



# Aquaculture Big Numbers



***Cover photographs:***

*Left:* Women in Aquaculture in Nepal: Members of a community fish production and marketing cooperative in Nepal harvesting fish. Photo credit – J. Pant. (WorldFish); *Top Right:* Sampling of fish growth performance in a pond by field researchers in Bangladesh. Photo Credit – Mark Prein. (GIZ); *Middle Right:* Harvesting fish in a small-scale aquaculture operation in Malawi. Photo Credit – Randy Brummett. (World Bank); *Bottom Right:* Harvest of Indian major (rohu, catla and mrigal) and exotic (silver, grass and common) carps from a semi-intensive polyculture pond in Mymensingh, Bangladesh. Photo Credit – FAO/Mohammad R. Hasan.

# Aquaculture Big Numbers

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by

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# Preparation of this document

This document has been developed through a collaborative programme involving FAO and WorldFish, and financed by the Swedish International Development Agency (SIDA). It contributes to FAO's efforts to enhance understanding of the contribution of aquaculture to poverty alleviation, food security and towards improving the livelihoods of many rural communities engaged in aquatic production. The authors thank SIDA for its generous support.



**PLATE 1**  
Weighting *Pangasius* fish.  
Photo credit: Nesar Ahmed

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# Abstract

The “Aquaculture Big Numbers” research project seeks to: provide baseline information on the present status of the aquaculture sector from a human development perspective; identify the types and numbers of people employed by the sector; and explore the role of aquaculture in providing social and economic services at a global level, with a particular emphasis on small-scale stakeholders. The research findings presented here are based on a global synthesis of information from various sources and 9 country case studies undertaken in Africa, Asia and Latin America. The findings suggest that previous employment estimates of the global aquaculture sector based on official statistics are likely to be underestimates. Employment generated at farm level is found to be much higher than employment at other links in the value chain. The majority of fish farms are small-scale, integrated, household operations, and value chains oriented around small-scale producers are estimated to generate more employment than those from medium- and large-scale producers. Farm-level employment is found to be much higher in small-scale compared with medium- and large-scale value chains, while employment at other links along small-scale value chains is much lower than that for medium- and large-scale value chains. Employment from domestic-oriented aquaculture value chains is estimated to be much higher than employment from export-oriented value chains. Aquaculture, particularly small-scale aquaculture, is found to generate important social and economic services in the form of direct employment in production activities and indirect employment along the value chain. The findings highlight the limited nature of available “official” data. It is important therefore that more comprehensive data become available to enable successful monitoring of the sector and to inform aquaculture planning and policy in the future. Some indicators to monitor social and economic services from aquaculture at both the national/local and household levels are suggested. An important priority, particularly for developing countries, should be the inclusion of poor and small-scale stakeholders in the development of the aquaculture sector, both directly and indirectly. While the globalization of value chains and demands for certification appear to be marginalizing small-scale farmers, significant social and economic benefits could be generated by a small-scale sector that can participate effectively in certified export value chains. Thus, a key recommendation is that small-scale farmers should be involved in the development of certification procedures and standards and policies should be developed to support small-scale farmers to become certified. One approach that has had success in a number of countries is to support and promote group certification of farmers organizations or clusters of farmers. Supporting the small-scale sector to access services, technical knowledge and training to utilize better management practises is required in order to develop a sector that is productive and sustainable.

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# Abbreviations and acronyms

FTE	full-time equivalent
GDP	gross domestic product
IAA	integrated agriculture–aquaculture
NGO	non-governmental organization
SMEs	small and medium-sized enterprises
SSA	sub-Saharan Africa
VAC	garden, pond, livestock (system in Viet Nam)

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# Executive summary

## INTRODUCTION

Global aquaculture production has been increasing steadily since the early 1950s and 50 percent of total global food fish now comes from aquaculture. Developing countries account for about 80 percent of world aquaculture production. Aquaculture provides important social and economic services to people in many developing countries. A number of external drivers, such as increasing pressure on available land and water resources, climate change, and increasing globalization, is threatening the sector and the livelihoods of small-scale stakeholders in poor and vulnerable communities. Moreover, while the importance of small-scale aquaculture is widely promoted, its significance cannot be estimated due to lack of available and accessible data.

To address these issues, FAO and WorldFish have collaborated on the “Aquaculture Big Numbers” project. This research project, the results of which are presented in this report, is intended to: provide baseline information on the present status of the aquaculture sector from a human development perspective; identify the types and numbers of people employed by the sector, estimate employment (using a value chain approach); and understand the role of aquaculture in providing social and economic services at a global level, with a particular emphasis on small-scale stakeholders in Africa, Asia and Latin America.

## STUDY APPROACH

The research for this study was conducted through a global synthesis of information available from various sources and nine country case studies combined with in-depth community level consultations where possible. Case studies in Africa, Asia and Latin America were chosen to represent countries where aquaculture plays a significant role in providing social and economic services. Case studies were conducted for: Bangladesh, Chile, Ecuador, Egypt, Indonesia, Mexico, Thailand, Viet Nam and Zambia. Secondary data from China were also reviewed.

## GLOBAL SYNTHESIS

In total there were about 10 million “units” directly involved in aquaculture value chains in the 9 case study countries, which account for about 16 percent of global aquaculture production. Most of this number are grow-out production operations (9.1 million) dominated by households who have ponds and operate aquaculture as an integrated component of their farming systems. Roles played by small-scale and poor stakeholders vary along and between value chains. The present study indicates that 11.4 million jobs were generated by aquaculture in the 9 case study countries, most of which come from 3 top world aquaculture producers where small-scale aquaculture dominates, namely Bangladesh, Indonesia and Viet Nam.

The data now available suggest that previous estimates of global aquaculture employment are likely to be underestimates. Using findings from case study countries to extrapolate the number of people employed in global aquaculture suggests that total jobs (both full and part time) in global aquaculture value chains could be as high as 56.7 million. However, this projected global employment estimate might be an overestimate, as further information on employment from other major aquaculture producers, especially China, is lacking. As such, this study also estimates a lower bound for global aquaculture employment (27.7 million, of which 20.1 million generated on farm and 7.6 million from other links in the value chain), based on a lower employment estimate for China. Thus, it is estimated that total global aquaculture employment lies somewhere between 27.7 and 56.7 million full- and part-time jobs.

### **SMALL-SCALE STAKEHOLDERS AND WOMEN EMPLOYED IN AQUACULTURE**

Of the about 11.4 million people employed in aquaculture value chains in the 9 case study countries, 6.5 million are employed in small-scale aquaculture value chains, compared with 4.9 million employed in medium- and large-scale value chains. The number of people employed at farm level in small-scale value chains (5.3 million) is much higher than that of those employed at farm level in medium- and large-scale aquaculture (2.9 million). It is estimated that 3.1 million people are employed at other links along aquaculture value chains in the case study countries (1.2 million for small-scale chains and 2 million for medium- and large-scale chains).

While small-scale aquaculture value chains generate higher overall levels of employment, small-scale aquaculture contributes less than 30 percent to total aquaculture production in the case study countries (3.4 million tonnes from small-scale production versus 8.3 million tonnes from medium- and large-scale production). Consequently, the labour productivity of small-scale aquaculture producers is lower than that of medium- and large-scale producers.

The case studies show that women play a significant role in aquaculture value chains. Employment of women in aquaculture value chains in Indonesia, Viet Nam and Zambia was estimated to range between 40 and 80 percent and women were found to be active in post-harvest activities in aquaculture value chains in many countries and to assume important roles in household-based aquaculture such as feeding, managing ponds and marketing products.

### **AQUACULTURE VALUE CHAINS**

The case studies revealed that freshwater aquaculture value chains are structured around diverse products grown in earthen ponds, paddy fields, cages, net enclosures, and pens in floodplains, reservoirs, lakes and rivers. Freshwater aquaculture value chains for domestic markets consist of a variety of carps and catfish produced in integrated aquaculture–agriculture systems. A substantial portion of freshwater aquaculture production also enters value chains for export markets e.g. entrepreneurial and monoculture catfish and tilapia value chains from Indonesia, Thailand and Viet Nam. Value chains from integrated aquaculture

systems are simpler and contain fewer segments compared with monoculture value chains producing products for export markets.

Brackish-water aquaculture value chains are structured around a few commodities such as shrimp, milkfish and mud crab. The most important brackish-water aquaculture value chain observed in the nine country case studies is the shrimp value chain. The case studies showed that, in general, brackish-water shrimp value chains are buyer-driven and export-oriented, with unequal power relationships among actors involved in the various chain segments. Employment generated by domestic and export-oriented aquaculture value chains in the case study countries is estimated to be about 73 and 27 percent, respectively.

### **SOCIAL AND ECONOMIC SERVICES OF AQUACULTURE**

The case studies show that a large number of small-scale stakeholders, including the poor, are directly involved in various kinds of freshwater aquaculture production such as: subsistence farming in Zambia; homestead aquaculture in Bangladesh; and the integrated garden, pond, livestock farming system in Viet Nam. Freshwater aquaculture directly contributes to poverty alleviation by generating employment and income for the poor. In Latin America, aquaculture is commonly practised by medium- and large-scale operators; nonetheless, findings from Chile and Ecuador show that a growing number of small producers are currently operating seaweed and freshwater aquaculture ponds.

The case studies revealed that aquaculture also contributes to poverty alleviation indirectly via the involvement of poor and small-scale stakeholders in various activities along aquaculture value chains. In Bangladesh, many poor people work as fry collectors and in seafood processing plants. In Indonesia, Viet Nam and other countries, rural poor people are employed in processing plants and as labourers for various aquaculture-related activities. The case studies suggest that there are high numbers of small-scale actors directly involved in various value chains. Many of these actors are not poor but are likely to be vulnerable, engaging in aquaculture production, along with other livelihood activities, as a small-scale rural enterprise for income generation. Women were found to be actively involved in aquaculture, especially in Asia.

Per capita fish consumption has been increasing in most countries investigated despite the stagnation or decline of production from capture fisheries. The increasing rate of fish consumption has been supported by the increase in annual aquaculture production. The majority of rising aquaculture production comes from entrepreneurial and commercial aquaculture operated by small-, medium- and large-scale producers.

### **MAJOR AQUACULTURE DEVELOPMENT TRENDS AND INFLUENCES**

The rapid growth of the sector in terms of both production and trade of aquaculture products provides significant opportunities in all regions under analysis. Key drivers of change include the increasing consolidation and vertical integration of export-oriented value chains, driven in part by increasing stringency in product

quality, trading standards and increasing demands for certification of aquaculture products. Dynamic local development trends are also important, and climate change and variability is creating both threats and opportunities for the sector.

### **MAJOR TRENDS INFLUENCING SMALL-SCALE EMPLOYMENT GENERATED THROUGH AQUACULTURE VALUE CHAINS**

Findings from the case studies on the impacts of these trends on small-scale stakeholders are mixed. For example, the China review found that, while employment in agriculture and fisheries has been decreasing, the number of people engaged in aquaculture has been increasing rapidly. However, findings from other countries such as Thailand show that employment in certain global value chains has been decreasing, and that it is very difficult for the poor to benefit from involvement in commercial and vertically integrated aquaculture value chains other than in insecure and unstable jobs such as on-farm labourers or as workers in processing factories. It is unclear whether employment generation along the value chain from larger-scale commercial production can make up for the displacement of small-scale farmers.

