.

Another indicator of the scale is the total land area of the farm (i.e., the full extent/size of the farm), including the ponds which were being operated and rested. The majority (55%) of shrimp farmers had farming areas between one and three hectares in size. Thirteen percent of farmers were with less than one hectare of land. Sixteen percent and 11% of farmers had farm areas between three and five and five to seven hectares respectively. The recorded percentage of farmers with more than seven hectares of farm lands was 5%. Data also varied by community. None of the farmers from community B had more than 5 hectares of farm land. Only the farmers from community C used more than 7 hectares of farm land. Multiple reasons were produced by the farmers for having rested areas in their farms. The main reason for the majority (95%) of farmers was the disease risk—they were skeptical to invest in full capacity. According to Fast and Lester (1992), a World Bank study on marine shrimp farming has indicated that the ‘ideal’ size of a profitable shrimp farm is 300 ha under the semi-intensive system. In this context, shrimp farms in Sri Lanka are notably smaller in size.

Dahdouh-Guebas et al. (2002) identified three scales of production in Sri Lankan shrimp farming. This categorization was based on the industry situation before the year 2000. According to them, the average farm area criterion for large-, medium-, and small-scale shrimp farms was larger than 15 hectares, between two and 15 hectares, and between 0.5 and 0.7 hectares, respectively. However, based on the study data, the size of recorded farms ranges between one and three hectares. Even the largest farm is less than seven hectares in size. In contrast, before the year 2000, relatively large-scale farms did exist. However, such farms do not exist now due to multiple reasons such as disease outbreaks, existing management system, etc.

When compared to the scale of semi-intensive shrimp aquaculture farming systems in other countries, Sri Lanka has a relatively small-scale system. For example, the average size of a farm in Ecuador is about 50 hectares (Fast & Lester, 1992). Even at the beginning of the industry, in comparison to the scale of shrimp farming operations in other countries, there were no such large-scale shrimp farms. Although those farms were relatively larger than the average size of a current farm, on a global scale such farms may

be considered as medium in scale. The presence of a relatively small natural water body (compared to other shrimp farming countries) could be a reason for not having large-scale shrimp farms in Sri Lanka.

Some community shrimp farmers strictly believe that small-scale shrimp farming creates a relatively low impact on the environment compared to large-scale shrimp operations. Table 4.1 provides evidence to prove that small farms are comparatively less harmful to the environment. Small farms release relatively less waste water to the common water system in an intermittent manner. Therefore, the environment has the capacity to absorb and recycle waste water unlike in the case of larger farms, where waste is released in larger amounts at once. Further, economical loss due to shrimp diseases is less in small-scale operations.

Table 4.1: Comparison of impacts: small-scale vs. large-scale

Concerns	Small-scale farms	Large-scale farms
Amount of waste water released to the environment (small canal system)	Low	High
Nature of waste water release	Small amounts of water from time to time	Large amount of water at once
Environmental ability to absorb the waste	Relatively high	Relatively low
Economical loss due to disease conditions	Relatively low	Relatively high

Overall, the collected data provides evidence on the existence of small-scale shrimp farming operations in northwestern Sri Lanka. It seems that only the small-scale shrimp farms have managed to survive the shrimp disease conditions.

4.5 Better management practices or best management practices

Initially, there was confusion about the abbreviation ‘BMP’ used by shrimp farmers. In local language, the meaning of BMP translates as ‘better management practices’.

According to the National Aquaculture Development Authority (NAQDA) officers, it is a set of practices to be followed by shrimp farmers for the purposes of minimizing disease risk and for ensuring the sustainability of the sector. However, these guidelines are not rigid due to the dynamic nature of environmental, social, and economic factors prevailing

in different communities. According to farmers, in the history of shrimp farming, certain farmers have knowingly or unknowingly used some of these BMPs in managing their farms. Hence, farmers are very familiar with the BMPs.

NAQDA has introduced a set of basic 'better management practices' to community-level shrimp farmers' associations as a resource management approach. These management practices provide guidelines for the entire operational process (i.e., the steps that should be taken and the things they shouldn't do). Most of the time, these guidelines are flexible so that farmers can adapt based on their situation. For example, it provides a range for stocking density depending on the use of aerators (i.e., 4–6PLs/m² for a pond without aerators; maximum stocking density for a pond with aerators is 10 PLs/m²).

Associations adapt and fine tune these BMPs to suit their environment and social conditions (such as salinity levels in each area affecting use of paddle wheels, having mangrove vegetation closer to farms, success of previous crops, type of main water source to the community, etc). Therefore, management practices at the community level are unique and these could be identified as current 'best management practices' for that particular community. For example, NAQDA's guidelines mention the necessity of having aerators after one month of production cycle. However, community A's association's guideline (BMP) is to have at least two aerators before two weeks of shrimp seed stocking. It is the responsibility of community associations themselves to monitor whether farmers continue to follow BMPs set forth by them. Community associations are also responsible for reporting to NAQDA on adherence by farmers to these practices. NAQDA's current role regarding BMPs is to monitor through community associations. In conclusion, BMPs introduced by NAQDA is a set of guidelines aimed at better managing available resources. Once these guidelines are adapted at the community level (based on their environmental and social conditions), then such BMPs become 'best management practices' for that community.

4.6 Annual zonal crop calendar

Zonal crop calendar is a defensive shrimp disease management approach practiced by the shrimp farmers in northwestern Sri Lanka. It was initially introduced by the Sri Lankan Aquaculture Development Association (SLADA) in 2004 and the implementation was legalized by the fisheries ministry of Sri Lanka. The uncontrollable nature of shrimp disease conditions and the resulting impacts to the shrimp farmers and other stakeholders led to the development of the crop calendar. The objective of the crop calendar is to minimize the damages caused by shrimp diseases (mainly white spot viral disease) in order to increase national-level shrimp production. It provides an annual plan for shrimp farming in the northwestern area. How does the zonal crop calendar work? The foundation is the sub-zonal boundaries, which are developed based on the connected nature of the natural water canal system in the area. The calendar year is divided into three seasons of production: pre-yala (February to April); yala (April to September); and maha (October to February). Production seasons are assigned to sub-zones/farming communities by considering the disease spreading patterns along the water canal system. Each community gets at least one or two production season(s) per year. The zonal crop calendar becomes the most significant component of the existing management system as it determines all the other activities related to shrimp farming (PL production, shrimp production, etc). The statement given below illustrates the significance of the crop calendar.

“Now every shrimp farmer has to go through the community association to do shrimp farming... Not like early days; now it is controlled. No shrimp farmer can do farming ignoring the crop calendar.”

President (Community Association A)

Development and implementation of the annual zonal crop calendar is coordinated by NAQDA. Development of the crop calendar is a collaborative process taking place on an annual basis. Lessons learned by implementing the previous crop(s) is used in continuously improving the upcoming year’s crop calendar to suit prevailing conditions such as weather; canal water flowing patterns; water availability/salinity; disease prevalence, etc. Community-level associations meet during and after each crop season to discuss, evaluate, and come up with adjustments required for the current and the next

crop. These feedback and suggestions are escalated to the national-level crop calendar development meeting through sub-zonal and zonal representatives. Therefore, the zonal crop calendar (designed for a particular season) is an outcome of a continuous learning process. Figure 4.2 shows the learning process of crop calendar development.

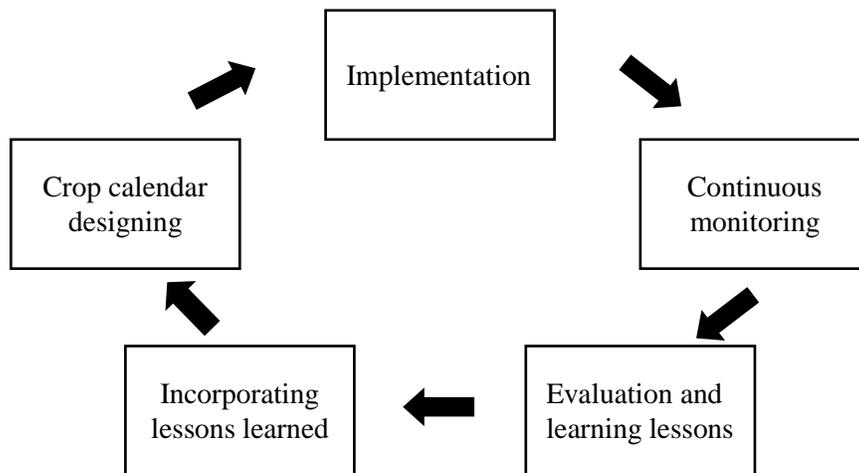


Figure 4.2: Learning process of crop calendar development

In conclusion, the zonal crop calendar system is a major component of the existing shrimp aquaculture management in northwestern Sri Lanka.

4.7 Basic shrimp operations

4.7.1 A shrimp grow-out pond

A shrimp pond consists of dikes, pond area, water outlet, outlet canal, and inlet water canal. Dikes surrounding the pond area provide strength to hold the water body inside. The depth of the pond is about one meter and it gets lower towards the dike area (See Appendix A for basic characteristics and a cross section of a pond.). Water is usually pumped to the pond from an inlet canal using large submersible pumps. The inlet canal is directly or indirectly connected to the water source. The pond outlet should be able to withstand the pressure from the entire water body inside the pond during harvesting/draining. Therefore, the outlet is usually made using concrete and bricks. The outlet canal is directly or indirectly connected to the inlet water source of the same farm and/or any other farms. The recorded average size of a current shrimp pond varies from 0.2 to 1.2 hectares. Pond size reflects the PL stocking capacity of a pond. Based on the

literature, the minimum pond size has to be 0.2 hectares to obtain an economically feasible harvest from a single farm (Fast & Lester, 1992).

4.7.2 Special requirements for shrimp farming

When compared to other provinces in Sri Lanka, major characteristics suitable for shrimp farming operations are found in the northwestern province, such as brackish water and appropriate soil type and topography. A reliable and consistent supply of water is crucial for shrimp farming. Specific soil and water quality parameters required are: salinity (15 to 25 p.p.t.); temperature (30 to 32 °C); soil pH (6.5 to 7.0); water pH (8.0 to 8.5); dissolved oxygen (> 4.0 p.p.m.); and ammonia concentration (< 0.1 p.p.m.). Another important requirement for shrimp farming is the soil type in terms of two aspects: retaining water for a long period of time without leaking and supplying soil nutrients to maintain a good algae growth in the pond water body. Soil types meeting these requirements are those with a good mixture of sand particles of different sizes (silt and clay). Topography of the land area for building a proper pond and a canal system should be elevated, flat, and easily drainable.

4.7.3 Inputs used

Main inputs used in shrimp aquaculture are given in Table 4.2. Dutch canal and lagoon systems act as major sources of water. Some farmers in the northern part of the northwestern province (*Kalpitiya* area) use tube wells as the water source, especially during the dry seasons of the year. According to calculations, the water requirement for operating a 0.5-hectare pond during a single cycle (four months) is more than 20 million liters.

Table 4.2: Inputs used in shrimp aquaculture

Input	Available types	Source
Culture medium	Brackish water	Dutch canal, lagoons
	Fresh water	Tube wells
Reared species	Postlarvae	Shrimp hatchery
Food source	Formulated feed	Feed suppliers/agents
	Algae	Naturally found in water
Aeration	Paddle wheel aerators	N/A
Water exchange mechanism	Water pumps, submersible pump	N/A

Input	Available types	Source
Power source	Diesel generators, electricity power	N/A
Pond area	Land	Mangrove area, wetland, coconut, paddy farm lands or government-owned bare lands

Postlarvae are purchased from shrimp hatcheries specialized for shrimp postlarvae production. Formulated feeds and algae are the main food sources of shrimps. Formulated feed is available from feed suppliers/agents or feed shops. Algae are naturally found in water. Certain farmers add vitamins and fertilizers into the water for a better algae growth. Paddle wheel aerators are used to aerate pond water (i.e., the culture media). Water exchange is done by using diesel pumps and/or submersible pumps, which are efficient. Paddlewheel aerators, water pumps, and submersible pumps demand a large amount of energy. Electricity power or diesel generators are the main power sources.

4.7.4 Basic economics of shrimp farming

Pond construction accounts for an initial significant cost in shrimp aquaculture. However, as of now, farmers in the northwestern area do not construct any new ponds due to the availability of already constructed ponds (which have been abandoned for a long time).

Table 4.3 details the major costs incurred in shrimp aquaculture.

Table 4.3: Major cost components of shrimp farming

Major cost component	Details
Pond preparation	Pond preparation involves two types of costs. Some farmers use machines (like excavators) to remove bottom sediments and to reconstruct dikes. Some farmers prefer to use manual labour.
Shrimp Postlarvae (PL)	Laboratory costs are involved in obtaining certificates on PL quality and in testing for any diseases. Cost is about CAD 25.00 per test. PL cost varies between CAD 0.005–0.01 per PL.
Shrimp feed	Feed is the most significant cost component of shrimp farming. Feed consumption of shrimps gradually increases throughout the four-month growth period. There are about three feed brands in the market. Average price is about CAD 2.00/kg.
Electricity and fuel	Electricity requirement is mainly for operating large water pumps, paddle wheels, and for lighting during night. The majority of farmers depend on diesel generators for electricity. This brings the cost of fuel.
Labour	Most shrimp farmers receive the help of their family members and relatives to carry out farming activities. Such farmers require a minimum

Major cost component	Details
	amount of external labour. The number of employees required per area is low. However, some large-scale farms hire staff, including a manager and a few skilled labourers.
Equipment	Frequent repairing and servicing is needed for machinery (water pumps, paddle wheels, generators) due to brackish water environments and frequent usage. Farmers service their equipment in between two culture seasons.
Fertilizer and chemicals	Farmers use dolomite to change water pH and cow dung to increase algae growth. They also have to purchase bleaching powder to disinfect water just after filling the pond and also in case of a disease situation, to disinfect both water and pond area.
Harvesting	Some farmers outsource the harvesting process to outsiders who are specialized and resourceful in harvesting operations (fishing gear, etc. are required). Harvesting is done by a group of people using different types of nets.

4.7.5 Presence of integrated production (polyculture)

During farm visits in the northwestern area, the researcher noticed very few farmers doing integrated production. The most common activity is the rearing of fish along with shrimp in the same pond. The most popular fish species is milkfish (*Chanos chanos*). Farmers believe that fish rearing helps growth of shrimps and minimizes disease risk. Most of the farmers introduce milkfish fingerlings after about 1.5–2months of shrimp PL stocking. The researcher met a single farmer rearing goats in his farm land. This farmer has about 50 to 60 goats reared for milk and meat purposes. Cultivation of fruits and vegetables, such as watermelon, tomato, and chili, on dikes of shrimp ponds was also observed.

4.8 Social-ecological systems of shrimp aquaculture

4.8.1 Connected water bodies and spreading of white spot disease

In the past, Sri Lanka has experienced three major shrimp disease outbreaks. The first one was *Monodon Baculo Virus* (MBV) spread during 1988 through the 1990s. MBV stunts growth of shrimps during their growing stage. The second virus was White Spot Syndrome (WSS) in 1996. Finally, both Yellow Head Virus (YHV) and WSS came together in 1998. WSS is the current major threat to shrimp aquaculture in Sri Lanka

(Munasinghe et al., 2010). WSS is a viral disease, which mainly infects Penaeid shrimp species. The virus causing WSS is Systemic Ectodermal and Mesodermal Baculo Virus (SEMBV) (Lightner, 1996). Two main characteristics of WSS are its ability to act fast and kill shrimps within about 24 hours, and its ability to spread fast using other aquatic animals (crustaceans, birds, etc.) as carriers. The latter creates the main impact as it quickly spreads throughout the entire water system and to all the shrimp farms connected by the water system.

As mentioned previously, almost all the shrimp farms in the northwestern province are directly or indirectly connected to a single major water body via the Dutch canal and lagoons. Figure 4.3 shows how water bodies are connected through the Dutch canal. Box (a) shows the map of study area and box (b) is a graphical representation of the main water bodies found in the area. *Puttalam* lagoon (28,000 ha), *Mundal* lagoon (3,600 ha), and *Chilaw* lagoon (700 ha) are the three main lagoons connected by the Dutch canal. *Kala Oya*, *Mi Oya*, *Daduru Oya*, and *Maha Oya* are the four main rivers connected to this water system. *Kala Oya* and *Mi Oya* directly empty out to the *Puttalam* lagoon. *Daduru Oya* and *Maha Oya* cross the Dutch canal and empty out to the sea. In addition to the above-mentioned water bodies, there are other relatively small rivers and streams connected to this system (such as *Karabalan Oya/Lunu Oya* in *Thuduwawa* area; *Mundal* lake at *Udappu* North area; *Sengal Oya*, *Ratambala Oya*, *Battulu Oya*, and *Madurankuli* stream). This interconnected water circulation system is the main feature considered in developing the seasonal crop calendar system.

The nature of WSS virus is such that it can live and develop within shrimps without reaching the disease stage. If shrimps are stressed out or become weak, then the disease surfaces. The researcher heard about some farmers continuously growing shrimps infected with SEMBV. Due to this situation, now it is mandatory for farmers to test postlarvae samples for diseases before stocking. A test called polymerize chain reaction (PCR) test is performed to check for this virus. The government also financially supports shrimp farmers for PCR testing as a precautionary measure to prevent diseases. As of

now, there is not any treatment available for this virus. Hence, better management practices (BMPs) is the only available solution for managing WSS.

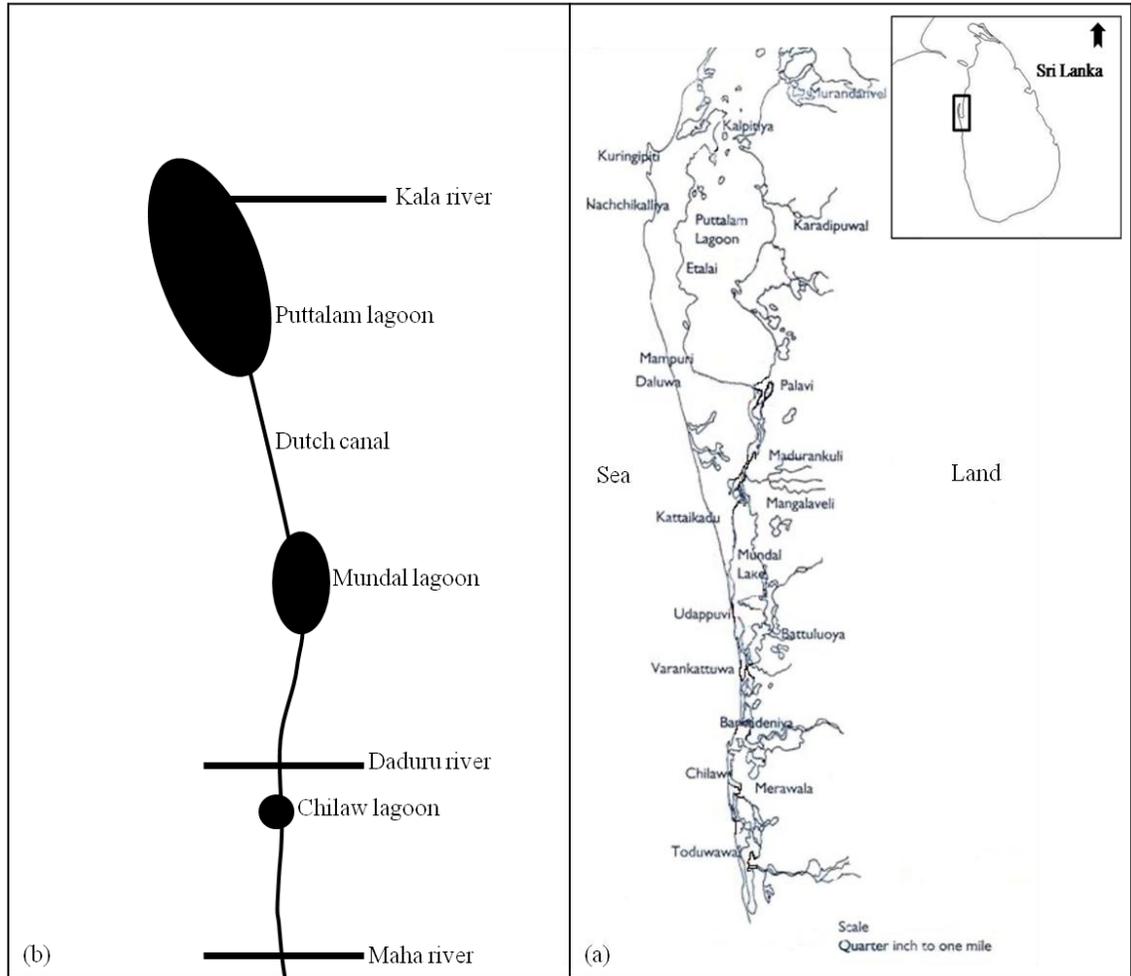


Figure 4.3: Map of connected water bodies in shrimp farming areas

4.8.2 Mangrove vegetation and shrimp farming

During the field data collection period, the researcher visited several other communities/sites as an observer (in addition to communities A, B, and C) upon hearing about any practices different from the usual ways of doing farming. During these visits, the researcher came across two sites located in *Karukapane* and *Bangadeniya* with several farms claiming to be doing well over the years despite disease outbreaks in surrounding farms.

A single community association manages shrimp farming activities of both these areas as the total number of active shrimp farmers coming from both these areas is about 30 (which is a low number compared to other areas). The researcher attended their association meetings as an observer. One time, the topic was to discuss if they should continue to farm during the next crop season or not. Farmers mentioned that the majority of their farms were already infected. However, a few farmers having farms which were not infected wanted to continue, as they believed that they were not at risk of getting any disease based on their past experience (over the last two to three years). The most interesting fact that surfaced during this discussion was that the geographical location of these farms was different from the rest. These farms were surrounded by mangrove vegetation.

During the farm visits, the researcher managed to visit four of the above farms, which were located in remote areas. These farms were bordering to mangrove forests (not totally surrounded by mangroves). Inlet water canals ran through rich mangrove forests and hence water was filtered through thousands of mangrove roots before entering ponds. After interviewing these farmers, it was discovered that the inputs they used (same water source—Dutch canal; feed; dolomite; other chemicals like bleaching powder to clean water; etc.) were similar to those used by the other farmers (with farms susceptible to diseases). They had even bought postlarvae from the same hatcheries. Therefore, the reason why these farms were not at risk for disease outbreaks could be the mangrove forest (or at least the mangrove forest could be one of the multiple contributing factors).

4.8.3 Social background of shrimp farming communities

Shrimp farming communities show diverse social backgrounds. For example, community A is a coastal fisheries community with the majority of people engaging in fishery-related activities as income sources. Community B is located in between a lagoon and a coastal area. Therefore, most people do both lagoon and coastal fishing activities. Community C is also a lagoon-based community. People in this community are involved in diverse income-generating activities, including lagoon fishery, salt manufacturing, vegetable cultivation, etc. All in all, shrimp farming communities very much rely on local resources in income-generating activities. The households also depend on local resources for food

(such as fruits, nuts, yams and roots, and herbs), medicinal plants, fuel wood, etc. Natural water sources are especially used for day-to-day activities such as bathing, washing clothes, cleaning animals, etc.

Friendliness, willingness to help each other, empathy, and collectivism are part and parcel of local culture. Many collectively managed arrangements beyond shrimp farming activities were observed. Most communities have their own small community hall (called *prajashalawa*) as the place for them to gather for different activities. Death benevolence society is one such collectively managed arrangement. The meeting place is busy on a daily basis and it needs to be reserved ahead of time for any activity. In certain communities, the temple or church provides a venue for community members to gather instead of a community hall. For example, village fishermen and women gather to discuss health-related matters, religious matters, etc.

Regarding local customs, community households have specific beliefs and values. In relation to shrimp farming, it was observed that community B farmers split a coconut on top of each pond dike before harvesting. A scented stick (*handun kuura*) and a candle-like, flammable small cube (*kapuru*) are lit on the coconut just before splitting. Farmers believe that this destroys any evil spirit.

Community households fulfill their needs within the community to a large extent. For example, they have retail grocery boutiques, a primary school, a temple/church, etc. For other activities they rely on nearby towns or cities. Some people sell fish in outside markets. Some work for the government or manufacturing companies (seafood, garments), etc. located outside of the community area.