A related trend and driver of change is the increasing demand for certification of aquaculture products. While these international standards may appear not to affect smallholder systems in countries where domestic and regional trade dominate, such as in sub-Saharan Africa, there is an increasing risk that they could create substantial barriers to development, by denying them access to wider markets. Several of the case studies from Asia highlighted the risks and challenges of small-scale farmers being able to comply with these international standards and the overall uncertainty in their ability to do so.

### **IMPLICATIONS FOR FUTURE AQUACULTURE PLANNING AND POLICY FORMULATION**

The data available to monitor the social and economic services generated by aquaculture are limited. It is uncertain how the development trends occurring in the aquaculture sector will affect the services generated from aquaculture such as value-chain employment, and the livelihoods of small-scale and poor stakeholders. Therefore, it is important that more-comprehensive data become available to enable successful monitoring of the sector and to inform aquaculture planning and policy in the future. Some indicators to monitor these social and economic services from aquaculture are suggested, distinguishing between macro- and micro-level indicators that can be applied at national/local and household levels. The proposed indicators also incorporate indicators to monitor social and economic services generated by the aquaculture sector generally and those that can be used specifically to monitor the services generated by small-scale aquaculture development. While the national-level indicators are “traditional” social and economic indicators, the indicators for monitoring small-scale aquaculture are “sustainability” indicators.



## CONCLUSIONS AND RECOMMENDATIONS

This study has found that previous estimates of global aquaculture employment based on official statistics are likely to be underestimates. The findings also suggest that employment generated at farm level is likely to be much higher than employment at other links in the value chain, and that the majority of fish farms are small-scale, integrated, household operations. Value chains oriented around small-scale producers were estimated to generate more employment than value chains from medium- and large-scale producers. Employment at farm level was also found to be much higher in small-scale value chains than medium- and large-scale value chains although employment at other links along the former is much lower than for the latter.

Overall, the findings indicate that aquaculture, particularly small-scale aquaculture, generates important social and economic services in the form of direct and indirect employment. These findings also highlight the importance of understanding the social and economic services generated throughout the whole value chain and not just at the production level. The study highlights the limited nature of available “official” data. Without accurate data, aquaculture planning, policy development and resource allocation are unlikely to provide the appropriate support to enable the sector to maximize its impacts, especially those generated by and beneficial to the small-scale aquaculture sector. The indicators suggested here provide a sound basis for data collection in the aquaculture sector.

An important priority should be to ensure the inclusion of poor and small-scale stakeholders in the development of the aquaculture sector, either directly through production or indirectly through value-chain employment. While the globalization of value chains and increasing demands for certification appear to be marginalizing small-scale farmers in many countries, significant benefits could be generated by a small-scale sector that is able to participate effectively in certified export value chains. Thus, a key recommendation is that small-scale farmers should be involved in the development of certification procedures and standards, and policies should be developed to support small-scale farmers to become certified. A successful approach in a number of countries has been to support and promote group certification of farmers organizations or clusters. Supporting the small-scale sector to access services, technical knowledge and training to utilize better management practices is required in order to develop a sector that is productive and sustainable.



**PLATE 2**  
Harvest from small-scale seaweed culture in Indonesia. Photo credit: Rohana Subasinghe

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# 1. Introduction

With capture fishery production relatively static since the late 1980s, aquaculture has been responsible for the impressive growth in the supply of fish for human consumption. Whereas aquaculture provided only 7 percent of fish for human consumption in 1974, this share had increased to 26 percent in 1994 and 39 percent in 2004. China has played a major role in this growth as it represents more than 60 percent of world aquaculture production (FAO, 2016). About 50 percent of total global food fish production now comes from aquaculture and most aquaculture growth takes place in developing countries, which account for about 80 percent of world aquaculture production. It is estimated that by 2030, the world will require the production of an additional 27 million tonnes of fishery products to satisfy the growing demand for food fish. Given the limited opportunities for growth, and possibly even a decline in capture fisheries, this increasing demand must be met by additional production from the aquaculture sector.

Aquaculture provides important trade and livelihood opportunities for rural people in many developing countries. Social and economic services are provided by aquaculture through: contributing to global and national food security; providing self-employment and paid employment for rural and peri-urban households and communities; creating employment along fish and seafood value chains; generating economic multiplier effects; contributing increasingly to national and international trade; and generating income at household, community and national levels. Nonetheless, aquaculture development today faces a number of serious challenges to meet future demand and to continue to provide its important social and economic services. A number of overarching external drivers are threatening the sector, and particularly the livelihoods of small-scale stakeholders in poor and vulnerable communities. These factors include, for example: increasing competitive pressure on available land and water resources for aquaculture expansion, pollution, climate change, natural disasters, and local risks associated with increasing globalization and others. Moreover, the importance of small-scale aquaculture to the sector as a source of income, food, and employment for many poor people is widely promoted, yet its significance cannot be estimated due to the lack of available and accessible data. It is also not certain whether a focus solely on small-scale aquaculture development will deliver the significant improvements in productivity and management required in order to secure the sector's future contribution to food security and poverty alleviation.

Recently, there have been attempts to better understand the contribution of capture fisheries to local and global economies through a "Big Numbers Project", implemented through a partnership involving the World Bank, FAO, WorldFish and others. The objective of this project was to better understand the social and economic values of the capture fisheries sector through generation of data on the

people involved in the sector and the trends and role of the sector in national and global economies. Despite the recent rapid expansion of aquaculture, involving many millions of small-scale farmers and poor people globally across multinational supply chains, no similar information or understanding exists. Without better understanding of the aquaculture sector, the numbers of people involved, and other factors, there will remain a poor basis for future planning.

To address these issues, FAO and WorldFish are collaborating on an “Aquaculture Big Numbers” project. This research project is intended to provide baseline information on the present status of the aquaculture sector from a human development perspective and an understanding of the role of aquaculture in providing social and economic services at a global level, with a particular emphasis on small-scale stakeholders in Africa, Asia and Latin America.

More specifically, the research is intended to:

- explore aquaculture industry structures (species, farming systems, value chains, scale of production, etc.);
- identify the types and numbers of people employed by the sector, using a value-chain approach to estimate employment from farm to market or point of export;
- analyse social and economic services provided to society from aquaculture structures, with an emphasis on small-scale stakeholders and the poor;
- identify major trends and influences on small-scale aquaculture farmers and poor people involved in aquaculture production and associated value chains;
- recommend a set of indicators for monitoring social and economic services of aquaculture for consideration in future aquaculture planning and policy development.

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## 2. General overview and study approaches

### 2.1 GENERAL OVERVIEW OF SOCIAL AND ECONOMIC SERVICES OF GLOBAL AQUACULTURE

The research for this study was conducted through a global synthesis of information available from various sources and selected country case studies combined with more in-depth community-level consultations where possible.

#### 2.1.1 Aquaculture and stakeholder classifications

This section provides a conceptual overview of aquaculture including its definition and classifications.

Aquaculture is defined by FAO as the process of farming aquatic organisms such as fish, shellfish and aquatic plants. Different criteria can be used to classify aquaculture, for example: cultured species (shrimp culture, fish culture, seaweed culture, etc.); cultured environments (e.g. freshwater, brackish water, marine culture); culture technologies (e.g. extensive, semi-intensive, and intensive aquaculture); scale of operation (e.g., small-, medium- and large-scale); and culture objectives (e.g. subsistence, commercial production). The study gives an emphasis on social and economic services of aquaculture, the types of people involved, as well as aquaculture systems and value chains.

From the review, it emerges that definitions of aquaculture systems based on the scale of operation are not widely agreed upon. Conventionally, there is a continuum of aquaculture systems ranging from small- to medium- and large-scale regarding land size, use of hired labour, capital investment, and level of technological sophistication. In sub-Saharan Africa (SSA), small-scale aquaculture often equates with subsistence farming, whereas in Asia it is commonly associated with a wide spectrum of subsistence and integrated farming through to small farm enterprises with various degrees of household specialization. Small-scale aquaculture is globally varied with regard to social organization, employment, as well as technological application, knowledge, species, and input use. Small-scale producers typically use low-input farming methods and a large percentage of farm labour is provided by household members. Its operations are commonly family-owned and highly vulnerable to external shocks induced by, among other drivers, global market consolidation (e.g. transforming global aquaculture production into buyer-driven value chains), climate change, and multiple pressures from local and domestic urbanization and industrialization.

The literature on small-scale aquaculture has largely been dominated by biologists who frame it as a productive activity having positive implications for rural development (Belton and Little, 2011). In the early 1990s, FAO coined

the concept of rural aquaculture, which was later elaborated by Edwards and Demaine (1997) as “the farming of aquatic organisms by small-scale farming households or communities, usually by extensive or semi-intensive, low-cost production technology appropriate to their resource base”. This concept is often used interchangeably with the concept of small-scale aquaculture. However, it is important to note that, by the concept of rural aquaculture, the authors emphasize the promotion of aquaculture systems appropriate to the resource base of small-scale farming households for poverty alleviation in rural areas. Rural aquaculture emphasizes the use of aquaculture as an important component for poverty alleviation and sustainable rural development (Edwards, 1999). It is characterized by aquaculture farming systems with low and on-farm inputs, low-cost and simple technologies accessible to the poor, aiming at improving farmers’ living standards and food security. Rural aquaculture can be operated as a single farming activity; however, it is commonly integrated with other farm subsystems, referred to as integrated agriculture-aquaculture (IAA), such as the garden, pond, livestock (VAC) systems found in Viet Nam.

This study attempts to take a wider approach to the aquaculture sector, identifying the types and numbers of people employed by the sector, using a value-chain approach. The purpose of using such an approach is to trace employment through the production systems, from farm to market. This approach, while conceptually appealing, is difficult to implement in practice because of limitations in the way data is collected in the aquaculture sector. Stakeholder classification is equally problematic, and various countries and studies use different ways of classifying types of people involved. This study has used existing in-country classifications, such as “small-scale”, “household” and other existing forms used in each country, rather than developing a new system. Nevertheless, the approach is problematic, and varied use of different classifications makes cross-country and global comparisons difficult.

### **2.1.2 Social and economic services from global aquaculture**

It is widely considered that aquaculture contributes to global and regional food supplies, improves national food security, generates household income, contributes to national and global gross domestic product (GDP), creates direct and indirect employment for rural populations, and contributes to national and international trade. Aquaculture development, especially small-scale aquaculture, can contribute to rural development, for example through efficient use of water, efficient use of farm products and other resources, diversifying livelihoods, utilizing family and rural labour, and enhancing social harmony and gender equity (Edwards, 1999).

Applying an ecosystem-based approach (MEA, 2005), social and economic services from aquaculture development can be categorized as follows:

**Provisioning services:** Aquaculture generates employment, livelihood opportunities, income, GDP, export revenue, and fish food supply, and contributes to poverty alleviation and increases farm productivity and efficiency.

At the individual and household level, available literature has established that aquaculture can improve livelihoods of the poor through improved food supply, employment and income (Edwards, 2000). The contribution of aquaculture to rural development has long been recognized; however, there have been limited hard data to justify this claim (Bondad-Reantaso and Prein, 2009). Income from aquaculture is often reported to be higher than that from conventional agriculture or other alternative livelihood options.

At the aggregate level (community, national, regional and global level), aquaculture provides important provisioning services such as supplying food fish and providing employment opportunities. With regard to employment, the estimated level of employment created by the global aquaculture sector varies from report to report and is influenced by aquaculture statistics compiled by FAO from national aquaculture statistics submitted by FAO Members. Valderrama, Hishamunda and Zhou (2010) recently collated information on aquaculture employment using FAO data. Their findings suggest that aquaculture has created about 23 million jobs. Most employment was found to be generated in Asia, with East Asia (plus India) accounting for 94 percent (15.6 million) of direct employment (16.7 million) and 92 percent (21.5 million), which approximately matches its share of world aquaculture production (91 percent). The findings generally support the broad understanding that high employment is created in regions with high aquaculture production. With regard to scale of production, total numbers of small-scale producers have been variously estimated by FAO as about 70–80 percent of total producers. This implies that total smallholder numbers are about 11.7–13.4 million. However, the present study shows that this could be an underestimate.

Aquaculture can be a vehicle for improving food and nutrition security as well as alleviating poverty in rural areas in developing countries. Aquaculture contributed 50 percent of fish for human consumption in 2015 (FAO, 2016), and is a major engine to meet increasing demand for fish and seafood. The Bangladesh case study, for example, notes that small-scale household aquaculture can act as a buffer to stop people falling back into poverty.

**Sociocultural services:** In some countries, farmed aquaculture products are used for ritual services. Having aquaculture ponds can also show prestige and status of the owner (e.g. in Ghana, the Lao People's Democratic Republic, and Nepal). In many countries, a certain proportion of fish from small-scale ponds is gifted to family, friends and neighbours in the community at harvest, thus increasing social capital and often increasing fish farmers' direct and indirect access to labour, food, money and social support from community members. Aquaculture can also be a vehicle for empowering women through job creation and encouraging men and women in households to work together to take care of aquaculture operations. In some countries selected for study, such as Bangladesh and Viet Nam, women dominate jobs at certain links along aquaculture value chains.

**Regulating services:** Aquaculture can provide waste assimilation and environmental cleaning, water storage and drought releases. Nutrient recycling in integrated aquaculture systems and integrated pest management can be viewed as regulatory services provided by aquaculture. Integrated fish culture systems such as rice–fish culture benefit poor and small-scale households and also have positive environmental impacts via nutrient recycling and reducing pesticides used for rice culture. In well-known VAC systems observed in Viet Nam, in addition to their main function of growing fish, fish ponds also play an important role in crop and livestock production in terms of nutrient recycling and waste assimilation.

## **2.2 STUDY APPROACHES**

### **2.2.1 Value chain approach**

Much attention on aquaculture and employment focuses on the production stage, but in reality there is a diverse array of stakeholders involved in aquaculture value chains from input supplies and services, through to producers and consumers. Among these are many small-scale stakeholders, and more broadly landed and landless poor, both directly involved in production as small farmers, or employed throughout the value chain. Social and economic services of aquaculture development generated along aquaculture value chains are not fully understood. Therefore, this study adopts the value chain analytical framework to evaluate the socio-economic contribution of aquaculture development, in particular the level of employment it generates. Secondary data for the analysis were collected from various available publications generated by international and national agencies as well as development projects. Primary data are mainly from the country case studies selected for the analysis.

As this study focuses on analysing social and economic services of aquaculture, especially in terms of job and employment generation, it adopts Tool 8: Analyzing Employment Distribution, of the “Making value chains work better for the poor” toolkit (M4P, 2008). The employment distribution analysis suggested in the toolkit involves a number of steps, beginning with defining the categories of actors involved and mapping out the value chain. In the following steps, the analysis focuses on determining and estimating employment at each level of the value chain and analysing employment distribution at different links of the chain. The estimation and calculation of employment along the value chain depend on available secondary information, results of surveys and fieldwork, and relevant assumptions made by the authors.

### **2.2.2 Country case studies**

This section describes how countries were selected for the study and the research activities and components included in the selected case studies.

Study countries in Africa, Asia and Latin America were chosen to represent countries where aquaculture plays a significant role in providing social and economic services. National studies were contracted by WorldFish and/or FAO to suitable partners in the selected countries in October and November 2010.



Table 1 presents aquaculture production of the major aquaculture producing countries globally, as available during the time of the study, and indicates those countries included in this study. Total aquaculture production from the countries listed in Table 1 was estimated at 45.5 million tonnes with a farm gate value of US\$71 million, accounting for 86 percent of total world aquaculture production, and 72 percent of world aquaculture production value in 2008, respectively. These percentage figures remain almost unchanged as of 2014.

TABLE 1  
Top global aquaculture producers and countries selected for the study

No	Country	Selection for study	Production (tonnes)	Production value (US\$000)	World rank
1	China	Yes	32 735 944	50 638 540	1
2	India	No	3 478 690	5 043 749	2
3	Viet Nam	Yes	2 461 700	4 599 850	3
4	Indonesia	Yes	1 690 121	2 813 673	4
5	Thailand	Yes	1 374 024	2 202 075	5
6	Bangladesh	Yes	1 005 542	1 766 182	6
7	The Philippines	No	741 142	1 576 141	9
8	Egypt	Yes	693 815	1 251 119	11
9	Zambia	Yes	5 640	16 313	-
10	Nigeria	No	14 3207	374 770	27
11	Chile	Yes	843 142	4 502 789	8
12	Ecuador	Yes	172 120	765 297	22
13	Mexico	Yes	159 309	565 705	25
14	Nicaragua	No	16 078	60 148	-
<b>Total</b>			<b>45 520 474</b>	<b>76 176 351</b>	
<b>Share of world aquaculture production and value (%)</b>			<b>86</b>	<b>72</b>	

Source: FAO (2012b).

Each country case study contains two major elements: (i) a national-level review; and (ii) a more focused community-level and value-chain analysis. Community consultations were conducted to provide community views and experiences on the social and economic services of aquaculture and provide insights on community impacts and influences related to aquaculture development. The country case studies are used to estimate the number of people involved in the aquaculture sector in each study country.

### 2.2.3 Terminology and Definitions

The following definitions are used for the study:

**Aquaculture:** the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants that occurs in both inland (freshwater) and coastal (brackish-water, seawater) areas.

**Aquaculture sector:** general classification of aquaculture based on environment: freshwater, brackish-water and marine culture.

**Aquaculture commodity:** a specific species such as tiger shrimp, tilapia, seaweed, sea cucumber, etc.

**Value chain/supply chain:** overall product flow from supplier to the end consumer. In this study, the value chains for aquaculture products that are processed and exported are analysed only to the point of export.

**Value-chain segment:** a fraction of a product flow chain. For example, farm segment, wholesale, processing, retailing, etc.

**Stratified value-chain segment:** value-chain segment based on defined characteristics, for example, this study explores different categories, such as small, medium- and large-scale aquaculture producers and systems.

**Harvest and post-harvest activities:** activities done after harvesting that are limited to those activities carried out at the farm area such as sorting, drying, grading, labelling, etc.

**Processing:** although this can be considered as part of postharvest activity, in this study processing refers to the industrialized processing of aquaculture products, which covers household scale and industry/company scale.

**Subsistence aquaculture farm:** poor aquaculture farms that operate and target their production for direct household consumption.

**Small-scale:** aquaculture systems with low annual production levels. In this study, the definition of small-scale is determined in the country case studies using multiple variables. The scales of these identified variables vary among the case study countries.

#### 2.2.4 Study constraints and limitations

The limitations of the study result mainly from limited data available on the aquaculture sector in different countries. Thus, not all aquaculture-producing countries are represented in the Global Synthesis in Chapter 3, which is primarily based on the country case studies commissioned for this study. Constraints were also faced in estimating employment in the country case studies due to the difficulty in obtaining disaggregated data on employment in different aquaculture value chains, especially given the fragmentation of some value chains and the integration of others. Difficulties were also encountered in: estimating full-time equivalent (FTE) employment; and scaling up and extrapolating employment in aquaculture value chains to the national and global levels. In addition, the various definitions of small-scale farmers and poverty used by different countries make cross-country comparisons of the types of people involved in different aquaculture systems very difficult.

## 3. Summary of country case studies

### 3.1 AQUACULTURE NUMBERS IN ASIA

Case studies from Asia were conducted for Bangladesh, Indonesia, Thailand and Viet Nam. Secondary data were also reviewed from China. This section presents brief summaries of the aquaculture sectors and employment created along aquaculture value chains in the case study countries, with full country case study reports available from WorldFish and/or FAO. A summary table presenting data from the country case studies on production and employment in aquaculture value chains is provided in Appendix 1.

#### Bangladesh

Aquaculture has been developing rapidly in Bangladesh in recent decades. Stakeholder interviews conducted by the study team revealed that a decade ago, aquaculture contributed about 30–40 percent of total national fish production. However, the contribution of aquaculture has increased to 60–70 percent of total fish production. Between 1984 and 2009, the aquaculture sector experienced an impressive annual growth rate of 9 percent. By 2009, total aquaculture production was estimated to be about 1.3 million tonnes of which about 399 000 tonnes of fish were produced from homestead ponds; 390 000 tonnes from commercial semi-intensive carp culture; 395 000 tonnes from pellet fed intensive systems; and 98 000 tonnes from shrimp and prawn production (Belton *et al.*, 2011). Triangulating data from various sources, the country case study reveals that aquaculture production estimated by official fisheries statistics of Bangladesh is underestimated by about 27 percent (1.06 million tonnes versus 1.35 million tonnes). The difference is mainly explained by the fact that national fisheries statistics are based on an old survey design that does not fully account for the recent dynamic development in the aquaculture sector such as the growth of intensive entrepreneurially operated systems.

Extensive and highly diversified water and fisheries resources have generated diverse aquaculture farming systems in the country: homestead pond aquaculture, entrepreneurial pond culture, seasonal floodplain culture, rice–fish culture, cage aquaculture, and “gher” culture. Pond culture systems dominate aquaculture production in Bangladesh, accounting for about 86 percent of total reported aquaculture production. Homestead pond aquaculture is operated by rural households who make opportunistic use of existing homestead ponds that are typically small in size. Homestead aquaculture is practised as a component of the larger household agriculture farming system, involving about 4.3 million rural households (20 percent of rural inhabitants), covering an area of about 265 000 ha

of ponds. About 25–50 percent of aquaculture production from homestead culture is used for home consumption and the remainder is sold to the domestic market for cash income. The case study indicates that homestead aquaculture is more likely to be practised by wealthier households. However, many fishpond owners that are categorized as relatively better-off among rural households are still poor. For example, 26 percent of those with moderate access to land, including fish ponds, of 0.61–1 ha, are under the poverty line. People employed along the value chains structured around homestead aquaculture are small-scale stakeholders.