4.9 Summary

This chapter provided evidence on the existence of community-based shrimp aquaculture management in northwestern Sri Lanka. Sample profiles of individual farmers gave an overview of shrimp farmers and their farming activities. The chapter also explored basic shrimp farming operations; scale of farming; better management practices; and social-

ecological systems of shrimp aquaculture. This chapter laid the basic foundation for the thesis, which sought to study applications of commons theory in order to investigate the option of using community-based operations as an alternative to large-scale aquaculture operations.

**CHAPTER 5: DRAMA OF COMMONS—SHRIMP AQUACULTURE IN
NORTHWESTERN SRI LANKA**



Plate 5.1: Community hall of community B



Plate 5.2: Dutch canal running through community B

5.1 Introduction

The objective of this chapter is to explore any commons institutions in the shrimp aquaculture system; how small-scale aquaculture operations can be connected through commons rules into community operations; and how these parts fit into an overall governance system. The chapter explores the commons in the context of shrimp aquaculture. In particular, rules relating to subtractability and excludability problems (Ostrom et al., 1999) are studied in detail. The evolution/development of the aquaculture commons management system is explored. The chapter further investigates the shrimp aquaculture system at three levels: individual farm and farmer; collective aspects of aquaculture operations (*samithiya*=association); and government institutions involved and co-management. It explores how each of these levels work as part of a commons governance system, including the scope of decisions made at each level. The chapter presents how information on shrimp aquaculture is shared in the community-based setting. Institutional mapping, relationship diagrams, and matrices are used in this analysis.

5.2 Commons applications

Before applying commons rules to the context of Sri Lankan shrimp aquaculture, it is important to identify the kinds of common resources in this context. Commons are different in shrimp aquaculture when compared to other areas such as offshore fisheries and/or forest resources, etc. In shrimp aquaculture management, the main common resource is not cultured shrimps, but the social-ecological systems within which farming is carried out.

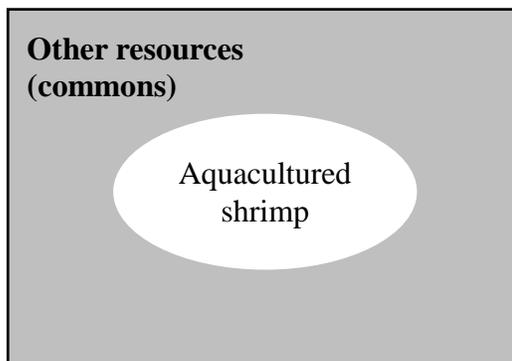


Figure 5.1: What are the commons in shrimp aquaculture?

Social-ecological systems of shrimp aquaculture are complex and include many inter and intra linked sub-systems. Based on observations and contextual understanding obtained during field work, an attempt was made to identify the components of these social-ecological systems. The identified components were: natural resources; resource users; waste/by-products; institutions; products; ecosystem services; systems and procedures; markets; and human well-being. Selected examples under each of these components are given in Table 5.1.

Table 5.1: Selected examples for social-ecological systems

Components of social-ecological systems	Selected examples
Natural resources	Common water body
	Mangrove and wetland ecosystems
	Biodiversity
	Atmosphere
Resource users	Shrimp farmers
	Community fishermen
	Community households
Waste/by-products	Waste water from shrimp farms
	Excess shrimp feed
	GHG emissions
Institutions	Community associations
	Government institutions
	Other stakeholder institutions
Products	Shrimp harvest
	Wild fish/shrimp caught from lagoon
	Handicraft and other small-scale entrepreneurs (e.g., basket weavers)
Ecosystem services	Water filtration through mangrove roots
	Algae production
	Plant photosynthesis
Systems and procedures	Zonal crop calendar system
	Community-level shrimp aquaculture management
	Better management practices
Markets	Shrimp processors
	Local markets
	Shrimp/fish collectors
Human well-being	Housing conditions
	Social harmony
	Health and human nutrition

Subtractability problem

The next important aspect of the commons rule is the application of two basic characteristics of commons: excludability and subtractability (Berkes et al., 2001). Among these two, subtractability (Ostrom et al., 1999) is the main problem related to shrimp aquaculture.

The subtractability problem (Ostrom et al., 1999) in shrimp aquaculture is mostly associated with the discharge of used pond water. A farmer may release disease-infected water from shrimp farming ponds into the surrounding environment. It affects the ability of other shrimp farmers to continue farming without being infected. For example, if a particular farm is infected with diseases at the latter stage of the production cycle, the rational behaviour of the farmer is to harvest the pond as soon as possible (before quality of shrimps is further degraded) to earn a profit. However, if this farmer releases contaminated pond water to the common water body, there is a high possibility of disease spreading into other farms. Other farmers may not have a marketable shrimp growth to survive the culture cycle. Therefore, release of disease-infected water can decrease total shrimp production and cause a loss of potential income due to disease spread.

Even under disease-free conditions, the subtractability problem (Ostrom et al., 1999) can occur in shrimp farming. Used pond water contains large amounts of excess shrimp feed, crashed and live algae, faecal matter of shrimps, etc. Ammonia concentration of waste water is high and it can be toxic to other aquatic fauna and flora. Nutrient-rich water and algae also leads to algae blooms and eutrophication conditions in surrounding water bodies. Moreover, water released from ponds contains sediment soil particles, which is capable of blocking the natural canal system. Aggregated effects of used/waste water releasing activity could break the ecosystem equilibrium.

How, and to what extent, shrimp farming activities affect the lives of people in the community is another way of looking at this problem. As discussed previously, shrimp farming activities and adding waste water into common water bodies creates significant environmental damage. This damage affects the livelihoods of people who live closer to

the water body. In the Sri Lankan rural context, it is very common for people to depend on natural water bodies for day-to-day activities such as bathing, washing clothes, and washing animals (e.g., cattle). Discharge of waste water to natural water bodies significantly reduces water quality causing water to be less desirable to use for daily purposes.

In addition, shrimp farming lands are connected to the subtractability problem (Ostrom et al., 1999). Most shrimp farms are on mangrove forests and wetlands (previously government-owned lands), affecting the aesthetic value of the environment. Many farms remain abandoned due to disease outbreaks. Further, during the 1990s, when the industry was growing, even coconut lands were converted into shrimp farms. People who worked for these coconut lands lost their source of income, since not many job opportunities are available in these areas except for general labour.

Shrimp farming demands a relatively massive amount of water within a short period of time. Some shrimp farmers pump ground water using large tube wells² to mix with high saline lagoon water. This practice is popular in community C (*Puttalam* area), which is a comparatively dry area. Use of ground water in shrimp farming could be a reason for the declined ground water table in this area, making water a scarce resource. People walking for miles every day to fetch water for drinking and for other household activities is not uncommon in this area.

All in all, the subtractability problem (Ostrom et al., 1999) related to commons in shrimp aquaculture is the main problem creating ecological, social, and economical damages. The main reasons behind this problem are: the rational behaviour of people (Hardin, 1968) and the existence of open/free access (Berkes 2009; Feeny et al., 1990; Ostrom et al., 1999) to the natural environment to extract resources and dispose waste. Individuals or firms neither have to pay for using the natural environment for dumping waste nor do they have an incentive to control this behaviour. There is also an environment externality as the waste disposal cost is not incurred by shrimp farmers who produce waste. In the

² Tube wells pump water from the deep underground aquifer.

case of using natural resources, there is no guideline on optimal usage levels (to ensure sustainability). Therefore, it is apparent that absence of a market and a price for using natural resources result in a market failure. This brings about the need of government intervention.

Excludability problem

The excludability problem (Berkes, 2009; Berkes et al., 2001; Feeny et al., 1990; Ostrom et al., 1999) in the Sri Lankan shrimp aquaculture sector is similar to that of other areas, basically due to the static nature of resources. Most of the lands used in shrimp farming are government-owned lands. Some shrimp farmers have managed to obtain legal deeds for the lands they use, but the majority face land ownership-related issues.

Common pool resources are defined as “a class of resources for which exclusion is difficult and joint use involves subtractability” (Feeny et al., 1990). This concept is applicable to the context of Sri Lankan shrimp aquaculture. In terms of categories of property rights within the common property regime, the current governance system seems to be largely a communal property, with some state governance. There are community-level shrimp farmers’ associations to manage resources. These community associations have their own constitutions and are capable of making their own rules for ensuring betterment of membership. Based on researcher observations, all three of the communities have strict rules for newcomers who wish to enter shrimp farming. Candidate farmers are observed for at least a period of six months by the relevant community association. These people have to attend community association meetings throughout that time. Only with the approval of the entire membership of a particular community association can they start farming. I met two such farmers, who came to community A’s association meeting. This is how a community association excludes others from using resources available in an area.

The zonal crop calendar system is another way of applying excludability at the zonal level. Zones are designed by SLADA based on geographical location and the common natural canal system in the northwestern area. These zonal/sub-zonal boundaries are used

to exclude farmers from using water and other natural resources during a certain period of time. Within a particular timeframe of the year, only a selected group of farmers coming from a certain sub-zone/zone are allowed to use the common water source for farming, instead of all farmers using the water source at once.

5.3 Development and evolution of commons management

The type of management system found in the 70s and 80s was a corporate-based management system. There were only about four large multi-national companies. These companies were the beginners in culturing shrimps in Sri Lanka. To begin with, all the operations were done in an integrated fashion, where shrimp breeding (hatcheries), farming, processing, as well as exporting activities were managed by the same company. According to available records, these companies were powerful and influential, as they managed to earn lucrative profits. There was minimum involvement and supervision (control) by central, provincial, and municipal government institutions, despite significant environmental impacts.

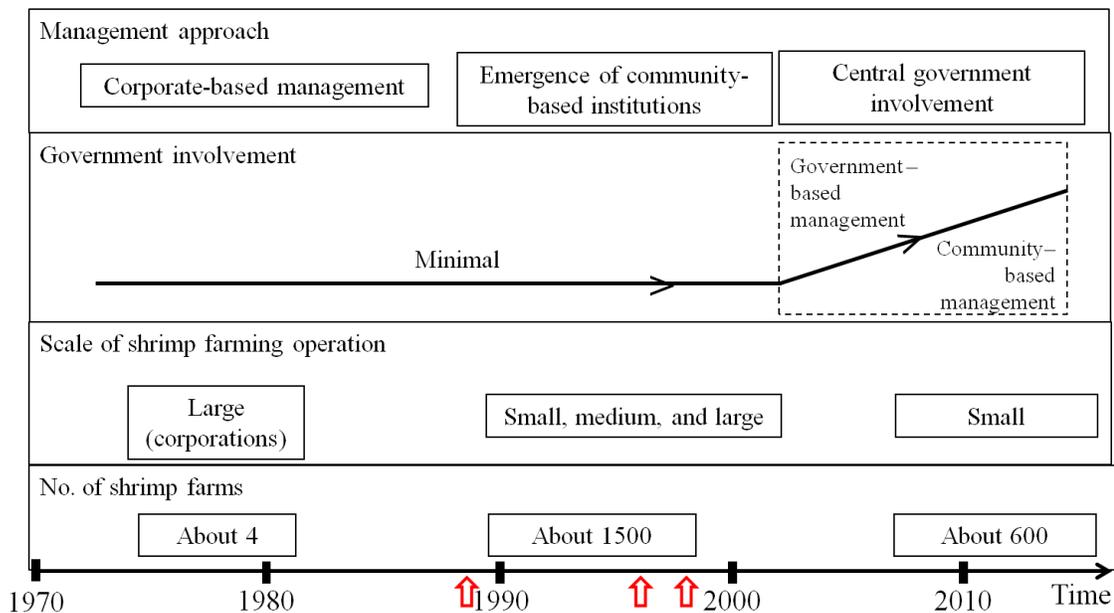


Figure 5.2: Trajectory of shrimp aquaculture under different management systems

By the 1990s, shrimp farming activities expanded all over the northwestern coastal region of Sri Lanka, when lots of medium- and small-scale farmers entered the sector. During

this time, community-based associations emerged in certain communities. By custom, Sri Lankan communities tend to act as collective groups for the betterment of everyone. Large-scale corporations continued farming as usual in the meantime. In 2003/4, the central government was directly involved in the management of the shrimp aquaculture sector through the NAQDA. Based on the facts gathered through the research, many changes took place followed by this involvement. These changes have been separated into three stages: A, B, and C.

Stage A (Year 2003–2006)

Before 2003, there was no proper control over shrimp farming activities. Resource management activities were restricted only to self-managed community-level associations; though these associations were not recognized by the government. There was no proper linkage between farmers and the government, resulting in mismanaged production and poor quality standards. For instance, there was no specific timeframe for stocking shrimp PLs. Shrimp farmers and hatcheries continued production throughout the year. People entered farming as they wished and quit whenever they experienced financial losses. Farmers in certain areas (e.g., *Arachchikattuwa*) faced financial losses due to disease infections as well as theft, conflicts, and other socially unacceptable behaviours such as threats, physical abuse, etc. According to farmers, threats and physical abuse often took place as a result of the involvement of certain community-level political leaders.

As mentioned earlier, NAQDA was the line authority through which the Sri Lankan government got actively involved in the shrimp farming sector in the year 2003/4. NAQDA's approach was to work in collaboration with SLADA and community-level shrimp farmers' and breeders' (hatchery owners) associations. Initially, it was not easy for the independently-operated actors of the sector (especially shrimp farmers and breeders) to adjust to the new management system. They were skeptical of the purpose of government involvement in the sector. Introduction of the zonal crop calendar system was one of the initial interventions (in 2005/6). The crop calendar significantly changed how farming operations were conducted. The initial reaction of shrimp farmers and

hatchery owners was to resist, mainly because the crop calendar limited the production cycle (number of crops per year). Moreover, the introduction of new standards and quality improvement measures targeting shrimp farms and hatcheries led to significant conflicts. Adoption of these measures required costly physical infrastructure changes such as construction of chlorine baths at farm and hatchery entrances to control disease spread. NAQDA field extension officers were tasked with monitoring these standards by visiting farms and hatcheries. However, these officers at times were not allowed to visit farms and hatcheries—there have been reported incidences of serious verbal conflicts and even physical harassment. NAQDA Head of *Battulu Oya* regional office recalled his experience of being hospitalized after being physically assaulted by some farmers during office hours. This incident exemplifies how difficult it was for the farmers to adapt to the new management system and how they responded to the changes.

During the first few crop cycles under the new zonal crop calendar system, some relatively large-scale shrimp farmers quit farming. For them, it was not profitable to maintain their farms in an idle state during some parts of the year, as they still had to incur costs of salaries, maintenance, etc. A few of the relatively large-scale hatchery owners also left the industry for the same reasons. The overall effect of these changes was a decrease in national shrimp aquaculture production after 2003. In contrast, farmers and hatchery owners who remained in the sector experienced a very successful crop just after the introduction of the zonal crop calendar. Farmers got a good harvest due to less disease-infected ponds, and hatchery owners got a good price for PLs. Interestingly, after realizing the success, some farmers who left earlier joined again in the following season; however, the result was an unsuccessful crop during the following season (in terms of production and market prices).

Stage B (Year 2006–2009/10)

During the period between 2006 and 2009/10, there were ups and downs in terms of shrimp production. People started to think that the white spot disease had been eradicated, but it kept coming back from time to time. Most of the medium-scale farmers also left farming due to the uncertain nature of production and significant increases in

costs of labour, fuel, chemicals (chlorine), etc. During this period, inflation in the country drastically went up.

By this time, the majority of farmers and hatchery owners in the industry had adapted to the new crop calendar system. Most of the existing community associations were also strengthened and some were newly established by NAQDA. In the meantime, NAQDA's aquaculture field extension officers visited farming communities without any problem. NAQDA itself became more flexible in their approach after the experience they underwent during stage A. Still, there were some recorded illegal activities such as shrimp postlarvae stocking and releasing disease-infected water into the natural water body. NAQDA and SLADA took actions against such activities with the support of community-level associations. Overall, the new shrimp aquaculture management system was relatively more established than at the initial stage.

Stage C (Year 2010–2012)

According to observations during field visits, the existing shrimp aquaculture management system had become well established compared to stages A and B. Certain community-level associations were capable in managing their farming activities with minimum supervision from NAQDA. For example, the researcher was invited by a community association in *Puttalam* area to attend one of their meetings as an observer. It was very impressive to observe how advanced they were in collectively addressing farmer issues and concerns promptly and in moving towards achieving their target. This community association was planning to buy land to build their own meeting place and a small laboratory (to test shrimp samples for white spot disease) to avoid the long drive to other laboratories. In addition, most of the community associations emphasize to their membership the importance of managing natural resources—an aspect that was totally ignored during the initial stages.

Based on records, in the late 90s there were about 1500 active shrimp farms in the northwestern area. This number had dropped down to about 600 farms by 2012. This is

also applicable to the hatchery sector. In 2003, there were about 70 shrimp hatcheries but only about 40 of them still exist. All of these hatcheries are small in scale.

The Sri Lankan coastal shrimp aquaculture resource management system has various types of arrangements: collaborative partnerships; power sharing; and multi-level participatory approach. Participatory management approach can be observed throughout the management process, especially in making decisions and implementing resulting actions. Development of the crop calendar; streamlining the aquaculture management license issuing process; and implementation of better management practices are the major areas managed using the participatory approach. Different institutions/entities involved in these arrangements are: community-level organizations; central government institutions; provincial government entities; municipal entities; and local/international academic institutions (Figure 5.3).

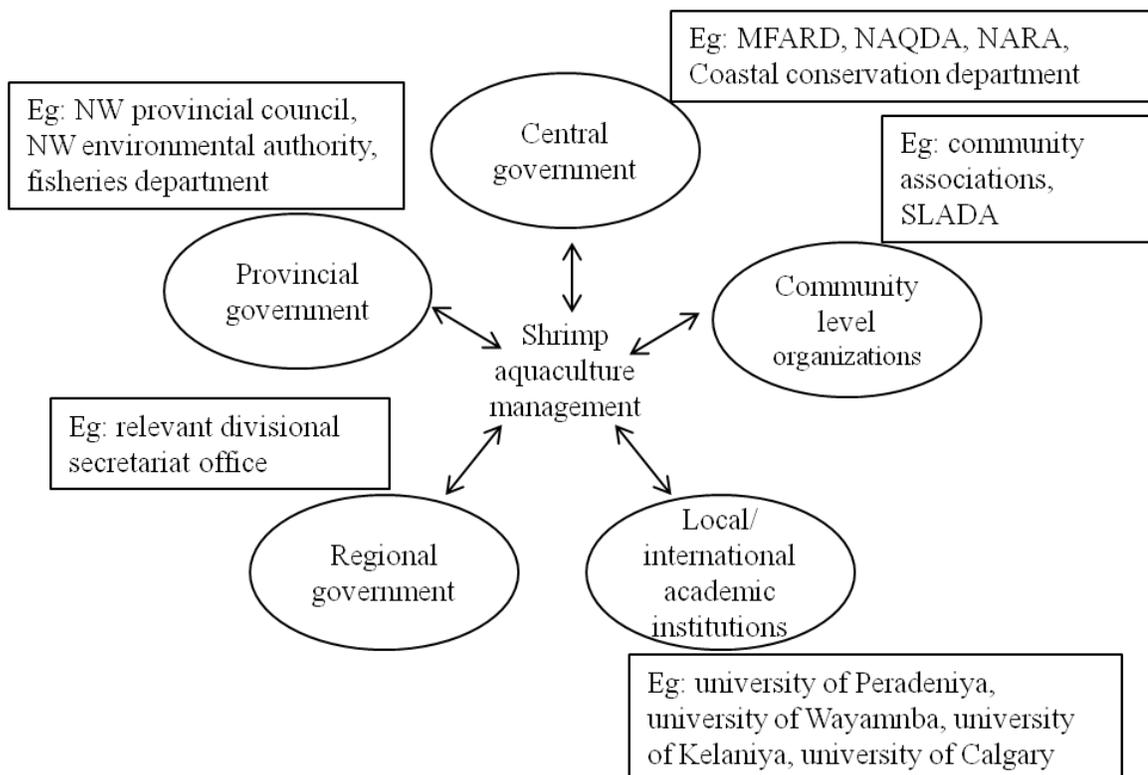


Figure 5.3: Collaborative relationships observed in managing shrimp aquaculture

5.4 Existing commons institutions

5.4.1 Community associations

Three community associations were studied. As shown in Table 5.2, these three communities are located in three separate zones (based on the zonal system described in Chapter Five). Community A (*Ambakandawila*) is located in zone one in the southern part of the study area. This is a rural, isolated, cohesive Sinhalese³ community. The nearest town is *Chilaw*⁴. The community shrimp farmers' association acts as a cluster organization representing two other surrounding communities/subzones (i.e., *Kaakkapalliya* and *Marawilla/Suduwella*). The reason for having a single association to represent both of the communities is due to the lower number of shrimp farmers coming from each of these areas alone. The community shrimp farmers' association was established in 2006 as a result of active involvement of government/NAQDA during the period when the crop calendar was introduced. In August 2012, this community association was registered under NAQDA. Membership is about 30, including seven officers. Officer positions are: president; vice-president; secretary; treasurer; and three committee members. Organization of these office positions is mostly flat.

Table 5.2: Comparison of profiles of selected community associations

Characteristics	Community A	Community B	Community C
Zone number	1	3	4
Subzones	Act as a cluster, managing 3 sub-zones together (<i>Kaakkapalliya, Ambakandawila, Marawilla/Suduwella</i>)	Act as a cluster, managing 2 sub-zones together (<i>Punapitiya/Watawana, Koththanhive</i>)	Act as a cluster, managing 3 sub-zones together (<i>Karamba, Mampuri/Eththale, Palliwasalthurel/Kandakuda</i>)
Ethnicity/culture of membership	Sinhalese	Tamil	Sinhala, Tamil, Muslim
Year of establishment	2006	1996	1995
Nature of origin (farmer initiated)	Government initiated	Farmer initiated	Farmer initiated

³ Sinhalese are the major ethnic group in Sri Lanka. They speak *Sinhala* language.

⁴ *Chilaw* is a coastal fisheries town in *Puttalam* district of northwestern province of Sri Lanka.

Characteristics	Community A	Community B	Community C
or government initiated)			
Registered year	2012	2002	1998
Registered under	NAQDA	Divisional secretariat office	Cooperative Act
Current membership	30	61	30
Number of officers	7	7	11
Availability of a constitution	Yes	Yes	Yes
Bank account	Yes	Yes	Yes
Letter head	Yes	Yes	Yes
Official rubber stamp	Yes	Yes	Yes
Meeting frequency	Monthly, special, and annual meetings	Monthly and special meetings	Monthly and special meetings
Power structure	Mostly flat	Hierarchical	Flat
Cohesiveness	High	Moderate	Very high

Community B (*Koththanthive*) is located in the center of the coastal line in the northwestern area. This is an isolated, rural Tamil⁵ community. Reaching this community is difficult due to poor road conditions and longer distance from the main road of Colombo- *Puttalam* main road. *Mundal* lagoon is the main water source for this shrimp farming area. *Mundal* lagoon is connected to the Dutch canal running from Colombo to *Puttalam* lagoon. Shrimp farms in the community are spread around the lake. Community B's farmers' association belongs to zone number three. The *Punapitiya/Watawana* sub-zone is also covered under this community association, which operates as a cluster. This is a farmer-originated community association. It was established in 1996 and registered in 2002 at *Koththanthive* divisional secretariat office. The initial membership of this association was 101. The present membership is 61 (the rest have quit farming). This association has eight officers and the positions are the same as in community A. Tamil is the language most frequently used during meetings and the power structure is hierarchical.

⁵ Tamil people are the second largest ethnic group in Sri Lanka.

Community C (*Karamba*) is located on the northern coastal line of the study area. This is also an isolated rural area. The nearest town is *Puttalam*. Shrimp farms in this area are located around *Puttalam* lagoon (which is connected to the Dutch canal) closer to the sea. Community Association C is considered to be one of the oldest shrimp farmers' associations in Sri Lanka. This association is a farmer-originated association. Even today, this is one of the most active associations in the study area. This association was established in 1995 and was registered under the Cooperative Act of Sri Lanka. Members come from Sinhala, Tamil, and Muslim⁶ ethnic backgrounds. Membership includes about 30 members, including 11 officers. The only difference when compared to the organization structures of other associations is the number of officers. This association has five committee members. Additionally, this is the only shrimp community cooperative the researcher found, with a full-time paid secretary position. Sinhala is the most commonly used language during meetings (all members are fluent in Sinhala).