Entrepreneurial/commercial aquaculture is a stand-alone aquaculture enterprise and involves significant capital investment and operates in semi-intensive and intensive farming systems. The two commodities/species that dominate this form of pond aquaculture in Bangladesh are *Pangasius* and Nile tilapia. Most output from commercial pond aquaculture is consumed domestically, although a small number of entrepreneurial producers are exploring opportunities to export *Pangasius* and tilapia to foreign markets. The commercial aquaculture value chain in Bangladesh involves more than 600 000 people including farmers and service providers such as traders and processors (USAID, 2006). The country case study shows that commercial aquaculture is playing a much more important role in alleviating poverty, through employment generation (on farm and along the value chain) and meeting national fish and seafood consumption needs, than previously understood (Belton *et al.*, 2011).

Gher culture involves shrimp and freshwater prawn production conducted in converted rice fields. The shrimp sector of Bangladesh grew rapidly from the 1970s until the mid-1990s. In 2009, the total land under shrimp and prawn production was about 244 300 ha, producing about 97 700 tonnes of tiger shrimp and giant freshwater prawn (*Macrobrachium rosenbergii*), of which the freshwater prawn's share was about one-quarter, with a total export value of about US\$380 million (DOF, 2010). Shrimp and prawn culture create export-oriented and buyer driven value chains linking stakeholders in Bangladesh to export markets. Producers, particularly small-scale producers, have little ability to influence prices and are frequently locked into contracts that limit the price they receive. Shrimp and prawn value chains employ over 1.2 million people in all stages of production, processing and marketing activities. Of these 1.2 million people, 400 000 work in prawn and shrimp fry fishing, many of whom are women and children (USAID, 2006), and an estimated 20 000 women work in shrimp processing factories. Other inland aquaculture systems such as floodplain aquaculture, cage aquaculture and rice fish culture are less important than pond farming; however, they may play significant roles in the future.

Aquaculture provides important social and economic services to Bangladesh. The total number of people involved in various aquaculture value chains in the country ranges from 6.0 to 6.4 million people (assuming each homestead aquaculture household has one person involved in aquaculture, which may be an underestimate). However, this number should not be interpreted as the number of FTE jobs as many homestead pond operators spend only a few hours a day

operating their fish ponds. In terms of FTE jobs generated in aquaculture value chains, it is estimated that there are about 3.15 million jobs at the farm segment (grow-out and hatchery production) and 642 000 jobs generated at other links, making the total number of FTE jobs generated along the overall aquaculture value chain about 3.8 million. Homestead aquaculture value chains associated with small-scale operations with an average pond size of 0.06 ha generate the largest number of jobs. A significant number of small-scale operators also participate in various nodes of the commercial fish and shrimp/prawn value chains. Social and economic services provided by homestead ponds include increased home consumption of fish and insurance to fish-farming households, via the ability to convert stocks of fish into cash, which can reduce vulnerability and enhance resilience to shocks and circumstances likely to precipitate poverty.

Fish is by far the most important and frequently consumed animal source food in Bangladesh. Fish provides about 66 percent of total animal protein intake to Bangladesh or about 14 percent of total protein intake. Data from the Household Income and Expenditure Survey 2005 (BBS, 2007) indicates that Bangladesh's fish consumption showed a strong upward trend between 2000 and 2005. However, there is a growing division in fish consumption between urban and rural citizens (18.1 kg and 14.5 kg per capita fish consumption respectively, compared with a national average of 15.4 kg). The country case study shows that there is also a substantial difference in fish consumption between social strata, ranging from 15 g to 96 g per day, or from 5.5 kg to 35 kg per person per year. On average, the poor consume 39 percent of the fish consumed by an average rich consumer.

## Indonesia

Aquaculture plays an increasingly significant role in Indonesia's economy, and it has been accepted by government and others as a viable alternative livelihood for fishers engaged in capture fisheries. Aquaculture in the country is practised in freshwater, brackish-water and marine water environments using various species and production technologies. The most common commodities from freshwater aquaculture in Indonesia are common carps, catfish, and Nile tilapia. Brackish-water farmed commodities are dominated by shrimp and milkfish, and marine water commodities/species are dominated by groupers and seaweed. Aquaculture in Indonesia is practised in small-, medium- and large-scale operations. Small-scale is interpreted as farms of less than or equal to 2 ha operating in extensive, semi-intensive or intensive aquaculture systems. It is noted that small-scale farms may require different levels of investment and management skills.

Aquaculture in Indonesia has been increasing steadily in recent decades. Production from aquaculture increased from 2.1 million tonnes in 2005 to 3.2 million tonnes in 2007 and to 4.78 million tonnes in 2009. Of the 4.78 million tonnes produced in 2009, 2.44 million tonnes came from marine aquaculture, 1.18 million tonnes from brackish-water aquaculture, 0.59 million tonnes from freshwater pond aquaculture, 0.336 million tonnes from floating net aquaculture, 0.085 million tonnes from rice-fish culture, and 0.063 million tonnes from

cage culture in freshwater waterbodies. Aquaculture production accounted for 20–25 percent of the total fish production in the country in 2005 and increased to 47.5 percent in 2009.

Aquaculture provides an important source of employment for Indonesians. Official estimates of Ministry of Marine Affairs and Fisheries (2009) suggest that aquaculture created 2 797 000 jobs at the farming stage, and about 1 215 000 jobs were generated at the processing and marketing stages in 2009. The official statistics reveal that the aquaculture industry created more than 4 million jobs for Indonesia in 2009. This number is probably an underestimate of the current employment levels in the aquaculture sector because it does not cover all employment opportunities generated along the entire value chains of different aquaculture commodities.

In terms of employment structures, there were about 2.4 million households involved in the aquaculture industry in 2009, representing about 40 percent of the total number of people employed in the fisheries sector. Freshwater pond farming makes up 54 percent of total aquaculture households – about 1.3 million people, of which 64 percent of households in fish farming own less than 0.1 ha of land and only 5 percent of households own more than 0.5 ha. Rice–fish farms make up 24 percent (550 000 households), and brackish-water ponds account for 16 percent (400 000 households). About 55 percent of the households involved in fish farming have less than 2 ha (which is commonly considered small-scale) and only 6 percent have more than 10 ha of land. There are about 150 000 households involved in marine culture (seaweed and marine fish). These figures suggest that aquaculture in Indonesia is dominated by small-scale operations.

Aquaculture provides significant social and economic services to Indonesia such as improving household food security, generating valuable foreign exchange and domestic revenues, and increasing the living standards and income of poor rural communities. Per capita fish consumption in the country was estimated at 12.8 kg/year in 1982, which increased to 22.67 kg/year in 2005 and to 30.17 kg/year in 2009. On average, per capita fish consumption increased by 2.7 percent annually from 1994 to 2005 and by 6 percent from 2005 to 2009. According to the official statistics of Indonesia, farmed fish production was projected to contribute about 7.7 kg/capita annually in 2009 and per capita farmed fish consumption tripled between 2005 and 2009 (GAIN, 2010).

Aquaculture provides an alternative source of income for coastal rural communities and supports sustainable rural development in Indonesia. In 2002, there were 8 090 coastal villages nationwide occupied by 16.4 million people or 3.9 million households, of which 5.3 million or 32 percent were classified as poor. The number of poor people in rural villages in the country dropped substantially from 25.1 million to 23.6 million between 2002 and 2007. Nonetheless, there is still a high percentage of poor people living in rural communities where aquaculture development could be a suitable livelihood for them to improve their living standards.

## Thailand

Aquaculture in Thailand is practised in freshwater, brackish-water and marine water environments. Most freshwater aquaculture is practised in the form of pond aquaculture, and 90 percent of freshwater aquaculture farmers are classified as small- and household-scale by the government (operating a farm of less than 5 ha). The contribution of freshwater aquaculture to the total value of fisheries production has ranged from 46 to 64 percent over the last decade. Freshwater aquaculture contributes more than one-third of fish consumed by Thai people, which is estimated at 30 kg/capita annually. Marine fish culture has been present in Thailand since the 1980s and is currently practised by both small- and large-scale farmers, however with limited production (Sheriff, Little and Tantikamton, 2008). Coastal aquaculture production in Thailand is dominated by shrimp and shellfish culture.

Aquaculture is viewed both as a commercial activity and also an important means for rural development and poverty alleviation in Thailand. Aquaculture is a highly successful agrifood-producing sector, providing significant livelihood, employment and other social and economic services to Thai people. Overall, aquaculture contributed about 44 percent to total fish consumption in Thailand in 2009. With the recent transformation of the aquaculture industry in the country (increased vertical integration and large farms taking over small farms), the number of jobs generated by the Thai aquaculture industry has decreased and is estimated by the case study at about 352 600 in 2010. Previous estimates of the employment generated by aquaculture in Thailand are mixed. The FAO National Aquaculture Sector Overview for Thailand (FAO, 2005–2014) indicates that 662 000 people were employed in the aquaculture industry in Thailand in 2005, of whom 400 000 were employed in freshwater aquaculture production, 78 000 were employed in brackish-water aquaculture production, and 184 000 were employed in processing and related industries. FAO (2009) reports that about 600 000 people were employed in the aquaculture sector in Thailand in 2008. Data from Thailand's Department of Fisheries for 2010 (DOF, 2011) reported in the case study suggest that there were about 660 000 people engaged in the aquaculture sector and that many of them were small-scale farmers practising aquaculture as a part-time and supplemental livelihood. Official statistics of Thailand for 2010 suggest that about 428 000 people were employed in the fisheries sector, of whom about 179 000 were in the aquaculture sector (NSO, 2011).

Shrimp farming is the most important coastal aquaculture business in Thailand. Taking a value-chain approach, Giap, Garden and Lebel (2010) suggest that about 390 000 FTE jobs were created in shrimp aquaculture and related industries along the shrimp value chain in Thailand. As noted above, participation of small-scale producers in shrimp farming has been declining in recent years. In recent years, there has been a strong structural transformation in Thailand's shrimp farming industry, with black tiger shrimp being gradually replaced by exotic white shrimp. Concurrent with the shift to white shrimp culture is a process of vertical integration. The shift in farmed shrimp species has enhanced the

competitive capacity of Thailand's shrimp industry in international markets and has also helped the industry to cope with stringent food safety, traceability and sustainability standards required by global markets. However, this structural transformation has put small-scale stakeholders in a disadvantageous position, and they are consequently being displaced from the shrimp farming sector. Large farms are taking over small farms, forcing small farmers to move into the fish and seafood processing industry as unskilled workers, earning lower incomes. The small-scale farmers who have remained in shrimp production face difficulties in complying with the complicated requirements of shrimp export value chains.

### **Viet Nam**

Viet Nam has a dynamic and rapidly growing aquaculture sector involving diversified aquaculture farming systems. From 2000 to 2009, the aquaculture sector experienced an impressive average growth rate of 23 percent per year, reaching a total production of 2.6 million tonnes in 2009. Aquaculture in the country is dominated by brackish-water shrimp and freshwater catfish production systems, accounting for more than two-thirds of the country's annual total fish and seafood exports, estimated at US\$4.5 billion per year in recent years. There are about 2.4 million households undertaking aquaculture production, of which almost 2 million are involved in fish culture and 337 600 practise marine, brackish-water and freshwater shrimp production. With the exception of those involved in capital-intensive catfish farming, for the majority of fish farmers in Viet Nam aquaculture is just one integrated component of their livelihoods (such as in the VAC system) rather than a main occupation.

The number of people involved in aquaculture and related activities along the aquaculture value chain in Viet Nam ranges from 3.2 to 4.2 million, of whom about 1.6 million are employed in shrimp value chains, 240 000 are employed in catfish value chains and between 1.5 and 2.2 million are engaged in traditional freshwater aquaculture (VAC) and other aquaculture systems. Except for freshwater catfish aquaculture (which has recently become controlled by large-scale production), aquaculture in the country, including traditional freshwater aquaculture, and brackish-water and marine aquaculture, is primarily small-scale in nature. About 75 percent of the 2.4 million households engaged in aquaculture production are small-scale producers, with farm sizes of less than 2 ha, and 90 percent of these households have farm sizes less than 3 ha.

## **3.2 AQUACULTURE NUMBERS IN AFRICA**

Aquaculture is underdeveloped in Africa despite its high biological and natural resource potentials suitable for aquaculture development, as well as its apparent need for new supplies of aquatic animals for food and nutrition. Currently, African aquaculture contributes less than 1 percent to global aquaculture production and significant quantities of farmed products are produced in Egypt, Ghana, Nigeria and Zimbabwe in large-scale operations (Brummett, Lazard and Moehl, 2008). Case studies in Africa were conducted in Egypt, where aquaculture is dominated



by large-scale producers, and in Zambia, where the majority of aquaculture stakeholders are small-scale and subsistence farmers.

## Egypt

Egypt is the largest aquaculture producer in Africa, and globally ranks as the eleventh largest, producing mainly tilapia and mullet for domestic markets. Traditional aquaculture, known as “hoshha”, was commonly practised for many centuries in Egypt. However, modern aquaculture began in the mid-1930s. The rapid development of modern aquaculture began in Egypt two decades ago. Extensive and semi-intensive production systems in earthen ponds are the dominant forms of fish farming in the country. Aquaculture production in Egypt increased from 212 025 tonnes in 1999 to 693 815 tonnes in 2008. Consequently, the relative importance of Egyptian aquaculture to total fisheries production increased from 34 percent in 1999 to 65 percent in 2008, making aquaculture the largest single source of fish supply in Egypt (GAFRD, 2000–2009).

The structure of the fish farming sector in Egypt is changing rapidly with increasing intensive aquaculture in earthen ponds and tanks and application of modern technologies to respond to increasingly limited land and water availability. The area of earthen pond fish farms increased from about 41 400 ha in 1999 to 151 000 ha in 2008. Private fish farms have increased from about 36 400 ha in 1999 to 143 500 ha in 2008, while state-owned farms only increased from almost 5 000 ha in 1999 to 7 440 ha in 2008. It is predicted that aquaculture in Egypt will continue to grow to meet increasing domestic consumption and future food security needs.

Among cultured species, tilapia is the most important, with a production of 390 300 tonnes in 2009, accounting for more than 55 percent of the country’s total aquaculture production in that year. Mullet and carp production accounted for 30 and 10.5 percent, respectively. Production of other species including catfish, sea bass, sea bream, and shrimp represented 4.5 percent of total aquaculture production in 2009.

Currently, aquaculture production in Egypt is dominated by medium- and large-scale enterprises. There are no reliable statistical data on the number of people employed in the overall aquaculture sector and related industries. Based on fieldwork and a review of the literature, the case study estimates that employment along the aquaculture value chain in Egypt ranges from 139 000 to 237 000. For the low estimation of 139 000 FTE jobs in the aquaculture sector, the tilapia value chain is estimated to provide about 84 000 direct and indirect jobs, the mullet value chain about 42 000 FTE jobs, and the carp value chain about 10 000 FTE jobs. About 11 percent of the total labour force employed in aquaculture is associated with small-scale enterprises.

## Zambia

Aquaculture in Zambia is exclusively of freshwater crustaceans, reptiles and fish. The most commonly farmed species are the indigenous *Oreochromis andersonii*

(three-spotted bream), *O. macrochir* (green-headed bream), *Tilapia rendalli* (red-breasted bream), and the introduced *O. niloticus* (Nile bream). Three government research stations are also conducting studies on the indigenous *O. tanganicae* as a candidate species for culture. Common carp (*Cyprinus carpio*), introduced to the country for aquaculture purposes in the 1950s, is still farmed in small quantities by a few farmers. According to FAO (2006–2011) and the Department of Fisheries of Zambia, aquaculture production in the country grew from less than 1 500 tonnes in 1990 to 5 640 tonnes in 2008, increasing by almost 8 percent per year since 1990. By 2010, aquaculture production was estimated at 10 000 tonnes. However, the case study findings suggest that annual aquaculture production was between 2 650 and 3 130 tonnes in 2010.

The aquaculture sector in Zambia involves two main types of farming namely, subsistence and commercial farming. The size of the operation, the amount of inputs, the number of employees needed and the yields produced vary greatly within each category of enterprise. Subsistence aquaculture activity is primarily a means of food security for the poor and vulnerable in rural areas where access to jobs and food sources are limited. Commercial aquaculture activity provides jobs for the poor and vulnerable in urban areas as well as food in these same areas where farming activities are limited.

In terms of aquaculture industry structure, aquaculture in Zambia involves about 5 000–13 000 subsistence farmers, 500 small-scale enterprises, 14 medium-scale enterprises, 1 large-scale enterprise, and 3 large traders/wholesalers that work with 450 smaller traders. For subsistence farmers, fish farming is just one aspect of their livelihood and productivity of their ponds tends to be low, producing about 2 tonnes/ha each year. Small-scale enterprises tend to have 2–3 part-time employees and annual yields of less than 3 tonnes/ha. Medium-scale enterprises have significant landholdings, produce their own single-sexed fingerlings, and employ 5–20 people to work full-time on the aquaculture venture along with other employees engaging in other activities present on the landholding. Annual yields from these medium-scale systems are less than 10 tonnes/ha.

In total, there are about 6 700–15 400 people employed in aquaculture farms and related links along aquaculture value chains in Zambia, about 45 percent of whom are women. Most women labourers in aquaculture concentrate on subsistence farming systems where they actively participate mostly in the feeding, cleaning and harvesting of ponds. Women in Zambia are also active in aquaculture trading activities, and of the 450 people employed by the 3 large traders/wholesalers in the aquaculture value chain about 400, or 88 percent, are women.

### 3.3 AQUACULTURE NUMBERS IN LATIN AMERICA

Aquaculture in Latin America is characterized by a mix of large- and medium-scale enterprises, but also smaller producers in some countries, often not captured by official statistics. Brazil, Paraguay, Ecuador and Chile are considered to have the highest number of small-scale producers, engaged in farming of several commodities, including tilapia and pacú (*Piaractus mesopotamicus*) in the case of

the first three countries, and the culture of marine macrophytes, chiefly *Gracilaria chilensis* and mussels in Chile. Export-oriented shrimp tends to be produced in larger quantities by medium- and large-scale enterprises, although significant numbers of people classified as smallholders are also involved. Case studies from Latin America were conducted in Chile, Ecuador and Mexico.

## Chile

Aquaculture in Chile is based on production of finfish (mainly salmonids), molluscs (mainly mussels) and algae. In 2009, the national aquaculture sector, including large-scale and small-scale production centres, was comprised of 3 285 licensed farms representing a total authorized area of 33 000 ha. Industrial or large-scale aquaculture contributes more than 90 percent of total production. Nevertheless, small-scale aquaculture farms represented 40 percent (1 330 farms) out of the total number of existing aquaculture farms in the country in 2009, covering 11 percent (3 523 ha) of the total area authorized for aquaculture nationwide. Small-scale aquaculture in Chile is conducted by three types of stakeholders, namely, individuals, individuals organized in formal micro or small businesses (i.e. legal persons), and organizations of individuals (unions, cooperatives, etc.).

Small-scale aquaculture farms in Chile are mainly oriented to the culture of *Gracilaria algae* (practised by 58 percent of the 1 330 small-scale farms), mussels (37 percent of small-scale farms) and other molluscs (scallops and oysters) and macroalgae (5 percent of small-scale farms). Small-scale aquaculture has a low level of capital concentration, and 75 percent of small-scale aquaculture farms are household enterprises, averaging 1.9 ha each. Between 2000 and 2008, small-scale aquaculture represented 5–9 percent of total annual national aquaculture production, and grew by 262 percent from 22 000 tonnes in 2000 to about 80 000 tonnes in 2008. The most productive small-scale aquaculture farms are those culturing Chilean mussel, *Gracilaria algae* and Peruvian calico scallops.

Based on statistical data of the national fisheries service of Chile (2008), it is estimated that 49 255 people were employed in the aquaculture sector in Chile, of whom 3 131 people (6 percent) were employed by small-scale aquaculture farms. Employment in small-scale aquaculture in Chile includes both permanent and temporary labour. The country case study reveals that permanent labour employed in small-scale aquaculture between 2000 and 2008 reached on average a total 1 870 people per year. *Gracilaria algae* and mussel farms are the most intensive in use of permanent labour accounting for about 68 percent and 21 percent of all those annually employed in this category, respectively. During the same period, temporary labour employed in small-scale aquaculture averaged a total of 1 700 persons per year. For this same period, *Gracilaria algae*, Chilean mussel and Peruvian calico scallop production centres hired 62, 24 and 7 percent, respectively of the temporary workforce used in small-scale aquaculture. In 2008, nonetheless, Chilean mussel centres hired 50 percent of the temporary workforce, and *Gracilaria algae* and Peruvian calico scallops centres another 44 percent of this workforce.

## **Ecuador**

White shrimp is the most important cultured species in Ecuador; however, finfish species, especially tilapia, trout, cachama and chame, are rapidly gaining importance in terms of the number of stakeholders and production in all regions, especially in the Amazonian region (Burgos, 2009). Ecuador's aquaculture production was estimated at 160 000 tonnes in 2009, of which white shrimp constituted the dominant share (143 000 tonnes) followed by tilapia (about 15 000 tonnes).

About 205 900 jobs were generated by aquaculture and related industries in Ecuador in 2009, of which about 95 percent were in the coastal region. Including hatcheries, export farms, local farms and processing plants, the coastal region has a total of 2 938 units providing 195 645 direct and indirect jobs; the Andean Highland region has 377 units employing 640 people, and the Amazon region has 2 469 units employing 9 620 people.

Aquaculture makes a significant contribution to socio-economic development in Ecuador. Seafood production represents the coastal region's economic power and nationally ranks the third in terms of foreign exchange earnings in Ecuador (BCE, 2010). The contribution of aquaculture to Ecuador's GDP ranges from 1.5 to 4 percent. Women account for about 19 percent of the labour force and are active in post harvesting activities such as working in seafood processing plants and in seafood business management.