It was interesting to probe into differences and similarities among community associations in terms of administrative practices. All three associations in the sample have their own customized constitutions. In particular, contents of constitutions vary according to the act/institution they have been registered under. For example, community B's association has a simple one-page constitution, basically to satisfy registration requirements of the divisional secretariat office. In contrast, community C has a detailed constitution, as it has been registered as a cooperative. Community A's association constitution is also a detailed document in compliance with NAQDA community association registration requirements. All three associations operate bank accounts for administrative and financial purposes. Moreover, they possess customized letterheads and official rubber stamps. All three of the associations conduct regular monthly meetings and special meetings depending on the requirements.

5.4.2 Sri Lanka aquaculture development association (SLADA)

SLADA is the national-level association which represents the stakeholders in the shrimp farming sector. This association was established in 2005 and later registered as a

⁶ By population, Muslim is the third largest ethnic group in Sri Lanka.

corporation in 2006. SLADA started with the representation of all the direct stakeholders of the shrimp aquaculture sector: shrimp farmers, hatchery owners, feed suppliers, shrimp processors, etc. The initial life and/or corporate type membership was 16. Later, zonal and sub-zonal community associations were allowed to become members, leading to an increase in membership up to 40 to 50 members.

Even though the current main objective of SLADA is to develop the shrimp aquaculture sector, initially their mandate was not restricted to shrimp aquaculture. Development and planning of ornamental fish aquaculture and inland aquaculture was also included in their mandate. In developing shrimp farming, SLADA appointed six committees to look at different subject areas, such as environmental protection, hatchery development, and shrimp farm development. Appendix C illustrates the organizational structure of SLADA. Moreover, SLADA and NAQDA jointly developed a technical advisory committee composed of experts from local universities, research institutes, etc. to obtain expert advice.

Shrimp aquaculture management system

The overall shrimp aquaculture management system is managed at three different levels by three management bodies (Figure 5.4). The top level of the hierarchy was represented by a combination of SLADA and NAQDA forming a common decision making body. SLADA represented community associations as well as all other stakeholders directly involved while NAQDA represented the government. The second level was represented by zonal-level associations. Shrimp farming areas were divided based on which divisional secretariat⁷ areas they belong to. A particular zone included one to three divisional secretariat areas. These zonal associations were mandated to closely work with divisional secretariat offices and provincial councils in the area. The third management level, or the bottom level of hierarchy, was named 'primary community associations'. These were the only farming organizations established by SLADA at the sub-zonal level. Ethnic, cultural, and language similarities of adjacent communities were considered in organizing these sub-zones, with the objective of overcoming communication barriers.

⁷ A divisional secretariat area outlines an administrative boundary.

Zonal/sub-zonal system

The northwestern shrimp farming area was divided into five main zones and 32 sub-zones. Some zones included just one sub-zone whereas the others could represent up to eight sub-zones. If the number of farmers coming from a particular sub-zone was not enough to claim it as a sub-zone, then adjacent sub-zones were amalgamated to form a single association to represent a cluster of sub-zones (to make sure a considerable number of farmers belong to each association). Primary community associations were represented by community-level shrimp farmers. Leaders of these sub-zonal associations represented the zonal association coming under a particular zone. All the zonal associations and the sub-zonal associations were collectively represented in SLADA. There was at least one representative from each zone and sub-zone. Structure of zonal and sub-zonal common institutions is shown in Appendix C.

It was the role of SLADA to assign different tasks to each level of management structure. Bottom-level primary community associations regulated community-level farming practices with the support of NAQDA field extension officers. For this purpose, SLADA requested MFARD (Ministry of Fisheries and Aquatic Resources Development) to establish a monitoring and extension unit in the northwestern area. As a result, the *Battulu Oya* shrimp farm monitoring and extension unit was established in 2008. It was the responsibility of second-level zonal associations to develop the infrastructure of shrimp farming areas in collaboration with divisional secretariat offices and provincial councils. Maintaining a link (mainly communication) between level one and level three was also a role of zonal associations. Finally, the role of top-level management (SLADA and NAQDA) was to develop a national-level shrimp aquaculture system overall.

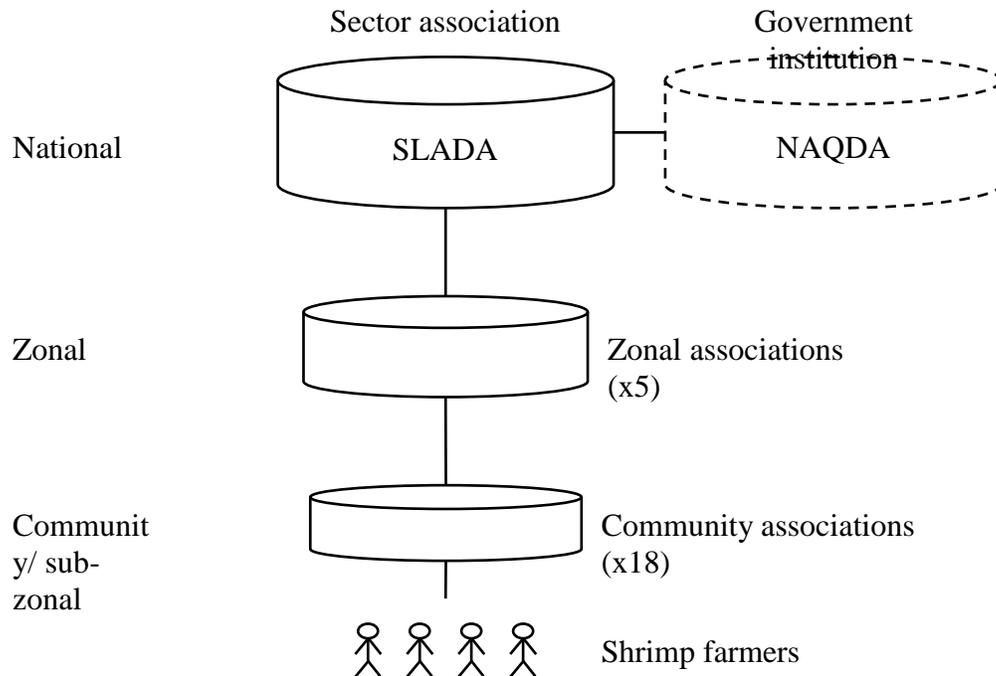


Figure 5.4: Structure of the commons institutions/hierarchy

Community-level meetings

Researcher observations indicated that all of the community-level meetings are structured in the same way. Generally, a community shrimp farmers' association meeting takes about 1–2 hours. The total time taken depends on the types of business to be discussed in a particular meeting. It was interesting to learn that the general expectation is for members to arrive at half to one hour's time late. Another interesting aspect is that the religious observations always take place at the beginning of the meeting. Meetings are chaired by the highest ranked officer in attendance (usually the president) or the secretary or treasurer. Physical arrangements of meeting places distinguish between officers and members; that is, the seating arrangement is such that the membership/audience faces the head table, where officers sit. The major component of a meeting is the scheduled businesses component. Subject matters are discussed in depth and lots of warm arguments and negotiations take place during this segment of the meeting. Lots of questions are asked by and of officers. Towards the end of a meeting, once the discussion slows down, the chairperson tries to conclude the meeting with a summary of decisions arrived at. Finally, closing remarks are given in the form of a thanking speech.

5.4.3 Exploration of government institutions involved

The structure of governmental institutions involved in the shrimp farming sector is illustrated in Figure 5.5. NAQDA is the central government institution directly relevant in managing the shrimp aquaculture sector. It comes under the purview of MFARD, which was established in 1999 by a Parliamentary Act (No. 53 of 1998) with a mandate to develop the aquaculture and inland fisheries sector in Sri Lanka.

The NAQDA shrimp farm monitoring and extension (M&E) unit in *Battulu Oya* monitors and regulates shrimp farming practices in the northwestern area. This unit is the direct policy enforcement interface of the government. Under this unit, there are three branch offices in different places in the northwestern area (*Pambala*, *Arachchikattuwa*, and *Paalawiya*) in order to improve the efficiency of monitoring activities. Staff of *Battulu Oya* office includes an assistant director, five aquaculturists, six extension officers, and six supporting staff. This unit is facing a challenge in retaining its employees due to the less attractive nature of the job.

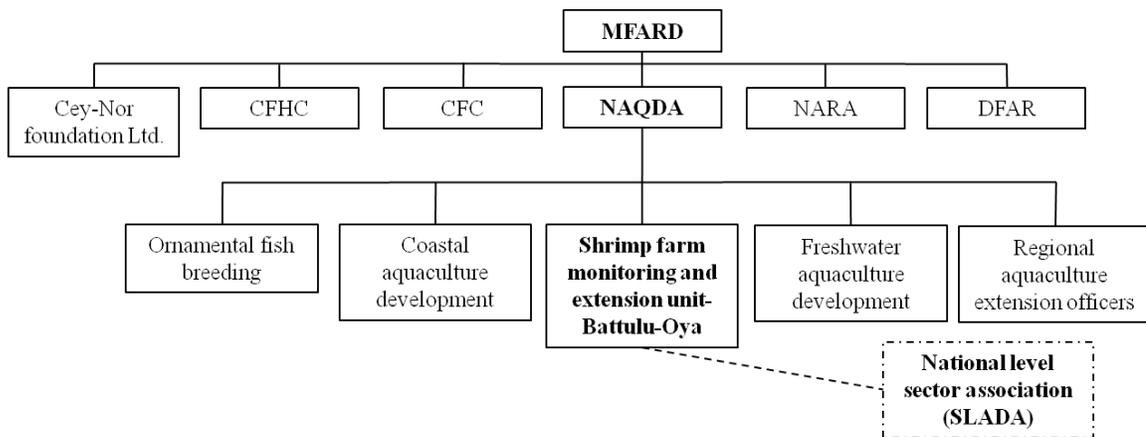


Figure 5.5: Structure of central government institutions

The roles/activities undertaken by the NAQDA M&E unit are: setting annual production targets; managing the shrimp farm licensing process; coordinating the zonal crop calendar process; monitoring better management practices; monitoring shrimp farming community associations; disease control; monitoring of shrimp postlarvae production; and monitoring of shrimp feeds and chemicals.

Northwestern provincial fisheries department is another institution involved in shrimp aquaculture management. It pays significant attention towards shrimp farming. This department is involved through NAQDA and/or through the M&E unit. Moreover, the northwestern provincial environmental authority plays a role in terms of environmental conservation and protection aspects related to shrimp aquaculture. Their involvement is also through the same M&E unit. Therefore, this unit undertakes a variety of roles/activities.

5.5 Resource governance process

Figure 5.6 is developed based on the researcher's understanding of the overall shrimp aquaculture governance system. The entire system functions as a cycle, which synchronizes with the production process of shrimps. Farming operation starts with pond preparation. Prepared ponds are supposed to be inspected by a community association officer (president, secretary, or treasurer) and the field extension officer from NAQDA. If they are not satisfied with the pond based on better management practice requirements, the farmer is asked to re-do or adjust the pond within a given period of time. If the pond is satisfactory, then the farmer can commence stocking/filling of water, etc. This procedure is common to all of the three communities visited. The next type of farm visit done by community association officers (only in communities A and C) is for water quality parameters like salinity. In community A, operating paddle wheels is a special mandatory requirement at this stage, in order to proceed to the next step.

After water stocking, the farmer starts searching for shrimp postlarvae in hatcheries. As part of better management practices, the farmer has to bring a sample of postlarvae for testing from the hatchery they are willing to buy from. Samples are tested for both white spot disease (PCR test) and PL quality⁸. PCR test report results should be negative. An acceptable PL quality report should show negative results for MBV disease with an acceptable score for PL body quality. These tests are done in *Battulu Oya* NAQDA laboratory and in two other private-owned laboratories. Farmers can proceed only if these reports are satisfactory. If not, the farmer then has to look for another hatchery and repeat

⁸PL quality report covers tests for Monodon Baculo Virus (MBV) and PL body parts: gut, muscles, gills, rostrum, cephalothoraxes, abdomen, and appendages.

the same testing process. Currently, there are about 40 shrimp hatcheries in the northwestern area.

Shrimp farmers need to obtain two other documents from the community association and NAQDA before stocking shrimp postlarvae. The first document is the ‘PL bill’ issued by the community association. The farmer has to show the PCR test report and PL quality report in order to get this PL bill. The payment involved is about CAD 10.00 (1000 Sri Lankan rupees) for stocking two ponds. Payment and the required extra documentation vary depending on the community.

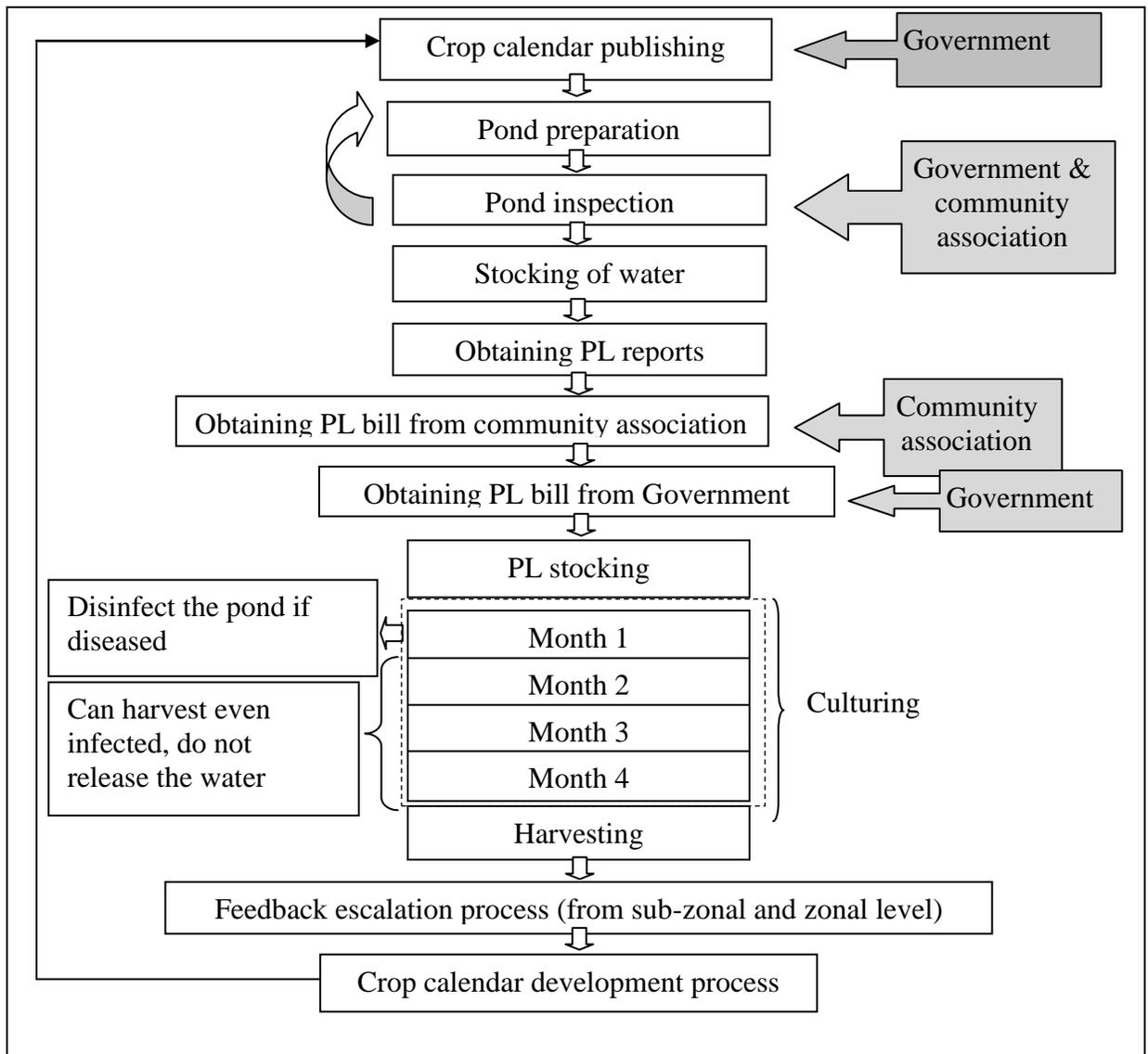


Figure 5.6: Existing process of resource governance

The NAQDA PL bill is a requirement specified by gazette no. 1677/7 in 2010 under NAQDA act no.53 of 1998. Mandatory documents required for obtaining a NAQDA PL bill are: PCR test report for PL sample; PL quality report; and PL bill/letter issued by community association. This bill costs about CAD 10.00 per shrimp farm. After obtaining NAQDA PL bill, shrimp farmers get the legitimate right for buying and stocking PLs.

Once stocked, if pond(s) is/are infected by disease during the first month of the crop cycle, then the farmer has to inform both the relevant community association and NAQDA immediately. Then the infected pond(s) should be disinfected using chemicals (chlorine). In community A, the rule is to disinfect any infected pond less than one month after stocking and/or when the average size of a shrimp is less than five grams. Community A's association has arrangements to compensate such farmers by paying 50% of the total financial loss. However, in other communities, if shrimps are grown up to a marketable size, it is allowed to harvest the ponds using bottom drag nets (without releasing water to outside water bodies).

When disease conditions occur after one month of PL stocking, farmers still need to inform their community association and NAQDA immediately. However, at this stage, farmers are allowed to harvest infected ponds without releasing water. In case of successful completion of the production cycle without any disease problems, then farmers can harvest and release water to the surrounding environment. In any case, before harvesting, farmers have to provide details on the harvest (date of harvest, average weight of a shrimp, etc.) to the community association. These details are later submitted to SLADA and NAQDA by the association.

After each crop season, the community association calls for a meeting to discuss how the recent crop went. Any suggestions on improving the next crop calendar are discussed in detail. Feedback from this meeting is escalated to zonal and national-level meetings by the representatives from sub-zonal and zonal levels. Such feedback is taken into

consideration during the zonal crop calendar development. Once developed, the new crop calendar is published in public newspapers for farmers to get ready for the next crop.

5.6 Decision making in shrimp aquaculture management

Existing decision making structure (in terms of scope of decisions made) is qualitatively analyzed under the three levels of: individual farmer/farm; shrimp farmers' associations; and government institutions.

5.6.1 Decision making at the individual farmer level

Decisions made by individual farmers are mostly operational in nature. Types of such decisions are: how many ponds are to be operated; which laboratory to go for PL sample testing; which hatchery to buy PLs from; which feed brand and supplier, energy source, and types of labour and financing will be used; whether to continue or skip a crop season; whether to newly start shrimp farming; when and how many PLs to stock; when to harvest; and whether to rent or sell farm lands. These decisions do not involve the community association and/or government institution. Personal contacts and previous experiences are the major influences on individual farmer decisions.

5.6.2 Decision making at the shrimp farmers' association level

In general, decisions made at shrimp farmers' association levels are collective in nature. 'Consensus' is the principle in decision making. Similar to any other association, officers (president, secretary, and treasurer) have the authority to make decisions on behalf of the membership. This decision making power is granted by a collective agreement specific to an association. However, any decision should be clearly explained and justified to the membership during the meeting. If a particular decision is highly important, officers can call a special meeting. During meetings, members openly express their ideas and concerns as there is no/little power difference among members.

Most importantly, associations have the power to make decisions related to regulation of community-level shrimp farming activities. Most of these decisions are on better management practices adapted by a particular community. Issuing PL bills from the association is based on regulations related to better management practices monitored by

community associations. Below are regulatory requirements related to better management.

- All sediments should be completely removed from pond bottoms. Bottoms should be completely dried out before filling with water.
- Pond bottoms should be tilled properly.
- Mesh filter types used in pumping water into the pond should be 576 net eyes/inch.
- Water should be properly chlorinated (30 p.p.m. concentration) to disinfect.
- Recommended PL stocking density is four to six animals/m². It can be increased up to a maximum of 10 animals/m² only if proper aeration facilities are available.
- Ponds should not be harvested when shrimps are less than one month old or less than five grams in average weight.
- Should not release or pump water until the two-month culture period is completed (community A).
- Partial harvests are prohibited (community A).
- In certain other communities (other than communities A, B, and C) it is compulsory to have water stocking tanks (*Thoduwawa* and *Iranawila*).

There are some other collective decisions made at the association level in regulating farming activities. For example, some community associations have made it a rule to issue fines (about CAD 5.00) if a member is absent for two consecutive meetings.

Community-level associations collectively decide on suggestions or concerns to be raised during zonal and/or national crop calendar meetings. Usually, special meetings are called for this purpose.

Even though consensus is the primary principle, based on researcher observations during community association meetings, it seems that associations sometimes tend to make decisions based on emotions/personal matters. These emotion-based decisions even lead to the breaking of their own rules and procedures. This situation was noticed in almost all of the community meetings attended, except for community A. For example, community B decided to go for a 10-day extension period for PL stocking based on a request made by two members (who were planning to engage in some other type of income-generating

activity, but later ran into some obstacles making them restart shrimp farming). In another community meeting, they decided to hold stocking dates until three farmers who had kept their ponds longer without harvesting (due to slow shrimp growth compared to the rest of the farms in community) were done with harvesting. It is the opinion of the researcher that these occurrences of breaking their own rules, is based on emotions.

Decisions made at zonal-level associations are primarily related to infrastructure development of farming areas. The major responsibility at the zonal level is to communicate between sub-zonal shrimp farmers' associations and top-level SLADA and NAQDA. I observed a mixed nature of decision making in zonal-level associations, where they sometimes consider farmer/association preferences.

5.6.3 Decision making at the national level (government/MFARD/NAQDA)

As discussed earlier in this chapter, the main government institution involved in decision making is NAQDA, representing MFARD. Decisions made by NAQDA are related to the following activities:

- Publication of the crop calendar
- PCR testing and PL quality checking (laboratory work)
- Issuing aquaculture management licences to shrimp farmers
- Monitoring of shrimp hatcheries
- Monitoring and extension activities related to shrimp farmers' associations
- Taking actions against illegal activities

When compared to the way that certain decisions are made at the association level, top-level governing bodies show an opposite nature in making decisions. Decisions made at top-level meetings are very logical and theoretical. For example, during the crop calendar meeting, the collaborative decision making body introduced a new requirement of having a water reservation/stocking tank in each shrimp farm. However, as many farmers have only one pond, it is not possible to quickly expand farms. Though they are willing to expand, the majority neither have another big piece of land next to an existing pond nor

are they capable of spending money to buy extra land. Further, the setting during meetings is less supportive towards effective discussions and sharing of ideas (compared to community-level meetings).

5.7 Effective information sharing for shrimp aquaculture management

Most importantly, community associations play a major role in sharing information with community shrimp farmers on daily farming operations as well as on long-term resource management. In this setting the majority, if not all, farmers are dependent on information shared through community associations. Major types of information shared (in order of importance in maximizing returns) are: shrimp PL prices; feed brands and prices; farm gate prices (i.e., price tagged on one unit of shrimp harvest); production quotas (volume of harvest that can be produced by a particular sub-zone); and stocking densities (number of PLs that can be added per m² of pond bottom); stocking dates based on seasonal crop calendar; and disease prevalence/spread.

Figure 5.7 was developed to exhibit the structure of the existing information sharing network as understood by the researcher. It is a 'hub and spike' type network, where the community association is the hub playing the driving role. Spikes are represented by other sector stakeholders. Both informal and formal communication arrangements/linkages are available in the existing network (i.e., the communication platform). Even though much of the communication happens during association meetings, cell phones are also used to communicate with farmers and other stakeholders in order to maintain a close, on time linkage with them. Use of cell phones is very common among shrimp farmers (almost all of them have one).