The importance of small-scale aquaculture is growing in Ecuador, particularly in inland regions. Export-oriented aquaculture in Ecuador, such as shrimp and tilapia farming, involves medium- to large-scale farmers and enterprises producing products largely for export markets. Within this export group there are however smaller-scale farmers. For example, small-scale producers (with farm sizes less than 50 ha) make up about 1 720 farms, or more than 50 percent of shrimp farms in Ecuador. Domestic market-oriented aquaculture involves small- to very small-scale farmers (in terms of farming area), producing aquaculture products for local markets.

## **Mexico**

Mexico ranks fifteenth among the major fish producers in the world and fourth in the Americas behind Peru, the United States of America and Chile (FAO, 2010). In 2009, total aquaculture production in Mexico accounted for 14 percent in volume (285 019 tonnes) and about 30 percent in value of total fisheries production. About 50 percent of aquaculture production comes from semi-intensive brackish-water shrimp farming.

The Economic Census of Mexico (Inegi, 2011) reports that in 2009 there were 19 443 economic units in the fisheries and aquaculture sector employing 180 083 people. About 1 905 economic units were engaged in aquaculture, of which 403 were undertaking shrimp farming and 1 502 were involved in farming other aquaculture species. On average, each aquaculture and fisheries production unit provided employment to 9.3 people. Aquaculture employed 22 582 people, the majority of whom were men, with women making up only 8 percent of the

total workforce. However, Conapesca (2010) estimated that the fisheries and aquaculture sector in Mexico employs 273 266 people directly, of whom 30 690 are in aquaculture production. About 56 percent of those employed in aquaculture activities are engaged in shrimp farming.

In 2009, there were about 2 044 aquaculture farms in Mexico, including post-larval shrimp and molluscs seed production labs, covering about 119 606 ha of water surface. When considering only the main cultured species, 42 percent of the aquaculture farms produce tilapia, 20 percent produce trout, 19 percent produce carp, and 11 percent produce shrimp. However, when analysing the area dedicated to the culture of all species, 68 percent is devoted to shrimp farming, 21 percent to carp, 5 percent to trout, and 5 percent to tilapia. These figures indicate that while the number of shrimp farms is much smaller, the surface of their tanks is much larger than those dedicated to farming other species. Tilapia farms commonly apply semi-intensive and intensive farming systems while shrimp farms are extensive and semi-intensive.

Fisheries and aquaculture contribute only 0.18 percent to GDP and 3.7 percent to agricultural GDP. Nonetheless, aquaculture and fisheries are important sources of food, employment and income in marginal communities in Mexico. Those involved in fisheries and aquaculture received the lowest incomes compared with those from all other national productive sectors, with an average annual salary of MXN31 600 per person, one-third of the average salary for all other activities.



**PLATE 3**  
Small-scale mollusc culture operation in Viet Nam. Photo credit: Rohana Subasinghe

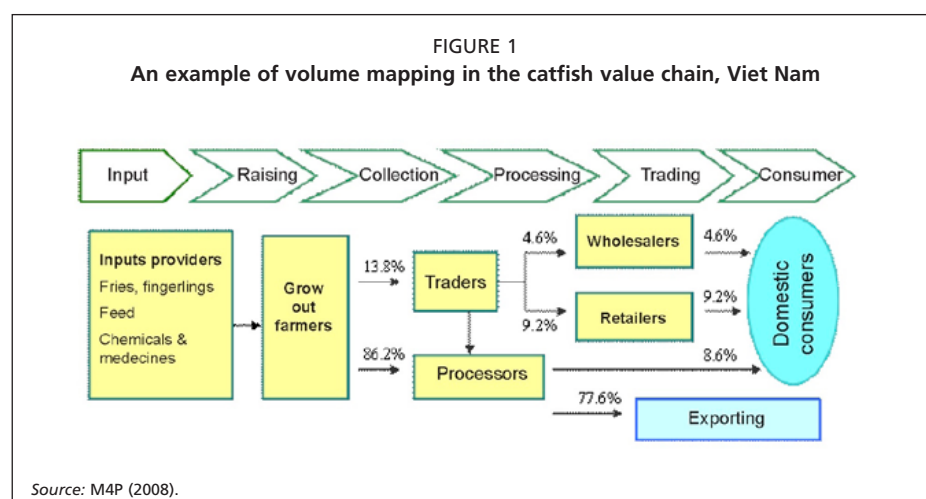
## 4. Global synthesis

The main objective of this study is to assess social and economic services of global aquaculture from a human development perspective, especially the employment generated by the aquaculture industry – or the “numbers” of people involved. This chapter reports on the types and number of people employed in aquaculture, based on the findings of the country case studies, and analyses the structure of the global aquaculture industry. It then examines: the multiple social and economic services generated by aquaculture; how aquaculture development affects small-scale stakeholders and the poor; the status of women’s participation in global aquaculture value chains; and how aquaculture can empower women and enhance gender equity. The chapter finishes by looking at some of the key development trends occurring in the global aquaculture sector, many of which have significant implications for poor and small-scale players involved in aquaculture production and associated value chains.

### 4.1 EMPLOYMENT ALONG AQUACULTURE VALUE CHAINS

#### 4.1.1 Aquaculture sector value chains

Aquaculture value chains vary considerably between the different countries, farmed products, farming systems and environments studied. Figure 1 provides an example of a value-chain mapping exercise completed for Viet Nam’s *Pangasius* industry. In other countries, there are significant variations depending on the above-noted variables. Consequently, the numbers of people involved along different value chains also varies with the associated degrees of complexity, from a simple household subsistence aquaculture operation through to a globalized value chain involving catfish or shrimp.



### 4.1.2 Type of people employed by the aquaculture sector

Findings from the country case studies show that various types of stakeholders are employed along aquaculture value chains (Table 2). These stakeholders play different functions in the value chains: providing inputs to aquaculture production (e.g. veterinary drugs, chemicals); engaging in the industry as feed mill owners and workers; operating hatcheries and grow-out aquaculture facilities; processing; and distributing and exporting final fish and seafood products to consumers. In total, there were about 10 million “units” directly involved in aquaculture value chains in the 9 case study countries, which account for about 16 percent of global aquaculture production. Most of this number are grow-out production operations (9.1 million) dominated by households that have ponds and operate aquaculture as an integrated component of their larger agriculture farming systems.

TABLE 2

**Type and number of stakeholders participating in aquaculture value chains from case study countries**

Type of stakeholder	Number of “units”	Major entry points for poor and small-scale stakeholders
Hatcheries and nurseries	30 962	Employees
Aquaculture farms/ households	9 105 676	Employees in commercial farms, services (e.g. harvesting teams), direct engagement in household oriented aquaculture
Feed mills	307	Employees
Input suppliers	7 108	Employees
Middle traders	80 534	Employees
Processing plants	16 467	Employees, significant in several export oriented industries
Exporters and domestic distributors	776 053	
<b>Total</b>	<b>10 017 107</b>	

The poor and “small-scale” stakeholders are not easy to classify from the data provided, but they appear to enter aquaculture value chains at different links, including hatchery and nursery production, grow-out production, middle trading, and processing and packaging stages. Roles played by such stakeholders vary along and between value chains. At the seed-providing stage, they mainly work as employees or fry collectors, e.g. in Bangladesh, while at the grow-out production stage; many small-scale stakeholders operate IAA systems, as evidenced in the Viet Nam and Bangladesh case studies. Middle trading and processing segments of aquaculture value chains are also important for poor and small-scale stakeholders where they are employed as workers in processing plants or operate family based businesses collecting aquaculture products from the farm and selling to larger middle trading establishments or processing plants. Processing plants represent a significant employer in several countries with export-oriented aquaculture, including the Vietnamese *Pangasius* industry, and the shrimp aquaculture sector in several Asian countries.



### 4.1.3 Number of people employed in the aquaculture sector

Aquaculture is an important source of employment for millions of people all over the world, especially those living in rural communities in inland and coastal areas where there may be more limited employment options. Despite its importance, there are limited data and studies on employment in the global aquaculture industry (Ahmed and Lorica, 2002; FAO, 2010a). This section presents employment estimates in the aquaculture sector from the case study countries. As the case study countries account for only about 16 percent of global aquaculture production, some extrapolations and use of secondary data are necessary to arrive at more global figures.

Table 3 presents the number of people employed (both FTE and part-time) in the aquaculture sector in the nine case study countries. Employment at farm level includes people operating hatcheries, nurseries, grow-out production facilities, and part-time and occasional labourers hired to work for aquaculture production at farm level. Employment at other links along aquaculture value chains includes people working as input suppliers, middle traders and domestic fish distributors, processors and exporters. It is estimated that there were about 11.4 million people employed in aquaculture value chains in the nine case study countries, of whom about 8.3 million employed at farm level and 3.1 million employed at other links along aquaculture value chains up to the exporting stage (Table 3). Not all country case studies were able to separate full- and part-time equivalent employment. Part-time and full-time employment covers a wide range of employment types from, for example, small-scale farms in Bangladesh (where household members work on a part-time basis, as one of a number of household activities that may involve men, women or children), to estimates of full-time salaried employment in large-scale commercial farms in Thailand. Data provided by countries are not fully accurate on such aspects; hence, these figures should be treated as estimates. Where possible, this study estimates the number of people employed in global aquaculture based on FTE jobs per year. For aquaculture producing countries where small-scale integrated producers are dominant, such as Bangladesh and Viet Nam, the actual number of people “involved” full- and part-time in aquaculture is higher than total employments in the aquaculture value chains reported in Table 3.

Most of the people employed in the aquaculture sectors in the nine case study countries are from Bangladesh, Indonesia and Viet Nam. These countries are among the world’s ten largest aquaculture producers (FAO, 2010a). Although Thailand also belongs to this top ten, total employment in its aquaculture value chains is relatively small (363 000 FTE jobs) compared with that in Bangladesh, Indonesia and Viet Nam. The difference can be partly explained by the fact that Thailand’s aquaculture industry is perhaps now more highly vertically integrated and has more large-scale operations, with capital-intensive technologies replacing labour-intensive technologies, which are still dominant in Bangladesh, Indonesia and Viet Nam. In addition, while Thailand’s employment estimate is based on FTE jobs, employment estimates from most of the other country case studies are based on both full- and part-time employment and, thus, overestimate FTE employment.

TABLE 3  
**Estimated production and employment in aquaculture value chains in case study countries**

Case study country	Aquaculture production (tonnes)	Employment at farm (including grow out and hatchery)	Employment at other value chain links	Total employment
Vietnam**	2 233 000	1 744 900	900 056	2 644 956
Bangladesh*	1 305 048	3 153 120	641 805	3 794 925
Thailand*	1 370 000	217 883	145 190	363 073
Indonesia**	4 780 100	2 797 005	1 215 258	4 012 263
Chile**	870 000	49 694	27 375	77 069
Ecuador*	159 976	109 085	96 820	205 905
Mexico*	285 019	30 690	18 107	48 797
Egypt**	705 490	157 991	79 000	236 991
Zambia**	3 130	14 865	450	15 315
<b>Total</b>	<b>11 711 763</b>	<b>8 275 233</b>	<b>3 124 061</b>	<b>11 399 294</b>

Notes: \* Employment estimates based on FTE jobs

\*\* Employment estimates based on full and part time jobs (total number of people employed).

The number of people employed in global aquaculture varies from country to country, but the data suggest that previous values based on data reported to FAO are likely to be underestimates. FAO (2010a) indicates there were about 10.7 million people “involved” in aquaculture in 2008, the majority from developing countries, accounting for about 96 percent of people involved. Deriving data from FAO fisheries statistics and other sources, Valderrama, Hishamunda and Zhou (2010) estimated about 23.4 million FTE jobs were generated by global aquaculture and related activities in 2005 (16.7 million direct and 6.8 million indirect jobs).

For comparison, findings from case study countries are used to extrapolate the number of people employed in global aquaculture (see Appendix 1 for estimates, and Appendix 2 for method and details of estimation). This extrapolation suggests that total jobs (both full and part time) in global aquaculture value chains could be as many as 56.7 million. The present study indicates that 11.4 million jobs are generated in the case study countries, most of which come from three of the world’s top aquaculture producers, namely, Bangladesh, Indonesia and Viet Nam, where small-scale aquaculture dominates. However, the projected global employment estimate might be an overestimate, as the study did not have further information on employment from other major aquaculture producers, especially China. Given this, the study also estimated a lower bound for global aquaculture employment (27.7 million jobs, of which 20.1 million generated on farm and 7.6 million from other links in the value chain), based on a lower employment estimate for China (see Appendix 2 for details). Thus, it is estimated that total global aquaculture employment lies somewhere between 27.7 and 56.7 million full- and part-time jobs.

The difference between these new data and previous studies could be explained by the fact that the figure in this study was estimated using information from case study countries taking value chain approaches whereas the previous estimates by

FAO (2010a) and Valderrama, Hishamunda and Zhou (2010) were derived from FAO and national government employment statistics that may be underestimated and may also not take full account of employment at all links of the value chain. The estimate by Valderrama, Hishamunda and Zhou (2010) is also based on FTE employment, whereas the estimates in this study are based on both full- and part-time employment and so likely to lead to higher relative employment estimates.

The country case studies found a substantial number of people working in aquaculture as an integral component of farm production was not reported in official government statistics reported to FAO for global aquaculture statistics purposes. For example, in Viet Nam the country case study team found that, according to an agricultural census survey of national statistical office of Viet Nam carried out in 2007, there were about 2 million rural households practising aquaculture production. Of these, about 1.56 million were operating IAA systems in the form of the VAC model. However, the level of employment in the aquaculture sector was estimated at about 700 000 people by the former Ministry of Fisheries of Viet Nam, and this number was then reported to FAO. Another example is that reported by the Bangladesh case study team, which found that there were about 4 million rural households operating homestead pond aquaculture compared with 3.08 million fish farmers reported to FAO by the Department of Fisheries (DOF, 2003). While the new findings are partly a reflection of continued growth of aquaculture, they also clearly indicate the need for better and more comprehensive data at more “official” levels.

Labour productivity is an important indicator showing the performance of the aquaculture industry. Table 4 presents aggregated labour productivity at case-study-country-level measured by total labour productivity (taking into account direct employments in aquaculture value chains) and farm-level labour productivity (taking into account only employment at farm-level links). Labour

TABLE 4  
Aquaculture labour productivity in case study countries

Country	Total labour productivity (tonnes/worker)	Farm level labour productivity (tonnes/worker)
Vietnam**	0.84	1.28
Bangladesh*	0.34	0.41
Thailand*	3.77	6.29
Indonesia**	1.19	1.71
Chile**	11.29	17.51
Ecuador*	0.78	1.47
Mexico*	5.84	9.29
Egypt**	2.98	4.47
Zambia**	0.20	0.21
<b>Average</b>	<b>1.03</b>	<b>1.42</b>

Notes: \* Employment estimates based on FTE jobs.

\*\* Employment estimates based on full and part time jobs (total number of people employed).

productivity as reported in Table 4 is underestimated because not all case-study employment data are in FTE. Among case study countries in Asia, top aquaculture producers that have high employment levels in aquaculture value chains, such as Bangladesh, Indonesia and Viet Nam, have lower labour productivity. On the other hand, Thailand, also a top producer, has lower employment levels due to more industrialized aquaculture systems, characterized by high levels of vertical integration, and higher average labour productivity. Due to data constraints, labour productivity may be under- or over-estimated for countries where FTE jobs are unknown.

#### **4.1.4 Small-scale stakeholders and women employed in aquaculture**

Qualitatively, it has been established in the literature that small-scale aquaculture provides important social and economic services and can be an important vehicle for poverty alleviation in developing countries (e.g. Edwards and Demaine, 1997; Edwards, 2000; De Silva and Davy, 2010; Allison, 2011). Small-scale stakeholders dominate the number of jobs generated by the aquaculture industry in Asia, where aquaculture is locally operated by rural communities. To date, aquaculture in Latin America is still dominated by larger-scale operations. However, there is an increasing role for small-scale producers in aquaculture production as evidenced by increasing involvement of individuals involved in seaweed production in Chile reported by the country case study team. For Africa, Brummett, Lazard and Moehl (2008) suggest that more than 90 percent of African fish farmers operate one or a few earthen and family owned ponds with a surface area less than 500 m<sup>2</sup>, with annual production of 300–1 000 kg of fish per hectare or 15–50 kg per crop. The number of small- and medium-scale fish producers in Africa is increasing and this development will produce more benefits for more individual farmers, but the contribution of different enterprise scales to overall food security remains to be better understood (Brummett, Lazard and Moehl, 2008).

It is important to emphasize that categorizing aquaculture in terms of scale of operation has been used to guide aquaculture policy and development interventions (Belton and Little, 2011). However, the concept of small-scale aquaculture/stakeholders varies from country to country and embraces different criteria, of which farm size is the most common indicator. With a single indicator such as farm size, small-scale definitions also vary between farming systems with regard to farmed species and applied technology. Table 5 presents the number of people involved in aquaculture value chains in the nine study countries by scale of operation in order to estimate the contribution of small-scale aquaculture chains to total employment. In categorizing small-scale versus medium- and large-scale numbers, various criteria are taken into account such as farming environment, farmed species, and farming technology as well as case study country development contexts. For example, small-scale aquaculture can be categorized as subsistence aquaculture in Zambia, integrated aquaculture in a VAC system and small extensive and semi-intensive shrimp aquaculture in Viet Nam, homestead pond aquaculture in Bangladesh, or aquaculture farms with farm size less than 50 ha in Ecuador and Chile.

TABLE 5  
**Employment (full and part time) in aquaculture in case study countries by scale of operation**

Scale of operation	Small-scale					Medium- and large-scale					Total
Culture environment	Freshwater	Brackish & marine water			Sub-total	Freshwater	Brackish & marine water			Sub-total	
Species/ commodities	Fish	Shrimp & prawns	Shellfish	Seaweed		Fish	Shrimp & prawns	Shellfish	Seaweed		
Total production (tonnes)	1 275 152	607 694	484 650	1 036 995	3 404 491	4 909 889	1 047 697	805 287	1 544 400	8 307 273	11 711 763
Number of households	7 143 861	464 171	51 143	181 972	7 841 147	790 004	284 984	180 004	9 537	1 264 529	9 105 676
Number of employments at farm level	3 868 015	1 052 126	143 859	261 928.30	5 325 928	1 525 168	999 266	378 911	45 960	2 949 305	8 275 233
Employment at other links	435 450	719 055			1 154 505	297 450	1 078 583	593 523		1 969 556	3 124 061
Total employments	4 303 465	1 771 181	143 859	261 928	6 480 433	1 822 618	2 077 849	972 434	45 960	4 918 861	11 399 294

As presented in Table 5, of the about 11.4 million people employed in aquaculture value chains in the 9 case study countries, the number of people employed in small-scale value chains was 6.5 million, compared with 4.9 million employed in medium- and large-scale value chains. The number of people employed at farm level and related jobs in small-scale aquaculture value chains (5.3 million) is much higher than the number of people employed in medium- and large-scale aquaculture and related jobs needed for farm production (2.9 million). At farm level, the number of people (or households) involved in small-scale aquaculture is likely to be higher than the number reported as some case study estimates are based on FTE jobs.

Classifying employment at other links along aquaculture value chains into small-, medium- and large-scale sectors is challenging, as beyond the farm production level, value chain actors can work with both small-scale, and medium- and large-scale aquaculture farms and products. The tentative numbers in Table 5 suggest that there are 3.1 million employed at other links along aquaculture value chains in the case study countries. The number associated with other links along small-scale chains (1.2 million) is much lower than the number for medium- and large-scale aquaculture chains (2 million). While small-scale aquaculture value chains generate higher overall levels of employment, small-scale aquaculture contributes less than 30 percent to total aquaculture production documented in the 9 case study countries (3.4 million tonnes from small-scale production versus 8.3 million tonnes from medium- and large-scale production). Consequently, the labour productivity of small-scale aquaculture producers is lower than that of medium- and large-scale producers of the same farmed species.

Women's roles and participation in aquaculture value chains can be higher than those in capture fisheries (Weeratunge and Snyder, 2009). The FAO/WorldFish/

World Bank Big Numbers case studies in capture fisheries suggested that of the 34.7 million people employed full-time and part-time in fishing and post-harvest activities, 46 percent were women. Fisheries statistics in the nine case study countries do not disaggregate employment in aquaculture by gender; thus, it is not possible to estimate the percentage of women employed in aquaculture value chains. However, our country case studies show that women play a significant role in aquaculture value chains. Employment of women in aquaculture value chains in Indonesia, Viet Nam and Zambia was found to range between 40 and 80 percent and women were found to be active in post-harvest activities in aquaculture value chains in many countries and to also assume important roles in integrated and household-based aquaculture such as feeding, managing ponds and marketing products.

#### **4.1.5 Aquaculture value chains**

An important feature of current aquaculture production is the formation of value/commodity chains linking different stakeholders together in the process of providing inputs, producing, processing, distributing and finally consuming final products. A value chain is structured along a final product/commodity to be produced and distributed to final consumers. The characteristics, purpose and scale of aquaculture production create conditions constraining or strengthening the organization and governance of aquaculture value chains. Overall, aquaculture value chains can be classified as buyer-driven when buyers represented by retailers and supermarkets play dominant roles influencing the process of production and distribution of final products. However when examining inter-relationships between two successive links along a value chain, there can be a variety of governing and coordinating mechanisms ranging from free-market relations to network relations to vertically integrated relations. Industrial and manufacturing value chains are well organized whereas agriculture and aquaculture value chains may be loosely organized depending on particular product/species, farming systems, and technological intensification level as well as markets where final products are sold.

Findings from the nine country case studies revealed that freshwater aquaculture value chains are structured around diverse products grown in earthen ponds, paddy fields, cages, net enclosures, and pens in floodplains, reservoirs, lakes and rivers. Such chains for domestic markets consist of a variety of carps and catfish produced in IAA systems. A substantial portion of freshwater aquaculture production also enters value chains for export markets, for example, entrepreneurial and monoculture catfish and tilapia value chains from Indonesia, Thailand and Viet Nam. In the same farming environment (freshwater), value chains from integrated aquaculture systems are simpler and contain fewer segments compared with monoculture value chains producing products for export markets. Relationships among stakeholders involved in small-scale freshwater aquaculture chains for domestic markets are loose and characterized by market relations. However, more formal or structured relationships can be developed when small-scale producers enter contracts with larger firms or input supply or processing plants as documented in Thailand's case study on the tilapia value chain (Box 1).