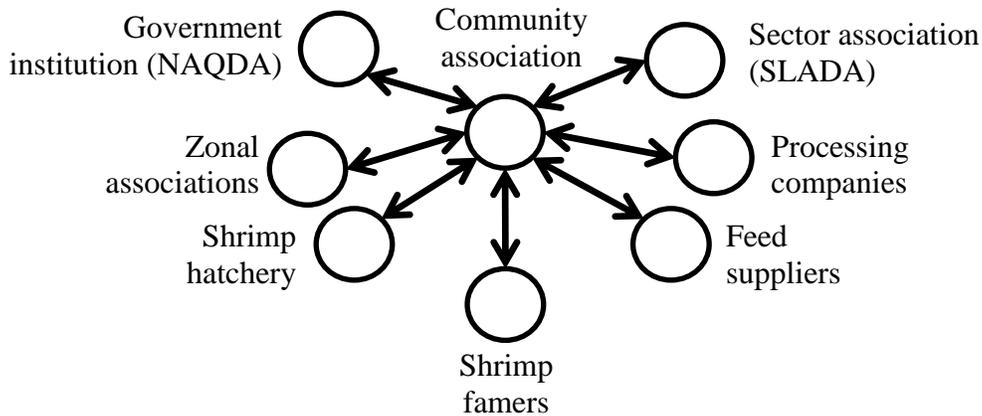


Figure 5.7: Structure of community association-based communication mechanism

The communication arrangement with NAQDA at the top level of the hierarchy is formal, basically due to the administrative requirement of documenting all correspondences. SLADA also seems to maintain a formal approach in communicating with community associations. In this case, administrative requirements as well as legal requirements become reasons for communicating. For instance, production quota and stocking periods for a particular sub-zone is communicated to community associations jointly by NAQDA and SLADA, based on a seasonal crop calendar (designed for the entire sector).

This information is disseminated among farmers through community associations, to decide on how many PLs are to be stocked in a farm. The only piece of information that is published in newspapers is the stocking periods, to avoid the possibility of any farmer complaining that they were not aware of stocking periods (which has led to legal actions in the past). The association is responsible for disseminating accurate information in a timely manner. The bottom layer of the communication structure is entirely based on informal type communication arrangements. However, minutes are kept to keep track of the records. By constitution, each community association has a separate officer and/or a member who is responsible for sharing information, messages and other correspondences.

5.8 Summary

Chapter Five explored the existing commons management structure, based on community associations and government institutions involved in the process. Social-ecological systems were identified as commons in the context of shrimp aquaculture. Commons

rules were applied considering different perspectives of subtractability and excludability problems. A detailed resource management process was identified. Decision making at all three levels of the management structure and the existing mechanism of information sharing were also investigated.

Chapter Six explores policy implications based on an analysis of strengths, weaknesses, opportunities, and threats of the studied shrimp aquaculture management system.

CHAPTER 6: POLICY IMPLICATIONS

6.1 Introduction

Chapter Six explores policy implications of community-based shrimp aquaculture as an alternative approach to large-scale commercial operations in improving sustainability. Objective number three deals with a variety of policy-related matters. This chapter determines whether community-based aquaculture is viable or not. If it is viable, can it be proposed as an alternative approach to large-scale commercial operations? Here, there is no assumption that large-scale shrimp production could be totally replaced by community-based operations; rather, the thesis explores a potential approach for building sustainability for the future. A SWOT analysis is used to identify current strengths, weaknesses, opportunities, and threats of the existing governance system. This analysis also captures the desired policy direction of the shrimp farming sector.

6.2 SWOT analysis

Viability of community-based aquaculture in northwestern Sri Lanka is explored based on strengths, weaknesses, opportunities, and threats (SWOT analysis) of the current existing governance system. For the purpose of this analysis, internal and external environments are defined. The internal environment involves bottom-level community associations, zonal associations, the national sector association (SLADA), and the relevant government institution (NAQDA). Beyond the limits of these entities is considered to be the external environment. The rest of the stakeholder organizations in the shrimp farming sector fall under this category.

A SWOT/environmental analysis provides an answer to the question “where does the existing management system stand now?”. It analyzes strengths and weaknesses of the internal environment and identifies unique capabilities of the system. It also assesses opportunities and threats that are prevalent in the external environment. Moreover, a SWOT analysis speaks to economic, environmental, and social aspects. In an effort to develop the sector, it is important to match the identified strengths and opportunities. Weaknesses of the system should be converted into strengths. Identified threats need to be analyzed thoroughly. Threats, which can be predicted ahead of time, can be converted

into opportunities. The next step becomes identification of strategic direction of the shrimp farming sector by answering the question “where does the sector want to be in the long run?”. Table 6.1 is the matrix type presentation of the identified strengths, weaknesses, opportunities, and threats (Appendix D for further details).

Table 6.1: SWOT matrix

Internal environment	
Strengths	Weaknesses
<ol style="list-style-type: none"> 1. Bottom-up management approach 2. Well established multi-level institutional structure 3. Goodwill and experience in producing high quality shrimps 4. Collective and collaborative decision making process 5. Limited need for expansion of shrimp farming areas due to availability of abundant farms 6. Environmentally favourable zonal crop calendar system 7. Small-scale shrimp farms with lower impact to the environment 8. Educated shrimp farmers 9. Topographically supportive natural water body, lagoons, and canal system 10. Natural boundaries allowing seasonal management of shrimp farming (zonal crop calendar) 11. Annual government budgetary allocation to develop the sector 12. Experiences gained and lessons learned in the past on managing resources 	<ol style="list-style-type: none"> 1. Lack of timely production 2. Weak institutional management 3. Purpose of the zonal crop calendar (adjustments based on environmental changes) being ignored 4. Less government attention on the use of diesel generators 5. Lack of gender balance in the sector 6. Connected nature of the common water body 7. Government’s priority is to increase production with a minimum effort on protecting environment and natural resources 8. Lack of resources (human and physical) 9. Lack of funding for research 10. Poor rural road network 11. Emotion-based decisions made in community-level associations 12. Presence of socially marginalized groups
External environment	
Opportunities	Threats
<ol style="list-style-type: none"> 1. Expanding demand for Sri Lankan shrimps from the export markets 2. Good reputation for the unique taste and quality 3. Possibilities of increasing industry capacity 4. Opening up of new niche markets 	<ol style="list-style-type: none"> 1. Political influences creating a difficult working environment 2. Lack of price bargaining power to farmers 3. Less research 4. Bad reputation of the sector due to historical experiences

5. Salt manufacturing as an alternative	5. Regional political instability influencing sector decision making 6. Rivalry from other shrimp producing countries 7. Impact of inflation on input prices 8. Impacts of global climate changes
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As the next step, identified weaknesses and threats need to be thoroughly studied to understand how each component affects the viability of the existing shrimp aquaculture management system. Sometimes, it can be unrealistic to convert weaknesses and/or threats into strengths and opportunities. Such weaknesses/threats decrease the viability of a community-based aquaculture management approach.

6.3 Analysis of weaknesses

Based on Table 6.2, the level of effort needed from the existing management system to convert its weaknesses into strengths is low or medium in most cases. Weaknesses requiring low effort can be converted into strengths through collective interventions (of SLADA and NAQDA). For example, the zonal crop calendar can be effectively planned by focusing on zonal boundaries and making regular updates (as the initial intention of the crop calendar development process was to incorporate lessons learned from previous crop seasons). Government priority on produce volumes with no consideration for protection of social-ecological systems can be addressed through a policy change. Government’s production focus is due to the budgetary allocation, which is tied to short-term shrimp production and annual export amounts. There is a timely need for revising this indicator to incorporate long-term environmental sustainability aspects. Lack of timely production can be addressed by improving coordination among sector stakeholders. To improve production, shrimp aquaculture management structure should ensure participation of all stakeholders. The lack of participation of parent shrimp (brood stock) suppliers is an important missing link the researcher observed. Government can intervene in settling ownership issues of shrimp farming lands in order for farmers to be able to apply for hydro-electricity services. Road network and infrastructure facilities can be improved in collaboration with divisional secretariat offices and provincial council. In

fact, improving roads and infrastructure is a main priority of the existing Sri Lankan government. Even though the government does not allocate any additional funding for research on the shrimp sector, a process can be initiated for conducting joint research through existing institutions. NARA should initiate and guide this process.

Table 6.2: Categorization of weaknesses

Weaknesses	Level of effort required to convert into strengths
<ul style="list-style-type: none"> • Purpose of the zonal crop calendar being ignored • Government priority on production volume • Lack of timely production • Less government attention on the use of diesel generators • Poor rural road network • Lack of funding for research 	Low
<ul style="list-style-type: none"> • Weak institutional management • Lack of resources (human and physical) • Emotion-based decisions made in community-level associations • Lack of gender balance 	Medium
<ul style="list-style-type: none"> • Connected nature of the common water body • Presence of socially marginalized groups 	High

Weaknesses falling under the medium level require a considerable effort and time to be converted into strengths. For example, weak institutional-level management and lack of human/physical resources are interconnected problems. Institutional structure needs to be strong enough to deploy more resources. Emotion-based decisions at the community level seem to be easily dealt with. Emotion-based decision making and lack of gender balance are culturally embedded features in most Sri Lankan rural communities. Hence, it is relatively difficult to address.

Longer time and a high level of effort are needed to convert weaknesses falling under the third category. In some cases, such weaknesses can only be partially addressed through alternative measures. For example, only the issues related to interconnectivity of the water body can be addressed, but the water body itself will remain connected (as it is the way the Dutch canal, lagoons, and canal system are geographically located). Presence of socially marginalized groups is a result of long standing social-economic disparity of the

society. A solution for this problem may not be found within the shrimp farming governance system; rather, this is a national-level concern.

Based on the above analysis, overall, most of the weaknesses can realistically be converted into strengths. This implies that the existing community-based management system is viable in the long run.

6.4 Analysis of threats

Threats originate in the external environment and are not within the purview of control of the shrimp sector governance system. Figure 6.1 analyzes the threats identified in SWOT analysis. Two axes/variables of the graph are: level of impact from a threat and ability of the internal environment to react to the impact. Accordingly, four quadrants can be identified in the matrix/graph. If both the impact and ability to react are low, then the system becomes less vulnerable to such threats. If impact is low and ability to react is high, then the risk is low and the system can prepare in advance for such threats. An area with a high level of impact and an ability to react is a vulnerable area. To address such threats, the system needs to develop a contingency plan. If the impact from a threat is high and the ability to react is low, then it is a high-risk situation and it is difficult to handle. In this case, there is nothing that the system can do to make a difference.

Identified threats were positioned in the matrix in Figure 6.1. A low level of impact from a threat with a low level of ability to react creates a less vulnerable situation. However, none of the identified threats fall in this category. A low impact with a high level of ability to react brings low risk and the system can prepare to face such threats. Industry rivalry is such a threat and it can be addressed by systematically planning for an increased production volume (by properly addressing disease problems) and improving product quality (by setting standards).

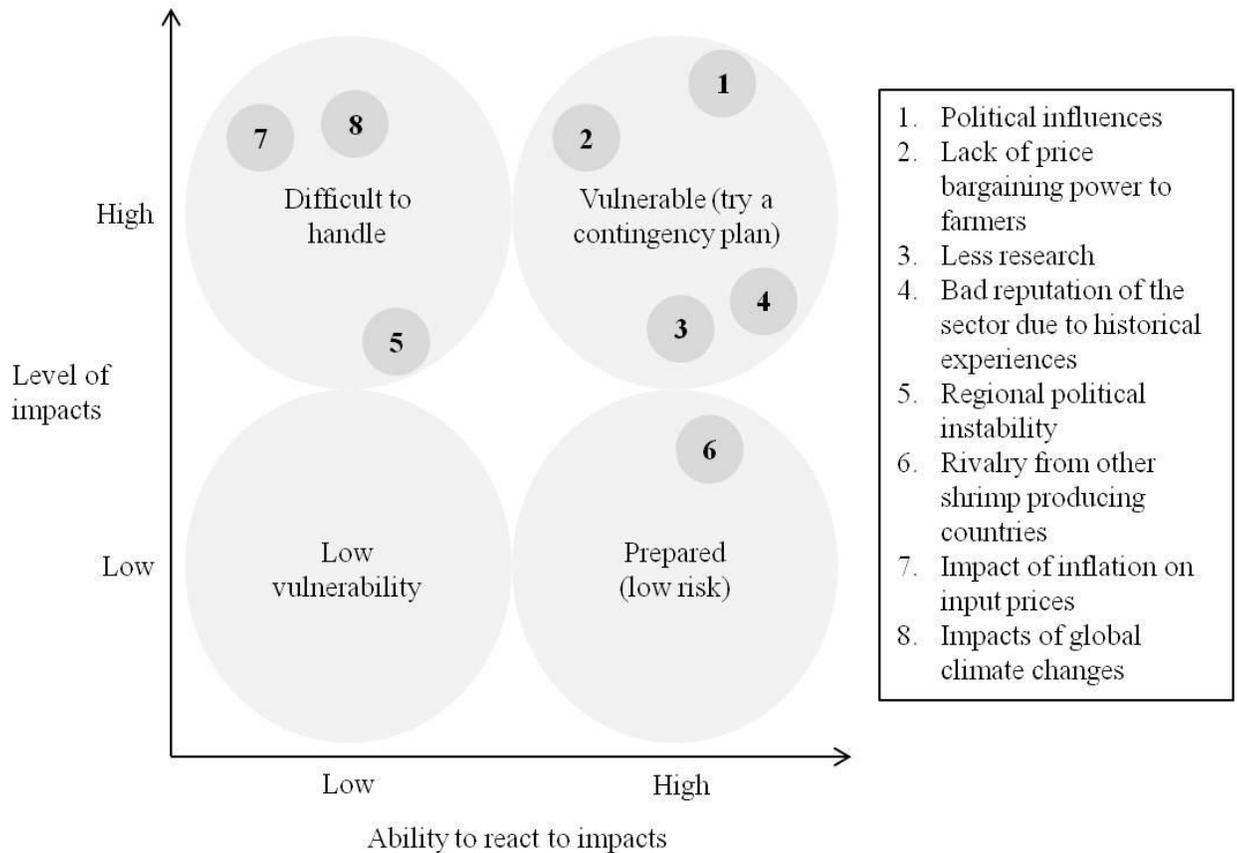


Figure 6.1: Matrix for threat analysis (adopted from Johnson et al., 2008)

Four of the identified threats fall in the category of high impact with a high ability to react. These are: political interference in local contexts; lack of power for farmers to bargain for prices; absence of research; and bad reputations due to historical experience of commercial-based shrimp farming. Based on the nature of the country’s political behaviour, where leadership changes within a short period of time it is difficult to independently continue farming operations. Political leaders intervene at the macro-level policy making process as well as in micro-level policy enforcement efforts. The only way to address this situation seems to be strategically handling political influences by establishing/maintaining a good relationship with political leaders on an individual/collective basis through the community associations. Moreover, collective bargaining power to farmers can be created through community associations. Research studies on the shrimp farming sector is a timely need. Even local universities seem to be unaware of the real picture of the current shrimp aquaculture management system. Improving awareness on the current state of the shrimp sector and initiating research

studies in collaboration with academia and government institutions seem to be a good approach to address the bad reputation (due to impacts caused by commercial-based shrimp farming on socio-ecological systems in the past).

South Asian regional (and world) political instability can be identified as a threat that has a high impact with a low level of system's ability to react. Political instability affects current funding programs. Other threats of this nature are the country's economic inflation and global climate change. These threats are very difficult to make an influence on.

Overall, threat analysis shows that there are some threats which can be addressed in favour of the existing governance system by converting them into opportunities that can be capitalized for the betterment of the sector.

6.5 Viability of community-based aquaculture

SWOT analysis provides a sound understanding of the environment within which the existing governance system operates. Based on the SWOT analysis, there is a long list of strengths and a few attractive opportunities to capitalize on. Based on the above detailed analyses on weaknesses and threats, it seems that most of them have the potential to be converted into strengths or opportunities. Therefore, overall, the current community-based aquaculture governance system in northwestern Sri Lanka is viable in the long run. Moreover, this governance system is socially acceptable due to its community-based and environmentally friendly nature.

The next step is identifying the strategic direction of the sector; that is, where does the sector want to be in the long run? In this journey, the main focus of attention should be on the sustainability of social-ecological systems within which farming operations are carried out.

6.6 Identifying strategic direction

Strategic direction of the sector should be based on sustainability of social-ecological systems, in order to continue farming operations in a community-based setting. Based on

study findings, it is apparent that community-based operations are capable of controlling social-ecological impact. In this regard, the two major variables determining current and future positions of the sector are: level of impact on natural resources and level of dependency on community associations. Figure 6.2 is based on these two variables.

The first variable is the level of dependency on community associations, represented by the horizontal (x) axis. Level of impact on natural resources is the vertical (y) axis. Both axes of the matrix are divided into three levels: low, medium, and high. Accordingly, there are nine possible areas where shrimp farming can be placed (based on study findings and the researcher's contextual understanding).

In terms of dependency on community associations, most existing communities can be placed at a medium position, with a potential for further strengthening its role. Based on the three sampled communities, these are the most important activities that farmers are dependent on:

- To obtain recommendation necessary for obtaining aquaculture management license
- To obtain PL bill before stocking shrimp PLs
- To access information required for day-to-day farming activities
- To provide feedback and influence decisions made at higher level of governance structure
- To get shrimp disease test samples free of charge

When compared to the period where existing governance system and community associations were established, community associations have evolved a lot, making farmers more dependent on them. However, there is potential for further improving the role of community associations to make sure that outstanding concerns are collectively addressed (e.g., bargaining power-related issues in PL and feed buying, in harvest selling, etc).

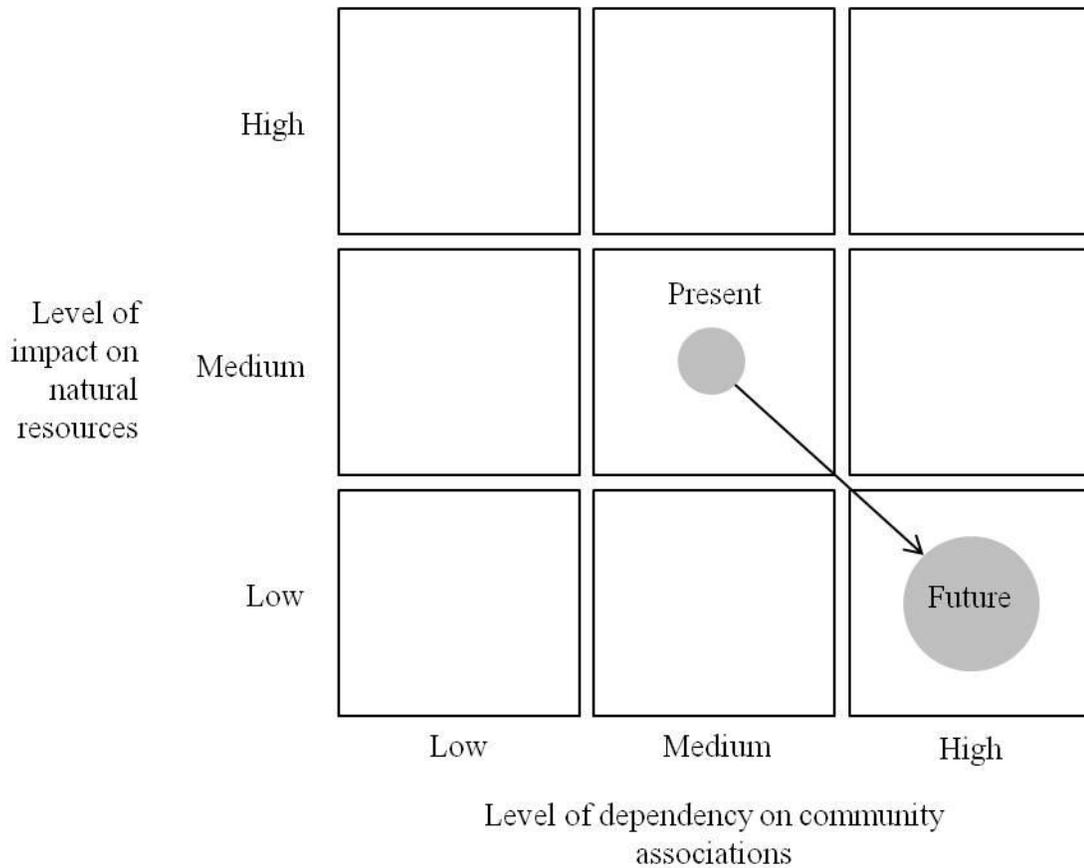


Figure 6.2: Strategic direction based on sustainability of social-ecological systems

Level of impacts on natural resources can be identified as medium. The main natural resources directly impacted by shrimp farming are: common natural water body including lagoons and the canal system; wetlands; mangrove forests, etc. During the late 1990s (when farming was geographically spreading), there was a huge impact on coastal ecosystems, agricultural ecosystems, mangroves, government-owned lands, and lagoon supporting areas, due to construction of shrimp farms (Cattermoul & Devendra, 2002). At that time, there were relatively large-scale commercial operations (running in full capacity throughout the year). Such operations consumed a large amount of water from the common water body while releasing waste water back, making it difficult for the natural ecosystem to absorb the waste. However, the current situation is much more different as only small-scale shrimp farms remain in the northwestern area. Moreover, all of them run under capacity because of disease conditions. There is no more construction of new farms. Therefore, current impact from shrimp farming on the ecosystem is much lower than in the past. Table 6.3 provides a comparison.

Table 6.3: Comparison of past and present impacts

Characteristics	Late 90s to early 2000s	Year 2012
Size of the farms	Large/medium/small scale	Small scale
Number of farms	About 1,500 to 2,000	About 600
Operating time	Throughout the year	Seasonally (following a calendar system)
Number of ponds used	All ponds	About one-third of the total number of ponds
Shrimp farm construction	Very common	Not any more (not needed)
Impact to natural resources	Relatively high	Relatively low

It is obvious that the sector should be in a better position in the future than it is today. Based on the matrix, there is no argument that the impact on natural resources should be further reduced. In order to do this, dependency on community associations need to be further increased. As a result, desired future position of the sector should be in the right-hand side/lowest part of the matrix (Figure 6.2). This defines the long-term strategic direction of the sector, highlighting the gap between present and desired positions.

6.7 Application: Community-based operations as an alternative approach to large-scale aquaculture operations

To recap, the main characteristics of the studied shrimp aquaculture governance system are: community-based institutions; zonal crop calendar; and participatory/collaborative approach. Multi-level community-based institutions in the structure have specific roles and responsibilities in managing shrimp aquaculture resources. Zonal crop calendar is the mechanism of reducing impact on the environment from shrimp farming. The participatory collaborative decision making body of SLADA and NAQDA plays a significant role in the decision making structure. Almost all of the existing shrimp farming operations are small in scale (either down-sized from large-scale or started up as small-scale operations), where the current community-based governance system is a best fit.

This study suggests that this governance system is economically viable, socially acceptable, and environmentally friendly to a greater extent. Therefore, community-based operation is an alternative to large-scale operation.

However, the studied governance system runs within a unique social-ecological system in northwestern Sri Lanka. Therefore, if the studied governance system is adapted in other contexts, its operational success will depend on certain characteristics. Characteristics of this social-ecological system are:

1. Interconnected nature of the common natural water body. Presence of lagoons and canal systems making natural boundaries in shrimp farming areas.
2. Existence of relatively small-scale shrimp farming operations
3. Specific shrimp species cultured due to their disease susceptibility, life cycle requirements, etc. (black tiger shrimp).
4. Being a part of a culture where collectivism is often practiced and valued. Most of the decision making arrangements are collective in nature.
5. Government's intervention at some point within the governance process. Government also promotes a bottom-up collaborative approach of resource management.
6. Production system of a semi-intensive and intensive mix

In conclusion, small-scale community-based shrimp aquaculture management systems can be considered as an alternative approach to the large-scale shrimp aquaculture operations. Success of the application would be subject to multiple factors related to the social-ecological system.

6.8 Summary

Chapter Six first identified strengths, weaknesses, opportunities, and threats of the existing governance system (SWOT analysis). Secondly, it analyzed the weaknesses and threats in detail. Viability of a community-based shrimp aquaculture management system was investigated based on the results of the SWOT analysis. Thirdly, the chapter identified the desired strategic direction of the sector. Finally, it discussed the option of

community-based operations as an alternative approach to large-scale aquaculture operations. Chapter Seven highlights the conclusions based on the study findings.

CHAPTER 7: CONCLUSIONS

7.1 Introduction

This chapter presents the conclusions based on the findings unfolded under each research objective. The three objectives are: (1) to understand the operation of community-based shrimp aquaculture in northwestern Sri Lanka; (2) to explore any commons institutions in the aquaculture system, how small-scale aquaculture operations can be connected through commons rules into community operations, and how these fit into an overall governance system; and (3) to explore the policy implications of community-based shrimp aquaculture as an alternative approach to large-scale commercial operations to improve sustainability.

Table 7.1: Questions and findings

Question	Findings
Objective One	
Does CBM exist in Sri Lanka?	CBM exists as the backbone of the resource management system. Community-level shrimp farmers' associations are the main commons institutions.
What is the scale of shrimp farming operations?	Sri Lankan shrimp farming operations are small in scale. Farming operations have been scaled down due to shrimp disease outbreaks as well as for adapting to the current governing system (with a lesser number of production cycles per year). Availability of a smaller natural water body also can be a reason for having small-scale operations.
What are the BMPs used in Sri Lankan shrimp aquaculture?	BMPs are used to minimize the risk of shrimp diseases. BMPs are developed at the national level as farming guidelines. BMPs are adopted and executed by the community-level associations as the management practices best suiting their farming conditions and needs.
What is the zonal crop calendar system?	The northwestern shrimp farming area is divided into five zones and 32 sub-zones based on disease-spreading patterns over the years. Creating buffer zones (using an annual time table and geographical location of farms) is the principle behind the crop calendar. The objective of the crop calendar is to minimize disease risk, which leads to economical losses and environmental damages. It is an adaptive management approach based on previous crops.
Objective Two	
What are the commons in shrimp aquaculturing context?	Commons are the social-ecological systems within which farming is done, but not the harvest (i.e., cultured shrimps). Social-ecological system includes the connected natural water body, mangrove ecosystem, wetland areas, soil, etc.

What is the subtractability problem?	Releasing of disease-infected water into the surrounding environment affects the ability of other shrimp farmers to continue farming practices without being infected. Aggregated effects of the waste water released by shrimp farms could break the ecosystem equilibrium.
How does the excludability problem apply?	Excludability problem applies in two main ways: community associations have their own rules to control newcomers entering shrimp farming; and zonal crop calendar system controls shrimp farmers accessing the common water body through geographical and seasonal (time) buffer zones.
Lessons from history and development of shrimp industry?	Two lessons: large-scale farming operations are not sustainable in face of disease outbreaks; small-scale shrimp aquaculture can survive the disease challenge.
What are the commons institutions?	Three types: community associations; shrimp aquaculture sector association (national level); and the relevant government institution.
What is the commons regime?	A mixed commons regime of the government, communal, and private.
What are the features of CBM?	Multi-layered commons institutions; collaborative decision making body; adaptive and participatory approaches; and the management system evolving in response to shrimp disease conditions.
Objective Three	
What are the major strengths of a CBM system?	Bottom-up management approach; well established multi-level institutional structure; goodwill and experience in producing high quality shrimps; and collective and collaborative decision making processes (See Table 6.1 for a full list of strengths).
What are the major weaknesses of a CBM system?	Lack of timely production; weak institutional management; purpose of the zonal crop calendar (adjustments based on environmental changes) being ignored; and less government attention on the use of diesel generators (See Table 6.1 for a full list of weaknesses).
What are the major opportunities of a CBM system?	Expanding demand for Sri Lankan shrimps from the export markets; good reputation for the unique taste and quality; and possibilities of increasing industry capacity (See Table 6.1 for a full list of opportunities).
What are the major threats of a CBM system?	Political influences creating a difficult working environment; lack of price bargaining power to farmers; and less research (See Table 6.1 for a full list of threats).

Most of the commercially managed aquaculture operations are large-scale, corporate-based industries. Large-scale aquaculture results in both adverse social (Nayak & Berkes, 2010) as well as environmental impacts (Primavera, 1997). Unsustainability of large-scale aquaculture is well documented. For example, Huitric et al. (2002) studied the rise and fall of large-scale shrimp aquaculture all the way around the Gulf of Thailand,

environmentally ruining one area and then moving into another. Large-scale aquaculture tends to make its profit during the first few years, with the expectation that they can move onto another area, rather than aiming to establish sustainable practices and remain in one area. By contrast, small-scale community-based aquaculture farmers do not have the option of relocating. They cannot afford to act in unsustainable ways, as they are part of the local social-ecological system, and they have been living in these communities for a long time. Therefore, by design, small-scale aquaculture has built-in incentives to be sustainable (or else go out of business). Small-scale aquaculture brings a range of advantages compared to large-scale aquaculture.

- Small-scale aquaculture tends to have lower environmental impact, as argued above. For example, the release of waste water is limited and controlled (Chapter Five).
- Aquaculture in general is a high-risk business, but small-scale operations are relatively low in risk. Most of the family-based small-scale farming areas allow for constant monitoring of farms for disease.
- Since disease detection is faster, the potential for limiting the economic damage is relatively high. Thus, even under disease conditions, the net economic damage is relatively low because the shrimp can still be sold at market prices (if disease is detected at the initial stage), and also because of the lower cost of inputs and smaller investment in the operation as a whole.
- Small-scale aquaculture produces higher local economic benefits because of employment of family members and wage employment of mainly local people. These operations are not purely profit-oriented (as large-scale aquaculture tends to be) but rather generate a range of local benefits. As such, small-scale aquaculture can be characterized as “social enterprises” (Anderson et al., 2006).
- Small-scale aquaculture produces better benefits for women. Regardless of scale of operation, women dominate the processing sector. However, in the case of small-scale farms, women are the main harvesters of shrimp. They are also active in bookkeeping and in managing farms in general (Table Appendix B-11 and 12).

Competition over scarce resources is a common phenomenon throughout the world, and interactions among users tend to be competitive. However, in the context of small-scale shrimp aquaculture in northwestern Sri Lanka, farmers co-operate with each other by working collaboratively/collectively to overcome common disease challenges instead of competing. This is unusual and can be considered as a different way of doing things, even a “different worldview” (B. Dyck, personal communication, March 2013). First, shrimp farmers are empowered by their experience working for the old (and failed) aquaculture companies; they constantly apply this knowledge into the practice of their current small-scale operations. Secondly, multi-level commons institutions have been developed by shrimp farmers themselves, in cooperation with the government, for effective commons management. These commons institutions function collaboratively, using a participatory approach. They are not part of a formal co-management arrangement with the government, but small-scale aquaculture, as practiced in Sri Lanka, is *de facto* co-management.

7.2 Policy implications

The third objective is to explore policy implications of community-based shrimp aquaculture as an alternative approach to large-scale commercial operations in improving sustainability. SWOT analysis is used as a tool to answer the question “where does the existing management system stand at present?” Findings show that the majority of the identified weaknesses can be converted into strengths with a low/medium level of effort. Further, threat analysis shows a high ability to react to impacts for most of the threats in favour of the existing governance system.

Based on the SWOT analysis, the current community-based aquaculture governance system can be considered to be viable in the long run. Strategic direction is identified by considering the sustainability of social-ecological systems within which shrimp farming is done as a community-based operation. The current position of the sector has a medium level of impact on natural resources with a medium level of dependency on community associations. The desired future position of the sector should have a low level of impact

on natural resources. This can be achieved with a high level of dependency on community associations.

This study suggests that the existing governance system is viable, socially acceptable, and environmental friendly to a greater extent. Therefore, it demonstrates the potential to be an alternative to large-scale aquaculture operations. Its operational success will depend on unique characteristics of the social-ecological system within which it operates. Such characteristics are: interconnected water body; small-scale shrimp farming operations; species cultured; local collective culture; and semi-intensive production system.

7.3 General conclusions

In this study, it is argued how small-scale community-based shrimp farming operations become a viable alternative approach to large-scale operations in ensuring sustainability of the social-ecological systems. This argument is based on three research objectives: 1) understanding the existence of community-based shrimp farming operations in northwestern Sri Lanka; 2) exploring commons institutions, application of commons rules into community operations, and how these fit into an overall governance system; and 3) identifying policy implications of community-based practices as an alternative approach to large-scale commercial operations to improve sustainability.

The community-based shrimp aquaculture management system in northwestern Sri Lanka has evolved to its current state mainly under the influence of the shrimp disease problem, which spreads through the interconnected natural water body. Another influential factor is the historical/cultural tendency towards a collective approach in managing/sharing resources. This management system will continue to evolve in the face of numerous changes in the social-ecological system into the future. The trajectory of the northwestern shrimp aquaculture system provides two lessons: large-scale shrimp aquaculture operations are not sustainable; and small-scale shrimp aquaculture operations can survive the disease challenge.

Zonal crop calendar system; multi-level commons institutional structure; collaborative management; adaptive approach; and better management practices are the outstanding characteristics of the existing community-based management system.

The significance of the study is due to multiple reasons. Even though small-scale community-based shrimp aquaculture practices exist in the world (for example, Thailand), it seems that they are not documented/studied. This study attempts to shed light on this area by confirming the existence of community-based operations and by providing evidence that such operations are viable in the small-scale shrimp farming context. Further, the study suggests that the comparatively lower environmental and social impacts of this governance system make it a highly attractive alternative approach. Principles and practices of the explored community-based management system are applicable to other aquaculture as well as non-aquaculture-based operations with or without adjustments.

REFERENCES

- Amarasinghe, U. S. (2006). Culture-based fisheries development in Sri Lanka: a case study. In S. S. De Silva, U. S. Amarasinghe, & T. T. T. Nguten. *Better-practice approaches for culture-based fisheries development in Asia*, ACIAR Monograph No.120, (pp. 50–72).
- Amarasinghe, U. S. (2010). Inland fisheries resource enhancement and conservation in Sri Lanka. In M. Weimin, S. De Silva, and B. Davy (Eds.). *Inland fisheries resources enhancement and conservation in Asia* (pp. 113–128). Regional office for Asia and the Pacific, Bangkok: Food and Agriculture Organization of the United Nations.
- Amarasinghe, U. S., Chandrasekera, W. U., & Kithsiri, H. M. P. (1997). Traditional practices for resources sharing in an artisanal fishery of a Sri Lankan estuary. *Asian Fisheries Science*, 9, 311–323.
- Amarasinghe, U. S., & De Silva, S. S. (2001). Sri Lankan reservoir fishery: a case for introduction of a co-management strategy. *Fisheries Management and Ecology*, 6(5), 387–400.
- Anderies, J. M., Janssen, M. A., & Ostrom, E.(2004).A framework to analyze the robustness of social ecological systems from an institutional perspective. *Ecology and Society*, 9(1), 18. Retrieved from <http://www.ecologyandsociety.org/vol9/iss1/art18/>
- Anderson, R. B., Dana, L. P. & Dana, T. E. (2006). Indigenous land rights, entrepreneurship, and economic development in Canada: “Opting-in” to the global economy. *Journal of world Business*, 41, 45–55.
- Anon. (2007). *Ten year development policy framework of the fisheries and aquatic resources sector (2007–2016)*, Ministry of fisheries and aquatic resources, March 2007, 4. Retrieved from http://www.fisheries.gov.lk/English_link/10%20year%20plan.pdf/
- Anon. (2010). *Sri Lanka socio-economic data 2010*, Central Bank of Sri Lanka, June 2010. Retrieved from http://www.cbsl.gov.lk/pics_n_docs/10_pub/_docs/statistics/other/Socio_Econ_%20Data_2010_e.pdf/
- Anon. (2011). Fisheries and Aquatic Resources Act, No. 2 of 1996 of Sri Lanka, section 66, (p.21). Retrieved from <http://www.customs.gov.lk/docs/25295.pdf/>
- Atapattu, A. R. (1987). Territorial use rights in fisheries in Sri Lanka. Symposium on exploitation and management of marine fishery resources in South Asia, *Indu-Pacific Fisheries Commission, RAPA Report 1987*, 10, 397–410.

- Atkinson, R., & Flint, J. (2001). Accessing hidden and hard-to-reach populations: snowball research strategies. *Social research update issue*, 33, 2–3.
- Beckerman, W. (2002). A poverty of reason: sustainable development and economic growth. *The independent institute*, 1–10.
- Beddoea, R., Costanza, R., Farley, J., Garza, E., Kent, J., Kubiszewski, I.,...& Woodward, J. (2009). Overcoming systemic roadblocks to sustainability: The evolutionary redesign of worldviews, institutions, and technologies. *Proceedings of the National Academy of Sciences*.
- Berkes, F. (2003). Alternatives to conventional management: Lessons from small-scale fisheries. *Environments*, 31(1), 5–19.
- Berkes, F. (2006). From community-based resource management to complex systems. *Ecology and Society*, 11(1), 45. Retrieved from <http://www.ecologyandsociety.org/vol11/iss1/art45/>
- Berkes, F. (2009). Revisiting the commons paradigm. *Journal of Natural Resource Policy Research*, 1(3), 261–264.
- Berkes, F., Feeny, D., McCay, B. J., & Acheson, J. M. (1989). The benefits of the commons. *Nature*, 340, 91–93.
- Berkes, F., George, P., & Preston, R. (1991). Co-management: the evolution of the theory and practice of joint administration of living resources. *Alternatives* 18(2), 12–18.
- Berkes, F., & Folke, C. (Eds.). (1998). *Linking social and ecological systems: management practices and social mechanisms for building resilience*. Cambridge, UK: Cambridge University Press.
- Berkes, F., Mahon, R., McConney, P., Pollnac, R., & Pomeroy, R. (2001). Managing the commons, Chapter 7. In *Managing small-scale fisheries, alternative directions and methods* (pp. 168–192). International Development Research Centre, Canada.
- BOBLME. (2011). *Review of community-based ICM: best practices and lessons learned in the Bay of Bengal–South Asia*. BOBLME-2011-Socioec-01. Retrieved from <http://www.boblme.org/documentRepository/BOBLME-2011-Socioec-01.pdf>
- Bocxlae, I. V., Biju, S. D., Loader, S. P., & Bossuyt, F. (2009). Toad radiation reveals into-India dispersal as a source of endemism in the Western Ghats-Sri Lanka biodiversity hotspot.

- BMC Evolutionary Biology*, 9, 131. Retrieved from <http://www.biomedcentral.com/1471-2148/9/131/>
- Brosius, J. P., Tsing, A. L., & Zerner, C. (1998). Representing communities: histories and politics of community-based natural resource management. *Society and Natural Resources*, 11, 157–168.
- Bush, S. R., Van-Zwieten, P. A. M., Visser, L., Van-Dijk, H., Bosma, R., De Boer, W. F., & Verdegem, M. (2010). Scenarios for resilient shrimp aquaculture in tropical coastal areas. *Ecology and Society* 15(2), 15. Retrieved from <http://www.ecologyandsociety.org/vol15/iss2/art15/>
- Carlsson, L., & Berkes, F. (2005). Co-management: concepts and methodological implications, *Journal of Environment Management*, 75, 65–75.
- Carr, L. D. (2008). The strengths and weaknesses of quantitative and qualitative research: what method for nursing? *Journal of Advanced Nursing*, 20(4), 716–721. Retrieved from <http://onlinelibrary.wiley.com/doi/10.1046/j.1365-2648.1994.20040716.x/citedby/>
- Cattermoul, N., & Devendra, A. (2002). *Effective management for biodiversity conservation in Sri Lankan coastal wetlands, a measurement of the ecological footprint of shrimp farming in the Chilaw lagoon area* (pp. 4–31). University of Portsmouth Cemare.
- Clift, R. (2000). Forum on sustainability, *Clean products and processes* 2(1), 67. Berlin: Springer-Verlag.
- Cohen, D. J., & Crabtree, B. F. (2008). Evaluative criteria for qualitative research in health care: controversies and recommendations. *Annals of family medicine*, 6(4), 331–339. Retrieved from <http://www.annfammed.org/content/6/4/331.full.pdf+html/>
- Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches*, (3rd ed.). Thousand Oaks, CA: SAGE. pp.11-203.
- Dahdouh-Guebas, F., Zetterstrom, T., Ronnback, P., Troell, M., Wickramasinghe, A., & Koedam, N. (2002). Recent changes in land-use in the Pambala-Chilaw Lagoon complex (Sri Lanka) investigated using remote sensing and GIS: Conservation of Mangroves Vs. Development of Shrimp Farming. *Environment, development and sustainability* 4, 185–200. Netherlands: Kluwer Academic Publishers.
- Degen, P. (1998). Fisheries co-management in Sri Lanka: learning from the experiences of the others. *Mekong fisheries network newsletter* 4(1), 1–2.

- De Silva, S. S., & Davy, F. B. (2010). Aquaculture successes in Asia: contributing to sustained development and poverty alleviation, Chapter 1. In De Silva, S. S., & Davy, F. B. Success stories in Asian aquaculture, International Development Research Centre, Springer, 13. Retrieved from http://library.enaca.org/emerging_issues/success_stories/success-stories-asian-aquaculture.pdf
- Doherty, M. (1994). Probability versus non-probability sampling in sample surveys. *The New Zealand Statistics Review*, 21-28. Retrieved June 6, 2009, from [http://www.nss.gov.au/nss/home.NSF/75427d7291fa0145ca2571340022a2ad/768dd0fbbf616c71ca2571ab002470cd/\\$FILE/Probability%20versus%20Non%20Probability%20Sampling.pdf](http://www.nss.gov.au/nss/home.NSF/75427d7291fa0145ca2571340022a2ad/768dd0fbbf616c71ca2571ab002470cd/$FILE/Probability%20versus%20Non%20Probability%20Sampling.pdf).
- EJF. (2003). *Smash & Grab: conflict, corruption and human rights abuses in the shrimp farming industry*. London, UK: Environmental Justice Foundation, 2. Retrieved from http://www.ejfoundation.org/pdf/smash_and_grab.pdf
- EJF. (2004). *Farming the sea, costing the earth: why we must green the blue revolution*. London, UK: Environmental Justice Foundation, 3. Retrieved from http://www.ejfoundation.org/pdf/farming_the_sea_costing_the_earth.pdf
- FAO. (2010). *World review of fisheries and aquaculture (part 1)*. Food and Agriculture Organization of the United Nations, 18. Retrieved from <http://www.fao.org/docrep/013/i1820e/i1820e01.pdf>
- FAO. (2011). *CWP handbook of fishery statistical standards, section J: aquaculture*. Food and Agriculture Organization of the United Nations, 86. Retrieved from <http://www.fao.org/fishery/cwp/handbook/J/en/>
- Fast, A. W., & Lester, L. J. (1992). Marine shrimp culture: principles and practices, developments in aquaculture and fisheries science. *Elsevier*, 23–398.
- Faugier, J., & Sargeant, M. (1996). Sampling hard to reach populations. *Journal of Advanced Nursing*, 26, 790–797. Retrieved from <http://www.soc.washington.edu/users/brines/hardsampling.pdf>
- Feeny, D., Berkes, F., McCay, B. J., & Acheson, J. M. (1990). The tragedy of the commons: twenty-two years later. *Human Ecology*, 18(1), 1–19.
- Feeny, D., Hanna, S., & McEvoy, A. F. (1996). Questioning the assumptions of the "tragedy of the commons" model of fisheries. *Land Economics*, 72(2), 187–205.

- Galappaththi, G. E. K. (2010). *Exploratory study on supply chains of cultured prawns in Sri Lanka* (MBA dissertation). Postgraduate Institute of Agriculture, University of Peradeniya, Sri Lanka.
- Gerring, J. (2004). What is a case study and what is it good for? *American Political Science Review*, 98(2), 341–354. Retrieved from <http://journals.cambridge.org/action/displayFulltext?type=1&fid=228448&jid=PSR&volumeId=98&issueId=02&aid=228446/>
- Glaser, M., Krause, G., Ratter, B., & Welp, M. (2008). *Human/nature interaction in the anthropocene, potential of social-ecological systems analysis*, *Deutsche Gesellschaft Für Humanökologie*, 77–80. Retrieved from http://ec.europa.eu/research/sd/conference/2009/papers/7/thomas_jahn_-_social-ecological_systems.pdf/
- Golafshani, N. (2003). Understanding reliability and validity in qualitative research. *The Qualitative Report*, 8(4), 597–607. Retrieved from <http://www.nova.edu/ssss/QR/QR8-4/golafshani.pdf/>
- Groenewald, T. (2004). A phenomenological research design illustrated. *International Journal of Qualitative Methods*, 3(1). Retrieved from http://www.ualberta.ca/~iiqm/backissues/3_1/pdf/groenewald.pdf/
- Gunawardena, A., & Steele, P. (2008). The stake-net fishery association of Negombo lagoon, Sri Lanka: why has it survived over 250 years and will it survive another 100 years? In R. Ghate, N. Jodha, & P. Mukhopadhyay (Eds.). *Promise, trust and evolution: managing the commons of South Asia* (pp. 144–154). Oxford Scholarship.
- Gupta, M. V. (2001). Community-based aquaculture in India—strengths, weaknesses, opportunities and threats, Aquaculture section of the network of tropical aquaculture and fisheries professionals, *The ICLARM quarterly*, 24, 1–12. Retrieved from <http://worldfishcenter.org/Naga/Naga24-1&2/pdf/aquabyte%201.pdf/>
- Hancock, B. (2002). Trent focus for research and development in primary health care, An introduction to qualitative research. *Trent Focus Group*, 2. Retrieved from http://faculty.cbu.ca/pmacintyre/course_pages/MBA603/MBA603_files/IntroQualitativeResearch.pdf/
- Hanna, N. K. (2007). *From envisioning to designing e-development: the experience of Sri Lanka* (65–188). Washington, DC: The World Bank.

- Hardin, G. (1968). The tragedy of the commons. *Science, New Series*, 162(3859), 1243–1248.
Retrieved from <http://links.jstor.org/sici?sici=0036-8075%2819681213%201243%3A162%3A3859%3C1243%3ATTOTC%3E2.0.CO%3B2-N>
- Hess, C. (2008). *Mapping the new commons*. SSRN. [Presented at “Governing Shared Resources: Connecting Local Experience to Global Challenges;” the 12th Biennial Conference of the International Association for the Study of the Commons, University of Gloucestershire, Cheltenham, England, July 14–18, 2008]. Retrieved from <http://ssrn.com/abstract=1356835>
- Hess, C., & Ostrom, E. (2007). Understanding knowledge as a commons, from theory to practice. *The MIT Press*, 3–74.
- Huitric, M., Folke, C., & Kautsky, N. (2002). Development and government policies of the shrimp farming industry in Thailand in relation to mangrove ecosystems. *Ecological Economics* 40, 441–455.
- Huntington, H. P. (1998). Observations on the utility of the semi-directive interview for documenting traditional ecological knowledge. *Arctic*, 51(3), 237–242.
- Huong, T. T. T., & Berkes, F. (2011). Diversity of resource use and property rights in Tam Giang lagoon, Vietnam. *International Journal of the Commons*, 5, 130–149.
- IASC. (2012). The International Association for the Study of the Commons, Digital resources on the commons [Website]. <http://www.iasc-commons.org/library-resources>
- IISD. (2011). International Institute for Sustainable Development [Website]. <http://www.iisd.org/sd/>
- Jahn, T., Becker, E., Keil, F., & Schramm, E. (2009). Understanding social-ecological systems: frontier research for sustainable development. *Implications for European Research Policy*, 2, 1-8. Retrieved from http://ec.europa.eu/research/sd/conference/2009/papers/7/thomas_jahn_-_social-ecological_systems.pdf/
- Jayasinghe, J. M. P. K. (1998). Shrimp Culture in Sri Lanka: Key Issues in Sustainability and Research. In P. T. Smith (Ed.), *Towards Sustainable shrimp culture in Thailand and the Region* (48–51). Australian Center for International Agricultural Research.
- Johnson, G., Scholes, K., & Whittington, R. (2008). *Exploring corporate strategy, text and cases* (8th ed.) (156–160). FT Prentice Hall Financial Times.
- Joppe, M. (2000). The Research Process [Website]. <http://www.ryerson.ca/~mjoppe/rp.htm/>

- Korten, D. (1987). *Community management: Asian experience and perspectives*. West Hartford, Connecticut: Kumarian Press.
- Kularatne, M. G., Amarasinghe, U. S., Wattage, P., & De Silva, S. S. (2009). Evaluation of community participation for the development of culture-based fisheries in village reservoirs of Sri Lanka. *Aquaculture Economics and Management*, 13(1), 22–38.
- Latouche, S. (2004). Degrowth economics: why less should be much more. *Le Monde Diplomatique*, November 2004.
- Lightner, D. V. (1996). *A handbook of shrimp pathology and diagnostic procedures for disease of cultured Penaeid shrimp*. Baton Rouge, Louisiana, USA: World Aquaculture Society.
- Lowry, K., & Wickremaratne, H. J. M. (1987). Coastal area management in Sri Lanka. *Coastal management*, 275. Retrieved from <http://imcafs.org/download/SLKemICM.pdf/>
- Mack, N, Woodson, C., Macqueen, K. M., Guest, G., & Namey, E. (2005). Qualitative research methods: a data collectors field guide. *Family Health International*, 13–27. Retrieved from http://pdf.usaid.gov/pdf_docs/PNADK310.pdf/
- MFAR. (2009). *Fisheries Statistics Sri Lanka 2009*. Sri Lanka: Ministry of Fisheries and Aquatic Resources. Retrieved from [http://www.fisheries.gov.lk/Data/Fisheries %202009 %20Web.pdf/](http://www.fisheries.gov.lk/Data/Fisheries%202009%20Web.pdf/)
- MFARD. (2011). *Ministry of Fisheries and Aquatic Resource Development of Sri Lanka, Sri Lanka* [Website]. <http://www.fisheries.gov.lk/>
- Molnar, D., & Morgan, A. J. (2001). *Defining sustainability, sustainable development and sustainable communities: a working paper for the sustainable Toronto project, Final Draft* (pp. 8–29).
- Muir, J. (2005). Managing to harvest? Perspectives of the potential of aquaculture. *Philosophical Transactions of the Royal Society, Biological Sciences*, 360, 191–218. Retrieved from <http://rstb.royalsocietypublishing.org/content/360/1453/191.full.pdf+html/>
- Munasinghe, M. N., Stephen, C., Abeynayake, P., & Abeygunawardena, I. S. (2010). Shrimp farming practices in the Puttallam district of Sri Lanka: implications for disease control, industry sustainability, and rural development. *Veterinary Medicine International, Volume 2010*. Retrieved from <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2935178/pdf/VMI2010-679130.pdf/>

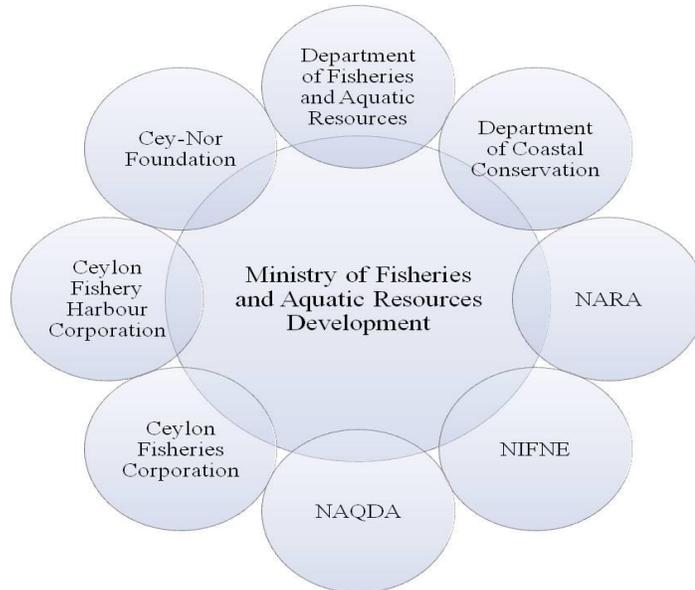
- NAQDA.(2011). *National Aquaculture Development Authority, Sri Lanka* [Website].
<http://www.naqda.gov.lk/>
- Nayak, P. K. (2006). *Politics of co-optation: self-organized community forest management and joint forest management in Orissa, India* (Master's thesis). Natural Resources Institute, University of Manitoba, Winnipeg.
- Nayak, P. K., & Berkes, F. (2010). Whose marginalization? Politics around environmental justice in Indian's Chilika lagoon. *Local environment* 15(6), 553–567.
- Nirodhawardane, H. D. L. U., Tilalak, C. R., Rajapaksha, R. M. B. U., & Munasinghe, P. (2003). *Study on better practices for shrimp farming in Chilaw and Puttlam districts of Sri Lanka* (11-34). Sri Lanka: Small fisheries federation, Centre for Rural Aquaculture Economics and Management.
- NSF. (1997). *Overview of qualitative methods and analytic techniques, common qualitative methods, Chapter 3*. Retrieved from
http://www.nsf.gov/pubs/1997/nsf97153/chap_3.htm/
- Ostrom, E. (1990). *Governing the commons: the evolution of institutions for collective action* (11–13). *New York: Cambridge University Press*.
- Ostrom, E. (2000). Collective action and evolution of social norms. *The Journal of Economic Perspectives*, 14(3), 137–158.
- Ostrom, E. (2009). Beyond markets and states: polycentric governance of complex economic systems, Prize lecture, December 8, 2009. *Workshop in political theory and policy analysis*, 408–444. Indiana University, Bloomington, IN 47408, and Center for the Study of Institutional Diversity, Arizona State University, Tempe, AZ, U.S.A..
- Ostrom, E., Burger, J., Field, C. B., Norgaard, R. B., & Policansky, D. (1999). Revisiting the commons: local lessons, Global challengers. *Science*, 284, 278–282.
- Pa´ez-Osuna, F. (2001). The environmental impact of shrimp aquaculture: causes, effects, and mitigating alternatives. *Environmental Management*, 28(1), 131–140.
- Pomeroy, R. S., & Rivera-Guieb, R.(2006). Fishery co-management: a practical handbook. *International Development Research Centre*, 16–17.
- Primavera, J. H. (1997). Socio-economic impacts of shrimp culture. *Aquaculture Research* 28, 815–827.

- Rabanal, H. R. (1988). *History of aquaculture*, ASEAN/UNDP/FAO regional small-scale coastal fisheries development project, Food and Agriculture Organization of the United Nations, 8. Retrieved from <ftp://ftp.fao.org/docrep/fao/field/009/ag158e/ag158e00.pdf>
- Rajaratnam, C. T. (2010). Economic development Vs sustainable development, October 28 2010 [News article]. Retrieved from <http://www.lankaweb.com/news/items/2010/10/28/economic-development-vs-sustainable-development/>
- Rönnbäck, P. (2001). *Shrimp aquaculture—state of the art*. Swedish EIA centre, Report 1. Swedish university of agricultural sciences (SLU), Uppsala. (ISBN 91-576- 6113-8)
- Sajise, P. (1995). *Community-based resource management in the Philippines: perspectives and experiences*, a paper presented at the Fisheries Co-management Workshop, North Sea Centre, 29–31 May, Hirtshals, Denmark.
- Scott Cato, M. (2009). *Green economics* (pp. 36–37). London: Earthscan.
- Sikdar, S. K. (2003). *Sustainable development and sustainability metrics*, Office of research and development, United States Environmental Protection Agency (EPA), Cincinnati, OH 45268, August 2003, 49(8), 11–47.
- Sofaer, S. (2002). Qualitative research methods. *International Journal for Quality in Health Care, Oxford Journals*, 14(4), 329–336.
- Soy, S. K. (1997). *The case study as a research method* (unpublished paper, University of Texas at Austin). Retrieved from <http://www.gslis.utexas.edu/~ssoy/usesusers/l391d1b.htm/>
- Spangenberg, J. H. (2002). Sustainability science: which science and technology for sustainable development? International Network of Engineers and Scientists for Global Responsibility, *INES Newsletter*, 38(1).
- Stavins, R. N. (2010). *The problem of the commons: still unsettled after 100 years*. Faculty Research Working Paper Series, Harvard Kennedy School, Harvard University, p.1.
- Stone, M, Bond, A., & Foss, B. (2004). *Consumer insight: how to use data and market research to get closer to your customers*, British library cataloguing-in publication data, 1–19. Retrieved from http://books.google.ca/books?hl=en&lr=&id=TcgdI3VAha8C&oi=fnd&pg=PP2&dq=consumer+insight&ots=bSvOnik0Y_&sig=Kbo8ln4zZk4Ks02yjrs7QBBv1Mw#v=onepage&q=consumer%20insight&f=false/
- Strauss, A., & Corbin, J. (1990). *Basics of qualitative research: grounded theory procedures and techniques*, Newbury Park, CA: Sage Publications, p. 17.

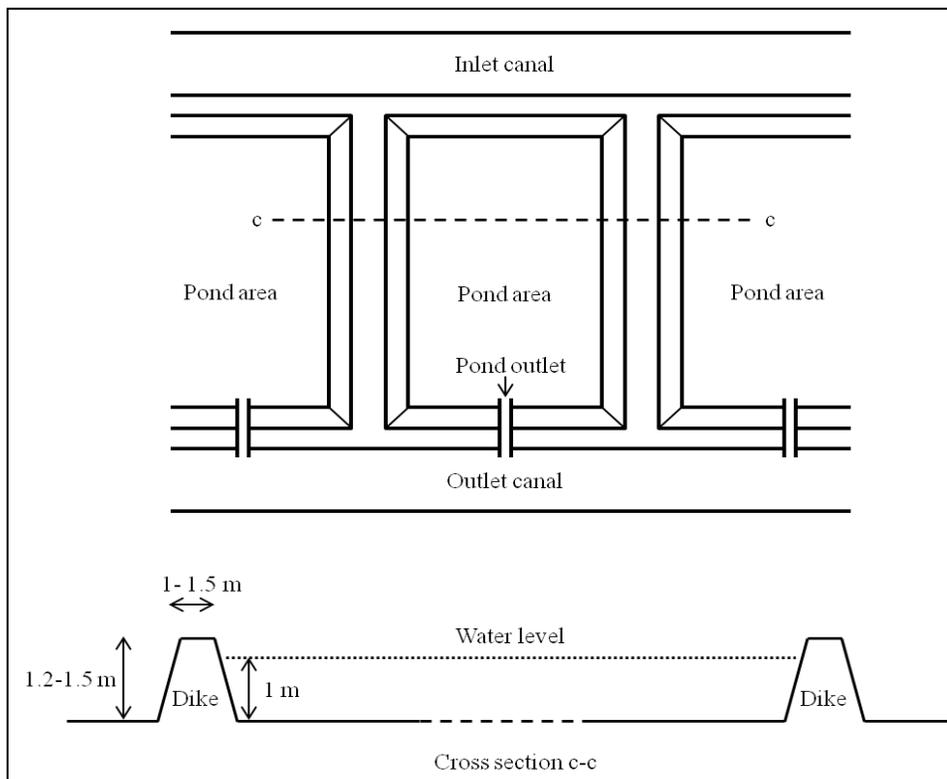
- Stuart, I., McCutcheon, D., Handfield, R., McLachlin, R., & Samson, D. (2002). Effective case research in operations management: a process perspective. *Journal of Operations Management* 20, 419–433. Retrieved from <http://www.sciencedirect.com/science/article/pii/S0272696302000220/>
- Tennakoon, I. M. (2009). *Start-up motives of business operations involved with prawn industry in Puttlam district of Sri Lanka* (MBA dissertation). Postgraduate Institute of Agriculture, University of Peradeniya, Sri Lanka.
- Treanor, P. (1997). Why sustainability is wrong. In *Liberalism, market, ethics*. Retrieved from <http://web.inter.nl.net/users/Paul.Treanor/index.html/>
- United Nations. (1987). *Report of the world commission on environment and development (42/187)*. General assembly, A/RES/42/187, 96th plenary meeting, 11 December 1987. Retrieved from <http://www.un.org/documents/ga/res/42/ares42-187.htm/>
- West London Friends of the Earth. (2001). *Sustainability*. Retrieved from [http://www.wlfoe.demon.co.uk/sustain.html./](http://www.wlfoe.demon.co.uk/sustain.html/)
- Wijenayake, W. M. H. K., Jayasinghe, U. A. D., Amarasinghe, U. S., Athula, J. A., Pushpalatha, K. B. C., & De Silva, S. S. 2005. Culture-based fisheries in non-perennial reservoirs in Sri Lanka: production and relative performance of stocked species. *Fisheries Management and Ecology*, 12, 249–258.
- Woods, P. (2006). *Qualitative research*. Faculty of education, University of Plymouth. Retrieved from <http://www.scribd.com/doc/77324644/Qualitative-Research/>
- World Bank. (1999). *Report from the International Workshop on Community-based Natural Resource Management (CBNRM)*, Washington, DC, 10–14 May 1998. Retrieved from [http://www.worldbank.org/wbi/conatrem/\(2003-02-14\)/](http://www.worldbank.org/wbi/conatrem/(2003-02-14)/)
- World Commission on Environment and Development. (1987). *Report of the world commission on environment and development: our common future*.
- Yin, R. K. (2009). Case study research, design and methods (4thed.). In *Applied social research method series*, volume 5 (240 pp.). SAGE publications.

APPENDIX A

Institutional structure of the MFARD (Adopted by: MFARD, 2011)



Features of a shrimp grow-out pond



APPENDIX B

Demographic information

Table Appendix B-1: Number of years of experience in the shrimp industry

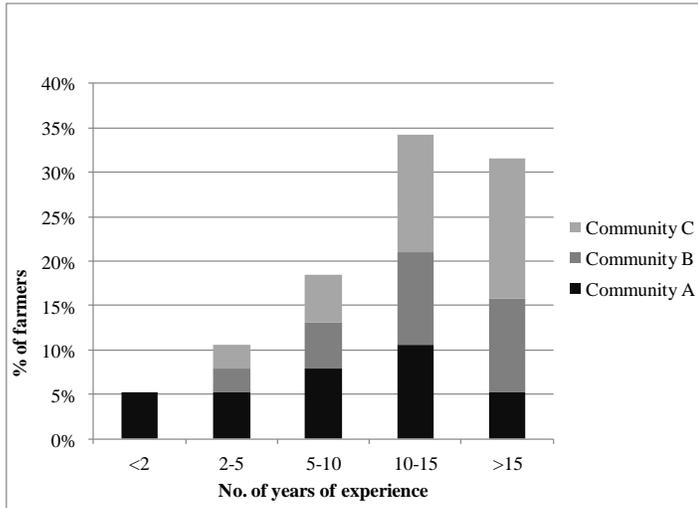
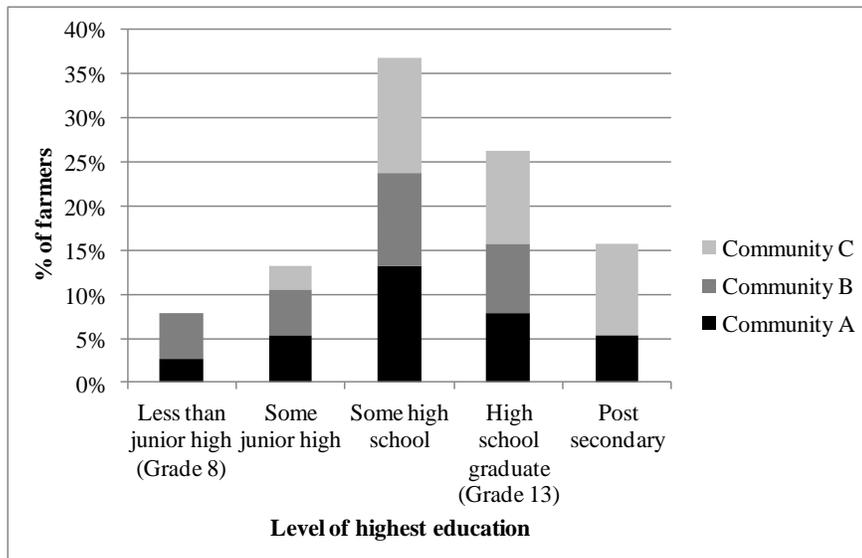


Table Appendix B-2: Highest level of education



Farming-related information

Table Appendix B-3: No. of ponds operated by each farmer

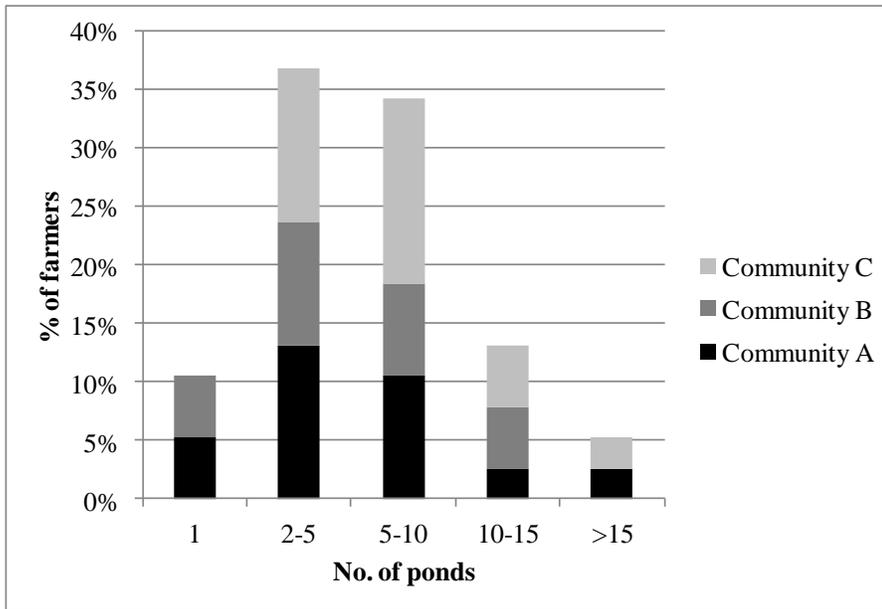


Table Appendix B-4: Total farm area used by each farmer

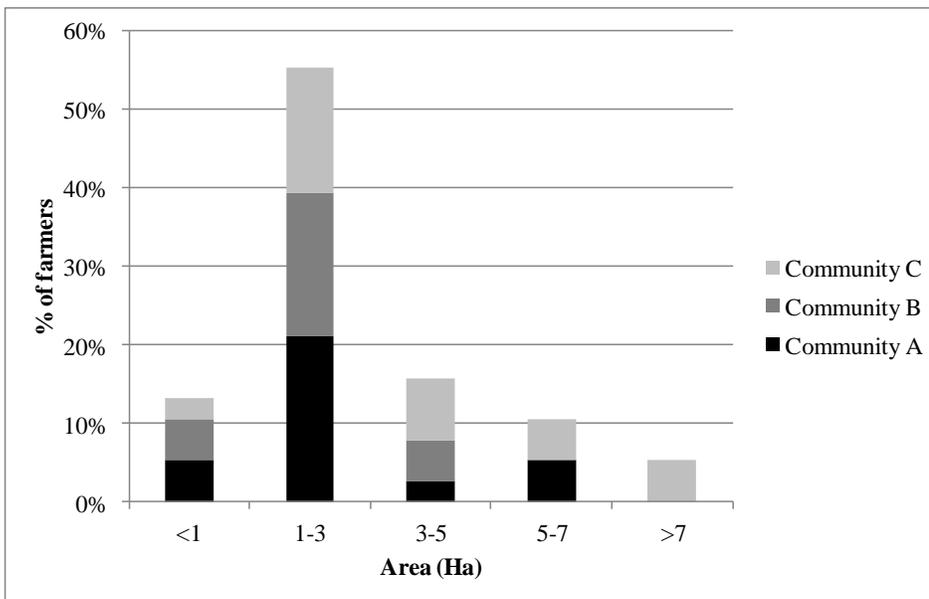


Table Appendix B-5: Reasons for having abandoned areas in the farm

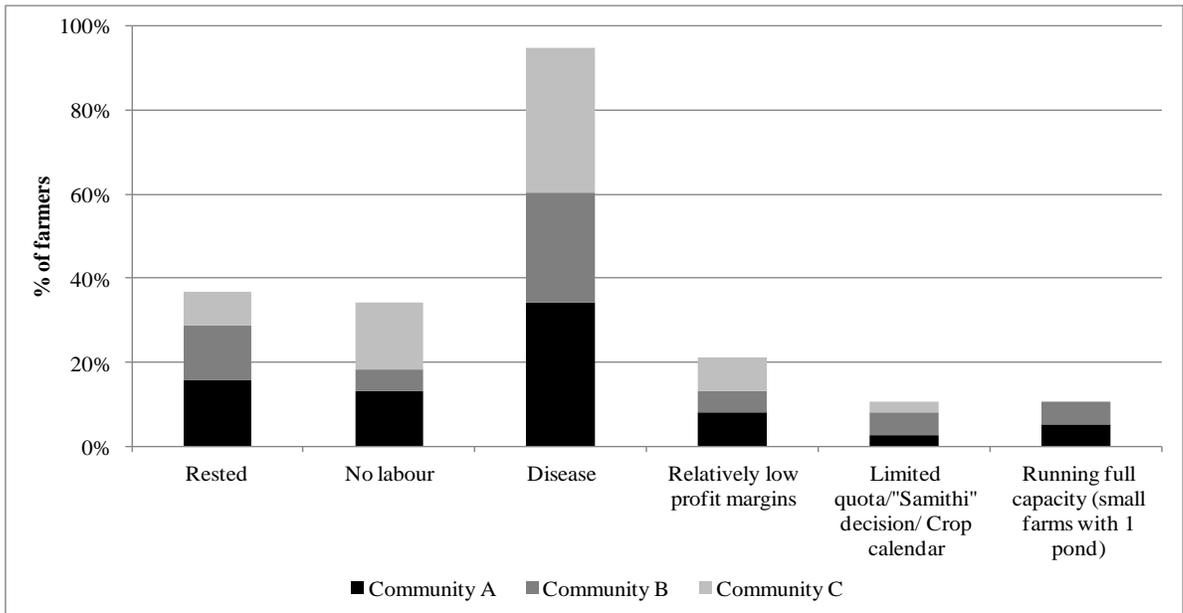


Table Appendix B-6: Sizes of the ponds in community C

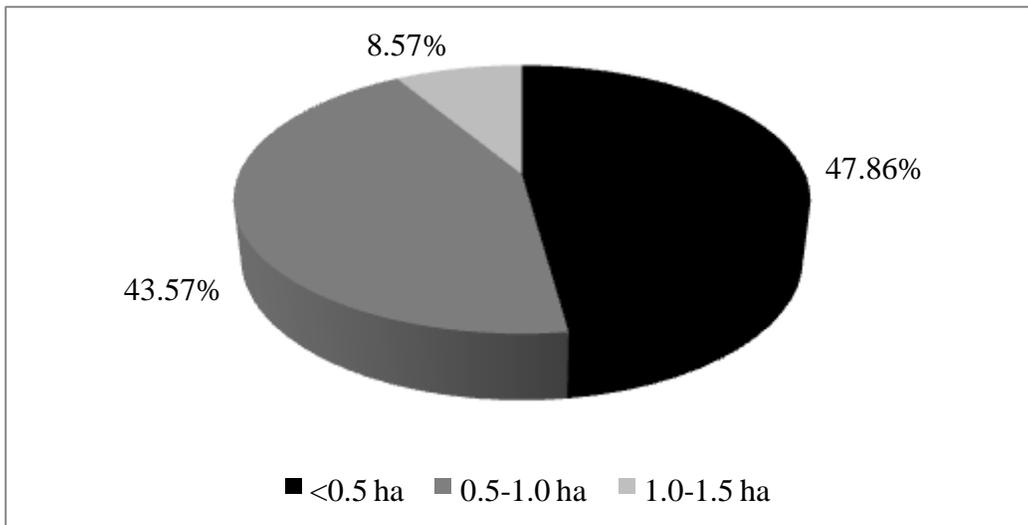


Table Appendix B-7: Farm land ownership types

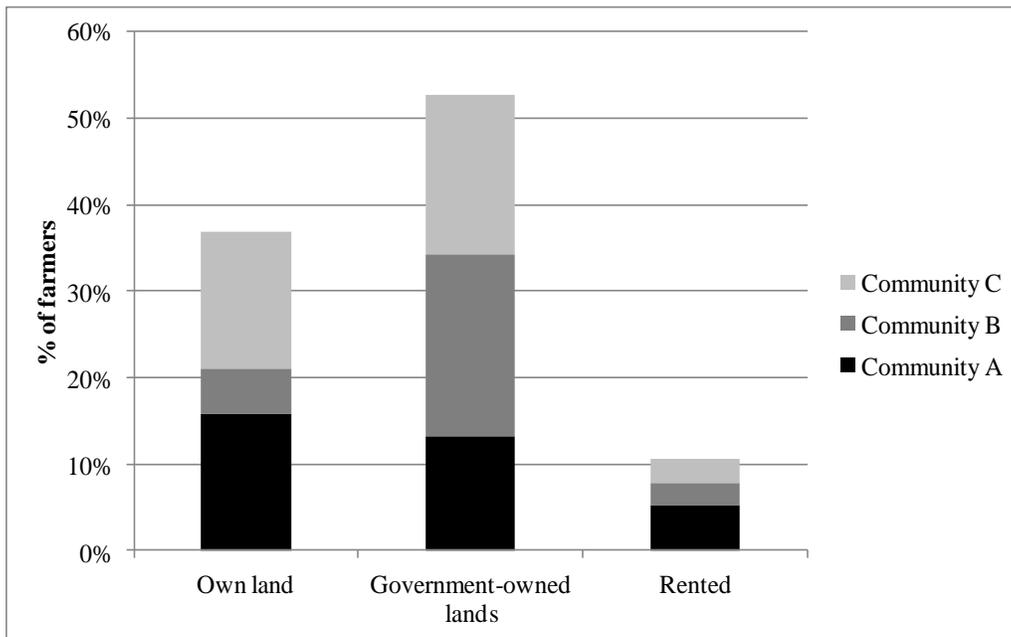


Table Appendix B-8: Types of business operations farmers carried out

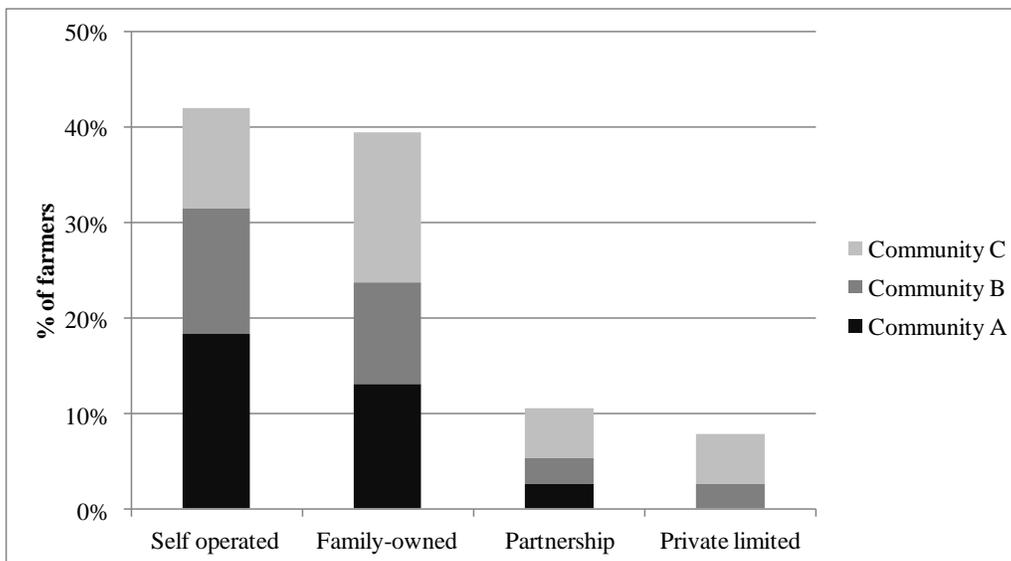


Table Appendix B-9: Number of wage employees in each farm

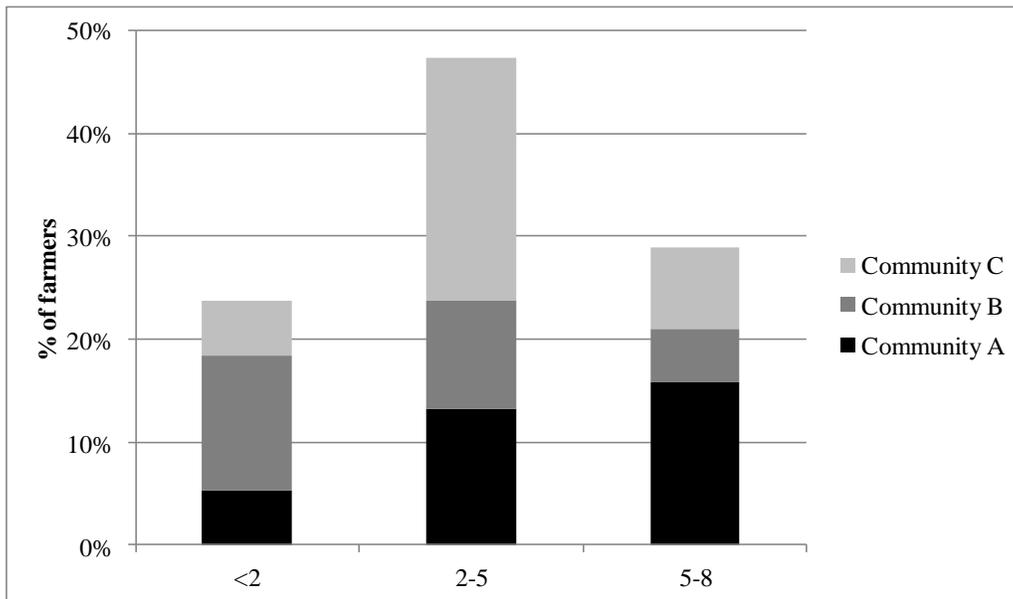


Table Appendix B-10: Involvement of the family members in farming operations

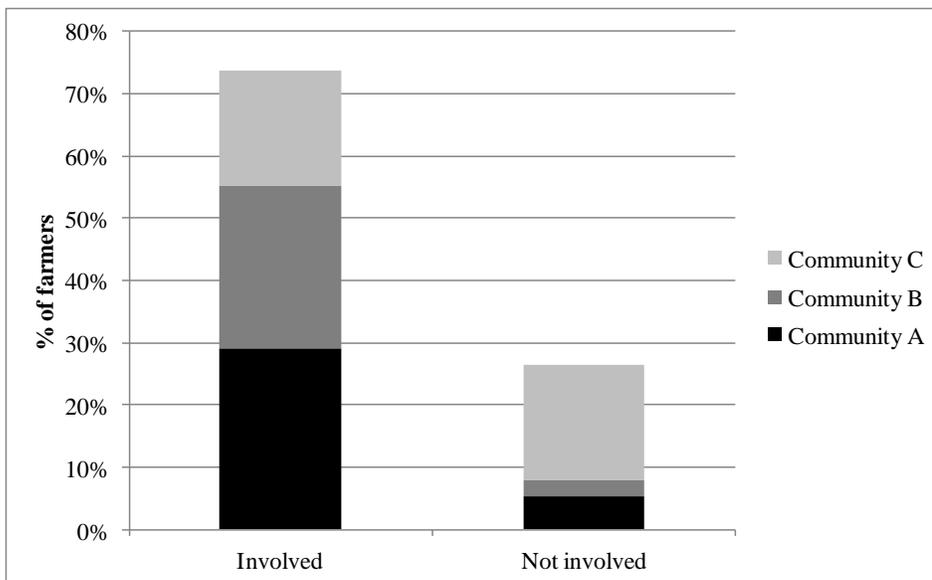


Table Appendix B-11: Type of family members involved in farming activities (of the 72% involved, Table Appendix B-10)

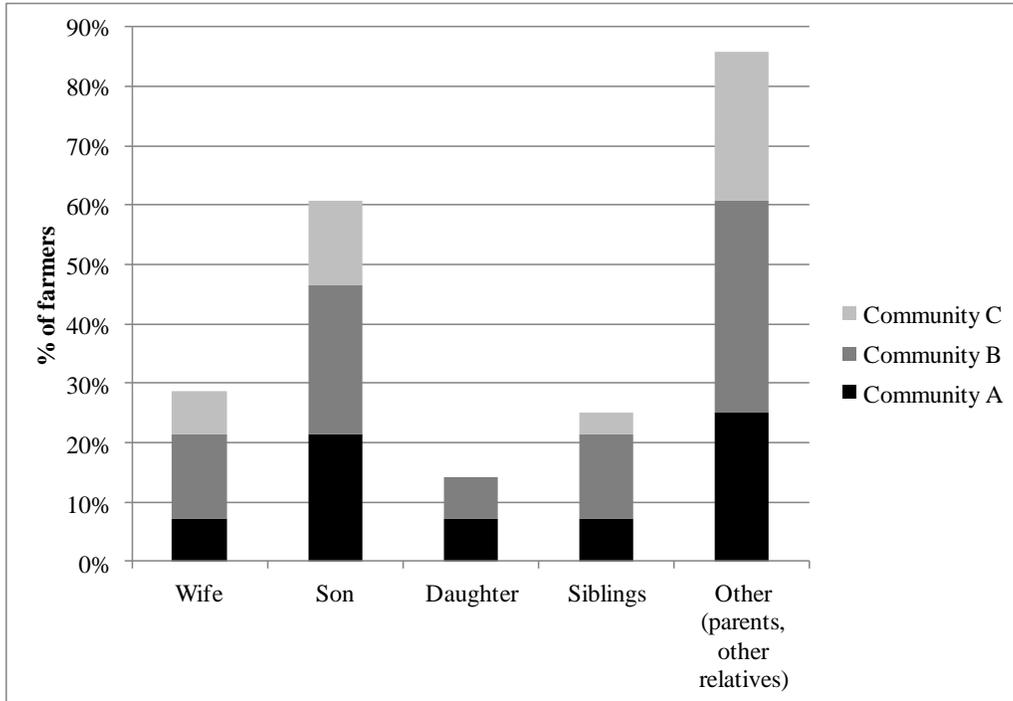


Table Appendix B-12: Nature of involvement of family members

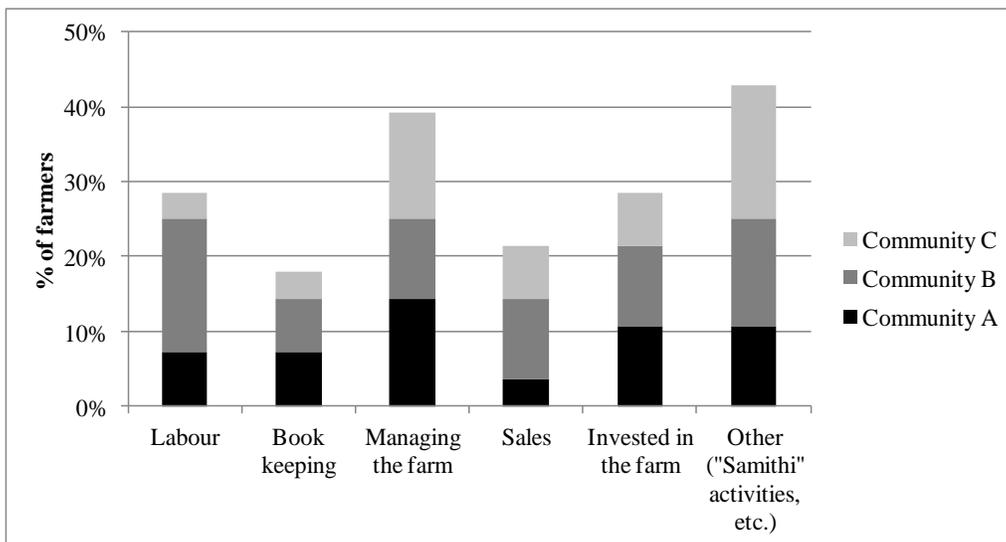


Table Appendix B-13: Number of production cycles per year

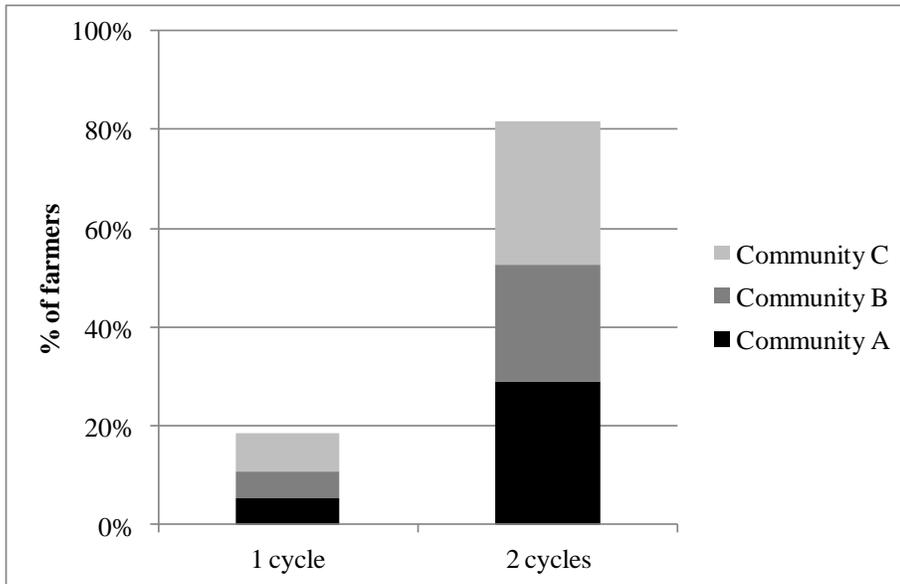


Table Appendix B-14: Type of power source used

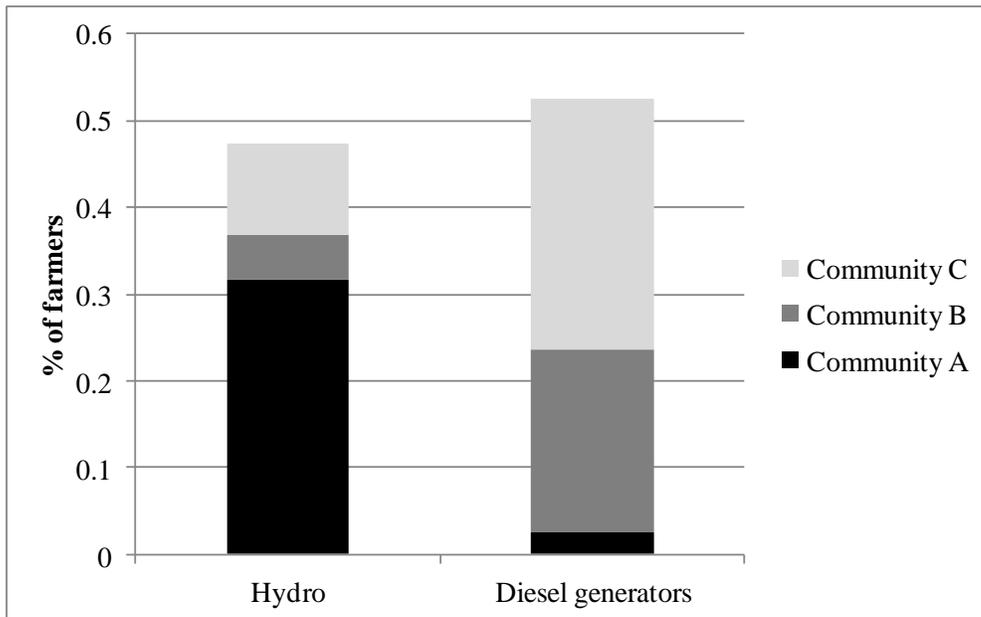


Table Appendix B-15: Farmers' involvement with organizations

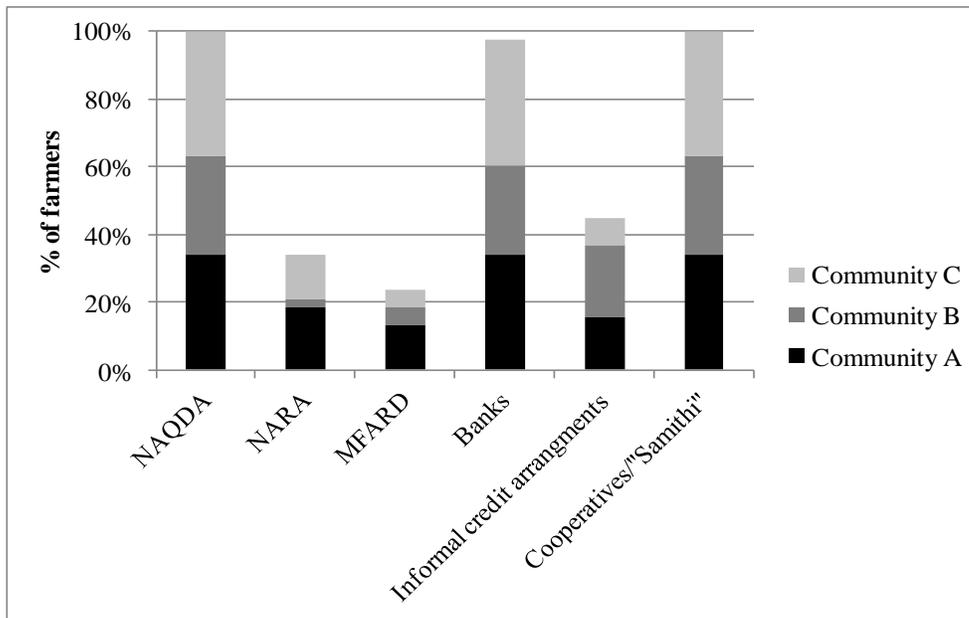
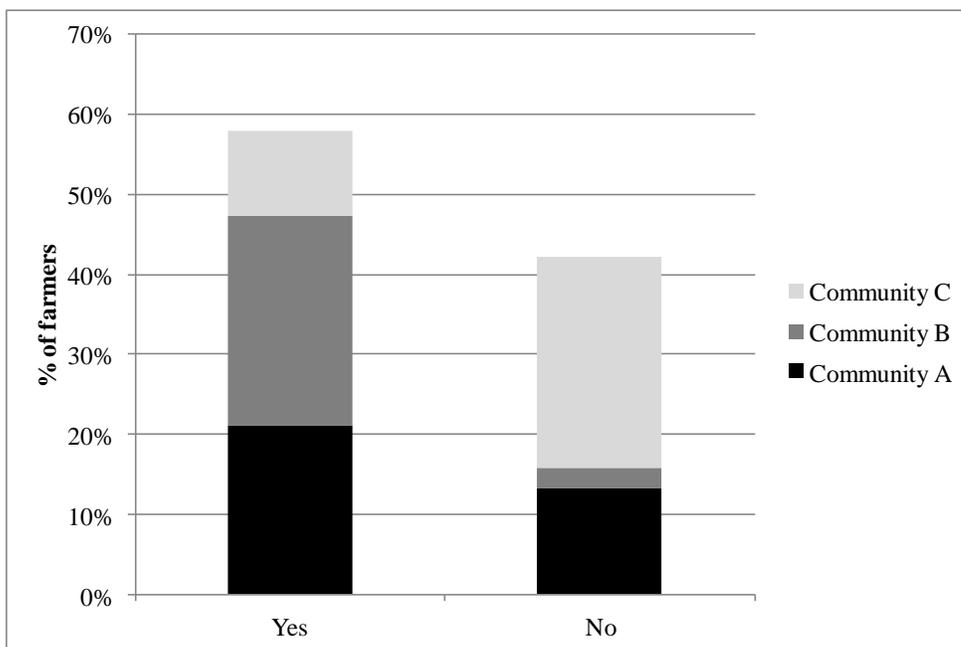
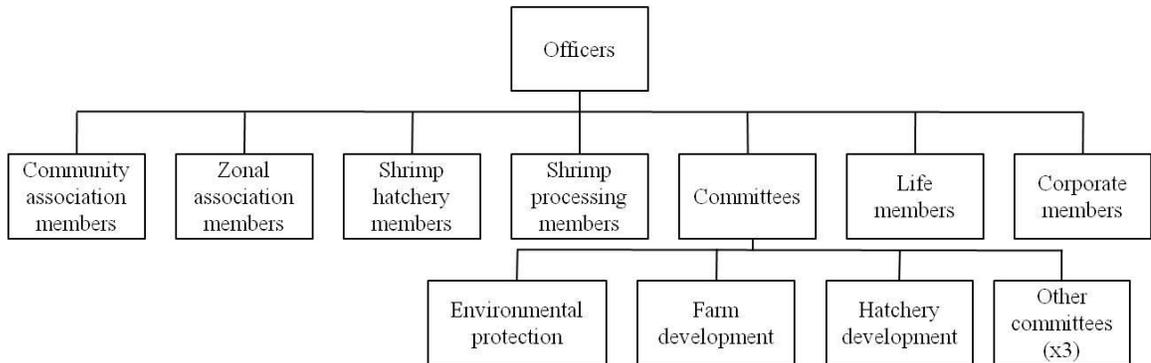


Table Appendix B-16: Income-generating activities other than shrimp farming

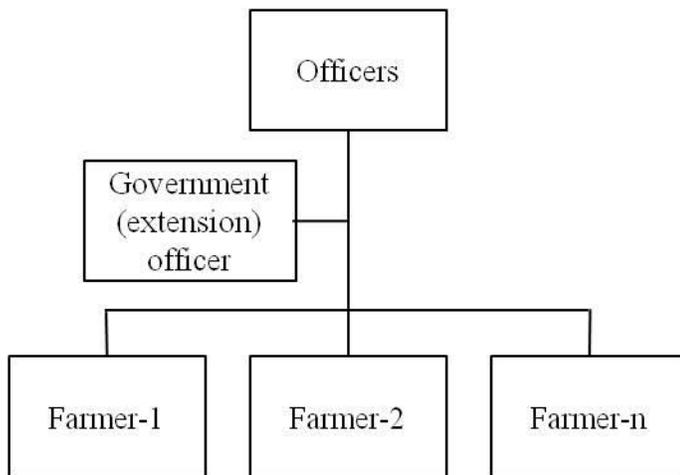


APPENDIX C

Structure of SLADA



Structure of zonal and sub-zonal community associations



APPENDIX D

SWOT analysis

Internal environment

Strengths

1. The bottom-up approach of involving community associations is recognized by the fisheries Act and government statutory bodies as a resource management approach

The ten-year development policy framework of the fisheries and aquatic resources sector (2007–2016) clearly highlights the importance of promoting a bottom-up approach in managing fisheries and aquatic resources. Cooperative arrangements (associations/societies) are well recognized by the constitution of Sri Lanka. This background provides a platform for the current shrimp aquaculture governance system to function smoothly. This system can be related to Ostrom's (1990) fourth design principle, which emphasizes the importance of community members having the right to devise their own rules that are respected by external authorities.

2. Well established and organized multi-level institutional structure

The governance structure is organized as multi-level community-based associations (community, zonal, and national level) with involvement of NAQDA at the top level. Separate roles and responsibilities are fulfilled by institutions representing each of these three levels. This structure can be related to Ostrom's (1990) eighth design principle on nested enterprises; i.e., appropriation, provision, monitoring and sanctioning, conflict resolution, and other governance activities are organized in a multi-level institutional structure.

3. Goodwill and experience in producing high quality shrimps for niche-markets

Sri Lanka is well known and reputed for a period of about three decades in supplying high quality shrimps. Niche markets are: USA, EU countries, and Japan. According to shrimp processors, there is a specific taste and texture to Sri Lankan aquacultured shrimps, which attracts a specific customer group.

4. Existence of a collective and collaborative decision making process

Examples for collective decision making on resource management aspects are available at all three levels of governance structure. In community (sub-zonal) and zonal association level, regulatory and operational decisions are collectively made. National-level decisions are mainly related to aquaculture resource management and are collaboratively made thorough a participatory approach. For example, the annual zonal crop calendar development process involves participation of representatives from community, zonal, and national levels; government institutions; relevant academic institutions; provincial authorities; and other stakeholder entities.

5. Limited potential for further geographical expansion of farming areas, protecting remaining natural resources

Currently, there are many abandoned shrimp farms in northwestern area as a result of a large number of farmers quitting farming at a later stage (due to disease outbreaks). Mangroves, wetlands, etc. have been used to construct these farms. However, existing shrimp farmers and new farmers are not required to waste time and effort in building farms. Instead, they rent or buy existing farms. Rules and processes imposed by the community associations on anyone newly entering farming are strict. These rules seem to result in less new farmers starting up. Under these conditions, the potential threat from shrimp farming to the remaining natural resources and socio-ecological systems is limited.

6. Close collaboration among sector stakeholders

Current resource management structure facilitates building and maintenance of close working relationships with many institutions on different shrimp farming-related aspects. Such institutions are: government institutions other than NAQDA (e.g., environmental authority), provincial councils, divisional secretariats, universities (national and international), and certain not-for-profit organizations (IUCN).

7. Adaptation of a zonal crop calendar system, which limits environmental degradation

The principle behind the zonal crop calendar system is the learning-by-doing approach, whereby the learning/experiences from previous crop(s) are incorporated into the plan for the next crop. This adaptive approach was designed by SLADA to address the high-risk nature of farming due to disease conditions. The crop calendar system minimizes disease spreading potential as well as environmental damage.

8. Most existing shrimp farms are small in scale, making a relatively low impact to the environment

Small-scale shrimp farming is known to make a relatively low impact to the environment compared to large- or medium-scale operations.

9. The majority of shrimp farmers are educated, compared to people who engage in similar types of economic activities

Based on the data gathered in this study, most shrimp farmers in these communities are educated, when compared to farmers who engage in similar economic activities such as paddy cultivation, fishermen, etc. Level of education is important when it comes to community-level management activities.

10. Natural water body, lagoons, canal system, and the soil available in the northwestern area provide landscape and resources needed for shrimp farming

Shrimp aquaculture is fully dependent on available natural water bodies as the culture medium. The canal system running through the area distributes water to farming areas and provides a natural landscape required for shrimp farming. The type of soil available in this area is the suitable soil type needed for constructing ponds, as it is capable of holding/retaining water for a long period time (with less seepage).

11. The nature of the water body allows for season-based management of shrimp farming based on naturally demarcated cultivation zones (zonal crop calendar)

The way the natural water body is located in the northwestern area demarcates clear boundaries. Based on how land is separated by water, shrimp farming areas can be divided into zones and community-level sub-zones. This zonal system is used in developing the seasonal crop calendar in order to manage farming operations.

12. Availability of diverse natural resources and unique biodiversity

Sri Lanka is a tropical country consisting of various climatic and topographical conditions within a relatively smaller land area. It is also considered to be a global biodiversity hotspot with many plant and animal species, which are recognized as being distinct at high taxonomic levels (Bocxlae et al., 2009). Therefore, the natural ecosystem is rich, including mangroves and wetland areas.

13. Annual budgetary financial allocation for shrimp farming-related activities

There is an annual budgetary allocation for improving shrimp farming activities and uplifting livelihoods of farmers. Currently, this money is being used for PCR testing, monitoring and extension services, etc. Funds are administered through NAQDA.

14. Experience gained and lessons learned from adaptation of different management practices over the years

The resource management process adapted in shrimp aquaculture is an ongoing learning process. It started three decades back and has resulted in several cycles of successes and failures. Existing shrimp farmers have learnt a lot from these experiences and they contribute their experience and knowledge for the development of the sector through community associations.

Weaknesses

1. Lack of timely production to satisfy market demand

From an economic perspective, the main weakness is lack of on-time production to retain the market and to get a good price. The problem starts from shrimp hatcheries. Hatcheries are unable to produce the forecasted level of PLs due to lack of proper management practices and disease problems. Actual shrimp farm production volume is also below the forecasted level mainly due to diseases. As a result, aquacultured production of shrimp

harvest available for processing is always below the forecasted level. See the illustration in the following Figure.

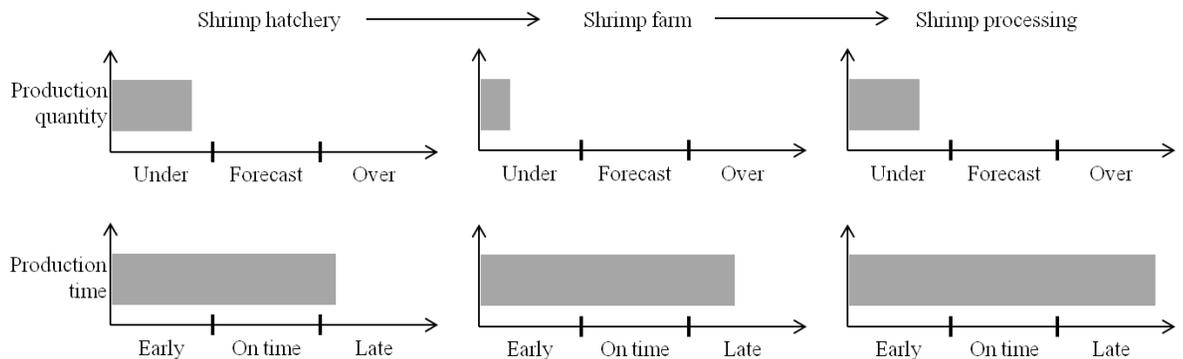


Figure Appendix D-1: Lack of timely production throughout production cycle

In terms of timing of production, most hatcheries delay production due to: unavailability of on-time breeding stocks (parent shrimps); delayed receipt of laboratory test results; and sometimes unfavourable weather conditions. As a result, the entire cycle gets delayed. Processing companies do not get required amounts of harvest on time; despite the fact that export demand for processed shrimps is seasonal. All the above-mentioned factors collectively affect the profit making potential of the shrimp industry. Starting from late 2009, due to the end of the civil war that lasted for three decades, shrimp processing plants have started to get wild catch harvests from northern and eastern coastal areas in addition to aquacultured shrimps coming from the northwestern area.

2. Poorly managed institutions

Most of the inefficiencies in performance of the shrimp aquaculture sector can be associated with weak intuitional management. Inefficiencies are common to both bottom-level community associations as well as the top-level participatory/collaborative arrangements. Weak institutional management results in corruption, egoism, relativism, favouritism, harassments, political influence, etc. (Hanna, 2007). These forms of mismanagement mostly affect enforcement of policies and procedures.

3. The purpose of the zonal crop calendar is forgotten during implementation

The main principle behind the zonal crop calendar is to continuously update and fine tune it to suit changes in the environment. It is an environmentally defensive approach in addressing disease problems as white spot virus (the main disease-causing virus) cannot be eradicated. The zonal system is a way of achieving expected results of the crop calendar system by creating time and geographical barriers against disease spread. However, currently, it seems that the crop calendar development process has deviated from its set objectives, as it is not being updated based on environmental changes; rather, it is mostly a continuation of a similar calendar. As an outsider, the researcher felt that the national-level crop calendar meeting is for the representatives and stakeholders to get together and allocate crop seasons among themselves.

4. Less government attention on use of diesel generators

Based on the researcher's interviews with representatives of government institutions, it seemed that they pay less/no attention to the issue of shrimp farmers totally depending on diesel generators during their production cycle. The use of diesel generators is not friendly to the environment. In addition, the cost of production is higher when compared to hydro. This situation is more critical in certain remote communities with no hydro-electrical connectivity. During community association meetings, there were many discussions on the difficulty of getting hydro-electricity services, mainly due to land ownership issues. If the government can intervene and make sure that electricity services are available in these areas, then use of diesel generators will go down. It will also reduce the reported illegal electricity thefts from common electricity lines. Farms will become more secured during night time against theft taking place mainly due to lack of power during night.

5. Gender balance is not visible in shrimp aquaculture context

All the shrimp farmers I met are males. Even though there is no female representation as farmers, female family members help in farming operations in different ways.

6. The connected nature of the water bodies causes quick spreading of diseases

Interconnected natural lagoons and the canal system increase the potential and speed of disease spread.

7. The government's priority is to increase production with a minimum effort on protecting environment and natural resources

The way government institutions contribute in the shrimp farming sector implies that their priority is to increase production. Less/no attention is given to protection of the environment and natural resources. For example, proper handling of waste is an ignored component, despite its significance in terms of sustainability.

8. Lack of resources deployed in the sector

Lack of human resources/expertise (such as aquaculturists, farming consultants, field extension officers, general labour), laboratory facilities, new technology, etc. limit the potential for a smoothly run resource management process and the development of the sector.

9. Absence of funding allocated for research to improve the sector

Even though NARA is the responsible government body for aquaculture research, it pays little/no attention to shrimp farming-related research. Due to the presence of NARA, the

government does not allocate any additional money for the shrimp sector (assuming that the research part is taken care of by NARA).

10. Poor rural road network affecting input supply delays and quality of inputs (e.g., PL quality, harvest quality)
11. Emotion-based decisions made at community-level associations

Decision making under the influence of emotional conditions (anger, empathy, etc.) could lead to incorrect decisions. This nature of decision making is common in the bottom level of the existing resource management structure.

12. Presence of marginalized groups in the sector, such as low income groups (some fishermen and rural households) creating a social disparity

External environment

Opportunities

1. Expanding the demand from export markets (such as Japan, USA, and some EU countries) on Sri Lankan aquacultured shrimps
2. Good reputation due to unique taste and quality (texture, size, appearance) of Sri Lankan aquacultured shrimps among potential buyers
3. Room for improving industry capacity. Currently, only 40% of the shrimp farms are functioning. There is a potential to expand production by using abandoned ponds
4. Opening up of new niche markets for Sri Lankan shrimps such as South Korea, China, and India
5. Salt manufacturing can be an alternative to effectively use abandoned shrimp farms in certain areas (*Puttalam* area) to create an alternative income source

Threats

1. Political influence creates a difficult environment for institutions to function independently in fulfilling their responsibilities. This can be observed throughout the resource management structure, especially at the field enforcement level.
2. Shrimp farmers do not possess power to influence the price of any input or output during the entire production process. The following Figure illustrates the actors who have the power to determine prices of inputs/outputs. Accordingly, all the other actors in the production process, except farmers, possess price-determining power. A farmer becomes a 'price taker' in immediate transactions in either side of the production process (i.e., PL-supplying hatcheries and harvest-buying processors). Therefore, farmers are in a vulnerable position in bargaining for the price.

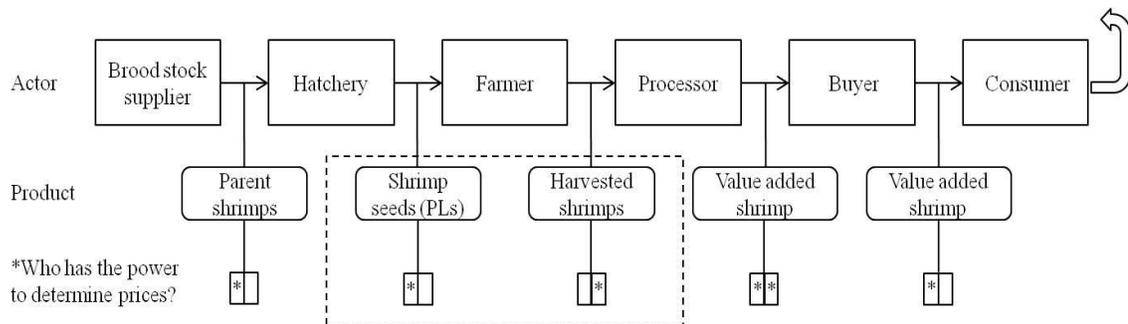


Figure: Who has the power to determine prices?

Farmers always seem to be questioning the transparent nature of farm gate price (i.e., unit selling prices of shrimp harvest) setting process. This study attempted to investigate the farm gate price-setting process based on opinions of farmers and other stakeholders.

3. Limited number of research studies on social-ecological systems and technical aspects of shrimp aquaculture. Most of the research and academic institutions of Sri Lanka are not aware of shrimp farming as a community-based, participatory, and collaborative management approach, but a commercialized business activity.

According to my understanding, the art and science of aquaculturing has largely evolved over time. This development is mainly due to the individual and collective efforts of shrimp farmers, rather than government institutions. Government played no/little role in this process until SLADA initiated and got NAQDA involved in the process (in 2005). Later, the existing collaborative governance system came into the picture. Still, there was no contribution from the government towards technical or operational knowledge advancement of the sector. However, research is costly due to the complex nature of farming operations.

4. Shrimp farming has earned a bad reputation in history due to its environmental and social impacts. Commercial operations have badly affected coastal ecological systems such as mangroves.
5. Regional political instability and actions influence the sector decision making and performance. This type of political influence has affected the shrimp sector since its outset.
6. Industry rivalry

Substitutes for tiger shrimps (other species) have emerged in large scale from other shrimp producing countries, creating a loss of market share for Sri Lankan aquacultured shrimps. *Penaeus indicus* and *Penaeus vannamei* products are the main substitutes for *Penaeus monodon* (black tiger shrimp). On top of this, wild catch from northern and eastern areas of Sri Lanka (since late 2009) saturates the market, creating a competitive situation for cultured shrimps.

7. Impact of inflation (percentage changes in major cost components) in shrimp farming.

Costs of hydro-electricity and/or fuel and labour have increased significantly over the years, even though the selling price remains more or less the same.

8. Global climate changes impact shrimp farming. For example, mass shrimp PL destruction happens due to sudden temperature variations. Further, due to unexpected rainfall patterns, disease spreading is more complicated and unpredictable.

APPENDIX E

Research Schedule

Year	2012												2013			
Month	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Chapter 1 – 3																
Defend proposal																
Ethics approval																
Field work																
Data analysis/writing																
First draft																
Revise first draft																
Oral defence																
Thesis submission																

Budget

Research field expenses	Monthly	Total (CAD)
Air Travel (two-way)		2,000.00
International travel expenses (\$50/day*4 days)		200.00
Living expenses	1,000.00	3,000.00
Accommodation in Sri Lanka		1,500.00
Ground transportation in Sri Lanka		2,000.00
Research supplies and materials		300.00
Sri Lankan Research Assistant		1,000.00
Total expenses		10,000.00

Open-ended question guide for semi-structured interviews

Questions related to Objective 1

General

- Are there any cooperatives (*samithi*) and/or any other collective management arrangements available for shrimp aquaculture?
- Where are they located? Who are the members? How recognized are the community-based organizations as resource management entities in the context of shrimp aquaculture?
- How dependent is the shrimp aquaculture sector on the existing resource governance system?
- What are the inputs and resources required for shrimp farming operations?
- What are the components (seed, feed, etc.) and the related operational costs?

Farm specific: See Appendix B

Questions related to Objective 2

- What is the scope of practice of these community-based organizations?
- What is their scale of operation? How capable are they in influencing member practices?
- What is the level of establishment/evolution (number of years since incorporation, presence of procedures/processes, registered/non-registered, self-organized or not, organizational structure, etc.)?
- How is the accountability in place and practiced? Compliance to rules?
- What decisions are taken by the cooperatives (*samithi*)?
- What is the process for decision-making in cooperative level?
- How strong is the member-cooperative relationship?
- How are the resource and institution boundaries determined?
- Who make the rules?
- Who has the responsibility of monitoring?
- What are the conflict resolution mechanisms and who decides those?
- How are operational and collective-choice rules formulated?
- How do they share power, authority, and accountability?
- How are the rules of excludability and subtractability determined?
- How does excludability and subtractability impact the cooperative level and individual farmer level?
- What is the nature of existing resource governance system (s)—community level, provincial level, national level?
- How are local collective management groups nested at multiple layers?
- What is the position of community-based organizations within the co-management structure?
- What is the status of recognition of the commons' institution by the state? Is the government undermining local authority?
- Are there any conflicts between local rules and the rules formulated at the policy level?
- Has there been a significant transfer of power and authority to the community institution?
- What is the level of external aid (skills, funds, information, etc.) provided to the community?

Questions related to Objective 3

- What are the strengths, opportunities, weaknesses, and threats attached to the existing cooperative governance system?
- Currently, to what extent does it address the sustainability aspects of the community, ecosystem, and livelihoods?
- What are the challenges faced by the community institutions and how have they been dealt with?
- What is the strategic direction (policy direction) of shrimp aquaculture in terms of livelihood and ecosystem sustainability?
- Are there any gaps to be addressed in ensuring the sustainability of the ecosystem and livelihood?
- What are the implications at the policy level?
- How would an appropriate business model look to ensure the sustainability?

Questionnaire for individual farmers

Case Number:

Date:

1. Are you a member of a cooperative/*Samithi*?

Yes

No

2. Affiliations with organization(s):

NAQDA
 NARA
 MFARD

Banks
 CoC
 Cooperatives

3. Location:

4. Age range (Years):

<30
 30-40
 40-50

50-60
 >60

5. How long have been in the shrimp industry (years):

<2
 2-5
 5-10

10-15
 >15

6. Gender: Male: Female:

7. Highest education level:

Less than Junior high (Gr.8)
 Some junior high
 Some high school

High school Grad (Gr.13)
 Post-secondary

8. Number of ponds operated:

Unit area (Acres)		Number	=	Total area	
<0.5	<input type="text"/>	*	<input type="text"/>	=	<input type="text"/>
0.5-1	<input type="text"/>	*	<input type="text"/>	=	<input type="text"/>
1-1.5	<input type="text"/>	*	<input type="text"/>	=	<input type="text"/>
1.5-2	<input type="text"/>	*	<input type="text"/>	=	<input type="text"/>
>2	<input type="text"/>	*	<input type="text"/>	=	<input type="text"/>
					<input type="text"/>

9. The balance of the area used:

Rested	<input type="text"/>
No labour	<input type="text"/>
Disease	<input type="text"/>
Not profitable	<input type="text"/>
Limited quota	<input type="text"/>

10. Land ownership/any arrangements:

Own land	<input type="text"/>
Lease	<input type="text"/>
Rent	<input type="text"/>
Other	<input type="text"/>

Specify:

11. Type of business:

Individual	<input type="text"/>	Family- owned	<input type="text"/>
Partnership	<input type="text"/>	Private limited	<input type="text"/>
Other	<input type="text"/>		

12. Number of employees:

<2	<input type="text"/>	9-15	<input type="text"/>
2-5	<input type="text"/>	>15	<input type="text"/>
5-8	<input type="text"/>		

13a. Are there any family members involved in the business:

No

Yes

If yes, numbers:

Wife	<input type="text"/>
Son	<input type="text"/>
Daughter	<input type="text"/>
Other	<input type="text"/>

13b. How (if yes):

Labour	<input type="text"/>
Bookkeeping	<input type="text"/>
Managing	<input type="text"/>
Selling	<input type="text"/>
Investing	<input type="text"/>
Other	<input type="text"/>

14. Number of production cycles per year:

None	<input type="text"/>
1	<input type="text"/>
2	<input type="text"/>
3	<input type="text"/>

15. Total stocking capacity for the last production cycle (in 1000s of shrimp "seed" or postlarvae):

<100	<input type="text"/>	500–	<input type="text"/>
100–250	<input type="text"/>	1000	<input type="text"/>
250–500	<input type="text"/>	>1000	<input type="text"/>

16. Total yield of the last production cycle (Tons):

<1	<input type="text"/>	4–6	<input type="text"/>
1–2	<input type="text"/>	>6	<input type="text"/>
2–4	<input type="text"/>		

17. Any other income-generating activities related to aquaculture farming:

Poultry farming	<input type="text"/>
Fish	<input type="text"/>
Vegetable	<input type="text"/>
Processing	<input type="text"/>
Other	<input type="text"/>

18. Any other income-generating activities not related to aquaculture farming:

Feed selling	<input type="text"/>
Seed selling	<input type="text"/>
Rice farming	<input type="text"/>

Animal farming	<input type="text"/>
Fishing	<input type="text"/>
Other	<input type="text"/>

Informed Consent



Natural Resources Institute

70 Dysart Rd,
Winnipeg, Manitoba
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General Office (204) 474-7170
Fax: (204) 261-0038

Research Project Title: Community-based Shrimp Aquaculture in Northwestern Sri Lanka

Researcher: Eranga Kokila Galappaththi Guruge

Proposed script for verbal recruitment of research participants in the semi-structured interviews that will be spoken in Sinhala:

I am currently in the process of conducting my Master's Thesis research. The purpose of the study is to understand how shrimp aquaculture can be carried out by community-based institutions as an alternative approach to large-scale commercial aquaculture operations for ensuring the sustainability of the industry in the long run. This does not mean that large-scale shrimp production operations could be totally replaced by the community-based institutions, but rather this could be a potential approach for building a sustainable industry in the future. It should be noted that the small-scale farmers who form the bottom layer of the cultured shrimp supply chain in Sri Lanka are also significantly contributing to the total yield. It is worthwhile to explore the potential of community-based aquaculture as an alternative business management model and propose it as a model for ensuring sustainability of the industry in the future. This research is being sponsored by the Canada Research Chair in Community-Based Resource Management, Dr Fikret Berkes, Natural Resources Institute, University of Manitoba, Canada. It has already been approved by the Joint-Faculty Research Ethics Board at the University of Manitoba (Canada).

This consent letter, a copy of which will be left with you for your records and reference, is part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like to know more details about something mentioned here, or to obtain information not included here, please feel free to ask for clarification. Please take the time to read this carefully and to understand this information.

In the course of the research you will be asked a series of questions that will help me understand the existing situation of the community-based shrimp aquaculture in your village. Specific aspects such as the level of participation, the structure of the local governance system, membership criteria, and decision making process of cooperatives

will be covered during the research process. You will be requested to participate in an interview session that will last between 30 minutes and 1 hour. If more time is required, a subsequent meeting can be arranged at your convenience. These interviews may be conducted at your place of work (farm), home, or at another location of your preference. After the interview, if the need arises, you may be contacted for further clarifications.

Your responses to questions during the several sessions of the research will be documented in a notebook. However, your names will not be recorded with the responses to ensure that your identity remains confidential. There will be a group meeting organized towards the end of the research where I will verify all the information collected during the research process. You will have an option to disagree to any such information, in which case the information would be suitably modified with your inputs. The data provided by you will be used to complete progress reports and my Master's thesis, and will potentially be published in an academic journal. You will not be identified by name in any such publications.

You are free to decline to participate in this research, withdraw from the study at any time, and/or choose not to answer any questions you may not be comfortable with. If you do decline to participate in the study or to answer any questions, you will not face any negative consequences. If I have not explained the study clearly, please feel free to ask for clarification or additional information at any time throughout your participation.

If you have any complaints or further questions about the nature of this research, your concerns may be directed to the Human Ethics Secretariat at the University of Manitoba (204-474-7122; research@umanitoba.ca) or to my advisor, Dr. Fikret Berkes, Professor, who may be contacted at 204-474-6731 or berkes@cc.umanitoba.ca. Please be advised that the staff at these offices speak only English.

Do you understand and agree to the terms described here?



UNIVERSITY
OF MANITOBA

Office of the Vice-President
(Research and International)
Research Ethics and Compliance

Human Ethics
208 - 194 Dafoe Road
Winnipeg, MB
Canada R3T 2N2
Fax 204-269-7173

APPROVAL CERTIFICATE

April 11, 2012

Canada Research Chair
(Dr. Fikret Berkes)

TO: Eranga K. G. Guruge
Principal Investigator (Advisor F. Berkes)

FROM: Wayne Taylor, Chair
Joint-Faculty Research Ethics Board (JFREB)

Re: Protocol #J2012:044
"Community-based Shrimp Aquaculture in Northwestern Sri Lanka"

Please be advised that your above-referenced protocol has received human ethics approval by the **Joint-Faculty Research Ethics Board**, which is organized and operates according to the Tri-Council Policy Statement (2). **This approval is valid for one year only.**

Any significant changes of the protocol and/or informed consent form should be reported to the Human Ethics Secretariat in advance of implementation of such changes.

Please note:

- If you have funds pending human ethics approval, the auditor requires that you submit a copy of this Approval Certificate to the Office of Research Services, fax 261-0325 - please include the name of the funding agency and your UM Project number. This must be faxed before your account can be accessed.
- if you have received multi-year funding for this research, responsibility lies with you to apply for and obtain Renewal Approval at the expiry of the initial one-year approval; otherwise the account will be locked.

The Research Quality Management Office may request to review research documentation from this project to demonstrate compliance with this approved protocol and the University of Manitoba *Ethics of Research Involving Humans*.

The Research Ethics Board requests a final report for your study (available at: http://umanitoba.ca/research/orec/ethics/human_ethics_REB_forms_guidelines.html) in order to be in compliance with Tri-Council Guidelines.