## BOX 1

**Tilapia value chain in Thailand**

Tilapia production grew from 134 000 tonnes to more than 190 000 tonnes between 2004 and 2009, involving 193 000–197 000 tilapia farms in Thailand. Farm production is conducted in ponds, cages, and paddy fields; however, most products (81 percent) are produced in ponds. Many small farms enter into contracts with larger farms or processing plants to purchase inputs, grow marketable products, and/or to sell back aquaculture products to companies and large firms. From the farm, about 86 percent of tilapia production is channelled to traders and then to wholesalers, and restaurants and retailers before reaching consumers in domestic markets. The remaining production (14 percent) is sold directly to processors, which then export processed products to export markets or sell to retailers and restaurants for domestic consumption. The bulk of tilapia production in Thailand (about 94 percent) is consumed domestically. From input supply to farm production, middle trading, processing, to marketing and distributing final products, tilapia value chains created 52 839 full-time equivalent (FTE) jobs in 2009, of which more than 50 percent were generated at farm production links. Annual labour productivity at farm level and full value chain level was estimated to be about 3.6 and 7 tonnes per person, respectively.

Brackish-water aquaculture value chains are structured around a few commodities such as shrimp, milkfish and mud crab. The most important brackish-water aquaculture value chain observed in the nine country case studies is the shrimp value chain. The case studies showed that in general, brackish-water shrimp value chains are buyer-driven and export-oriented with unequal power relationships among actors involved in the various chain segments. In Asia, export-oriented shrimp value chains can be highly integrated from input supply to grow-out production and to processing and exporting segments, as documented in the Thailand case study, or can be highly fragmented with participation of various stakeholders ranging from fry collectors, input providers, grow-out producers, middle traders, processors and exporters as found in the Bangladesh, Indonesia and Viet Nam case studies. Linkages between successive players along brackish-water aquaculture value chains range from spot market relationships to network relationships to vertically integrated relationships (Box 2).

Table 6 shows that employment shares generated by domestic and export-oriented aquaculture value chains in the 9 country case studies are about 73 and 27 percent, respectively. These estimates are based on a number of assumptions, due to the lack of disaggregated production and employment data along value chains. Therefore, they should be treated as broad indicators of the proportion of employment between domestic and export value chains rather than exact numbers. Moreover, as data on FTE jobs were not available for all country case studies, these estimates are based on numbers of people employed both full- and part-time. Despite the approximate nature of these estimates, the fact that most full- and

part-time jobs in the aquaculture sector appear to be generated in domestic, rather than export, value chains, reflects global trends of strong and rising domestic demand for aquaculture products as incomes rise and the demand for animal protein increases.

#### BOX 2

##### Players involved in the brackish-water shrimp value chain in Bangladesh

A pro-poor analysis of the shrimp sector in Bangladesh conducted by Gammage *et al.* (2006) found that the shrimp value chain provides significant economic opportunities to middle- and upper-level stakeholders as well as livelihood opportunities to the rural poor. The shrimp value chain in Bangladesh is complex and involves various players at each segment of the chain. It is centred around 150 000 shrimp producers, who are connected via backward linkages with 426 000 shrimp fry catchers, 118 hatcheries, and about 22 000 middle traders (Fry Faria, fry Aratda, Commission Agents, and nurseries) that bring fry to farmers. Producers are also connected via forward linkages to more than 9 000 middle traders, 35 processors and 85 processor/exporters before reaching shrimp buyers, mainly in foreign markets. The poor and small-scale stakeholders, including women and children, participate in a number of segments throughout the chain such as fry catching, grow-out production and processing. Poor and small-scale stakeholders have little bargaining power and may be locked into contracts with middle traders and have little ability to influence the price at which they sell their product.

TABLE 6

##### Employment generation along domestic and export-oriented value chains

Case study country	Employment in domestic oriented value chains	Employment in export oriented value chains	Total employment
Viet Nam**	1 232 250	1 412 706	2 644 956
Bangladesh*	2 605 207	1 189 718	3 794 925
Thailand*	208 129	154 944	363 073
Indonesia*	3 918 703	93560	4 012 263
Chile**	33 140	43 929	77 069
Ecuador*	43 851	162 054	205 905
Mexico*	40 160	8 637	48 797
Egypt**	236 991	0	236 991
Zambia**	15 315	0	15 315
<b>Total</b>	<b>8 333 746</b>	<b>3 065 548</b>	<b>11 399 294</b>

Notes: \* Employment estimates based on FTE jobs

\*\* Employment estimates based on full and part time jobs (total number of people employed).

## 4.2 SOCIAL AND ECONOMIC SERVICES OF AQUACULTURE

### 4.2.1 Aquaculture and poverty alleviation

Earlier studies by Dey and Ahmed, (2005) have shown that polyculture and monoculture of carnivorous and omnivorous fish species such as carps and tilapia are profitable and suitable for poor and small-scale stakeholders. Growing carnivorous species such as prawns and shrimp yield higher profits; however, they



are often beyond the financial capabilities of poor farmers. Recycling farm-based inputs in IAA systems increases farm productivity. However, the increase in farm productivity from recycling farm-based inputs is only effective to a certain level, beyond which farmers may require purchased feed and fertilizers and turn into small rural enterprises. Some recent publications show that capital-intensive forms of aquaculture practised on a larger scale also make significant indirect contributions to poverty alleviation (Belton and Little, 2011).

The contribution of aquaculture to rural poverty alleviation can be assessed by examining direct involvement of the poor in aquaculture value chains. Findings from the nine country case studies show that a large number of small-scale stakeholders, including the poor, are directly involved in various kinds of freshwater aquaculture production, such as: subsistence farming in Zambia; homestead aquaculture in Bangladesh; and the VAC farming system in Viet Nam. Freshwater aquaculture directly contributes to poverty alleviation by generating employment and income for the poor. In Latin America, aquaculture is commonly practised by medium- and large-scale operators. Nonetheless, findings from Chile and Ecuador show that a growing number of small producers are operating seaweed and freshwater aquaculture ponds. These findings are in line with those of previous studies on rural aquaculture (e.g. Edwards and Demaine, 1997; Edwards, 1999). Further expansion of aquaculture that directly involves the poor will be constrained by land and water access, as many of the poor do not own land and waterbodies for aquaculture production. Direct benefits to the poor from aquaculture development are therefore less than those to other better-off participants (Belton and Little, 2011).

As revealed by the case study findings, aquaculture also contributes to poverty alleviation indirectly via the involvement of poor and small-scale stakeholders in various activities along aquaculture value chains. As documented in the Bangladesh case study, many poor people work as fry collectors and workers in seafood processing plants. In Indonesia, Viet Nam and other countries, rural poor people are employed in processing plants and as labourers for various aquaculture related activities. The country case studies suggest that there are high numbers of small-scale players directly involved in various aquaculture value chains. Many of these players are not poor but are likely to be vulnerable, engaging in aquaculture production, along with other livelihood activities, as a small-scale rural enterprise for income generation. Aquaculture often provides higher income compared with other farming alternatives. Aquaculture can help to improve livelihoods and protect households from falling into poverty. The complex interaction between aquaculture and small-scale enterprise and poverty alleviation deserves further investigation.

Another dimension for understanding the link between aquaculture and poverty alleviation is fish food security. Fish is the lowest-cost animal protein and it can be supplied via aquaculture production. With both public-based and market-based interventions, global aquaculture has been developing rapidly in the last five decades and now contributes 50 percent of world food fish supply (FAO,

2016). With the exception of some export-oriented commodities, the majority of aquaculture production in developing countries is consumed domestically. Aquaculture development can also help to lower fish prices, making fish accessible to poor and small-scale stakeholders in both rural and urban areas. One important finding from the country case studies is that a high proportion of aquaculture production for both domestic and export markets is produced by small-scale rural enterprises and medium- and large-scale aquaculture farms. While subsistence and small-scale household-level production involves higher numbers of actors, this production is much less than commercial production of aquaculture outputs.

#### **4.2.2 Aquaculture and women**

Women play critical roles at different stages of aquaculture value chains. The functions and roles they assume differ between countries, farming systems and value chains. Women are not often directly involved in hatchery and nursery operations but are involved more in grow-out aquaculture production and play key roles in the processing and marketing of aquaculture products. As documented in the country case studies and previous gender-related studies, women are actively involved in aquaculture farming in Asia. In many developing countries, especially those in the South Asia and Southeast Asia regions, it is common for women and men to work together to improve their household-livelihood portfolios.

In some Asian countries, women's participation in economic activities is restricted due to cultural and/or religious prohibitions. However, there is room for increasing women's involvement through supporting homestead aquaculture where ponds are constructed adjacent to the homestead such as in Bangladesh. In Bangladesh, there is a high degree of female participation in shrimp value chains, where women work as fry collectors and workers in seafood processing plants. Women participating in informal jobs in shrimp value chains are subject to lower wage rates compared with men, and women who work as on-farm labourers can be vulnerable to exploitation. Nonetheless women's participation in shrimp value chains has "saved many rural landless poor families from starvation and hunger" (Hamid and Alauddin, 1998). In Africa, women's involvement in commercial aquaculture value chains can be limited (sometimes due to cultural and or religious prohibitions); however, in subsistence aquaculture farming systems, women often share the work of pond cleaning, feeding and management and fish harvesting with their husbands. Women also act as informal fish traders who buy fish from farms and resell them to domestic consumers, as reported in the Zambia case study. In some African countries, such as Ghana, the vast majority of fish traders and wholesalers are women.

#### **4.2.3 Aquaculture and food fish supply and nutrition**

Aquaculture accounts for about 50 percent of food fish production for human consumption locally and globally. Global aquaculture production has been increasing sharply in the last three decades or more, but it is unclear how this remarkable increase in global production has affected fish consumption and

nutrition of local people in developing countries, especially the poor. Ahmed and Lorica (2002) show that aquaculture development has positive income and fish consumption effects in developing countries. However, there is limited empirical evidence to support the view that aquaculture provides vital nutrition to poor households and contributes to poverty alleviation, thus improving the overall welfare of poor people in developing countries.

Results from the country case studies show that, at the country aggregate level, per capita fish consumption has been increasing in most countries investigated despite the stagnation or decline in production from capture fisheries. The increasing rate of fish consumption has been supported by the increase in aquaculture production annually. The majority of rising aquaculture production comes from entrepreneurial and commercial aquaculture operated by small-, medium- and large-scale producers. Sales of fish allow rural people to buy other staple food and enhance overall food security. Findings from the country case studies show that, on average, aquaculture development increases fish consumption. However, there is limited information to analyse disaggregated impacts on different stakeholder groups such as the poor, women and children. Some authors have raised concerns that substantial increases in aquaculture production are due to the increase in large and export-oriented aquaculture production that has no, or even negative, impacts on fish consumption and nutrition of poorer segments of populations in developing countries. This critical issue requires further examination.

#### **4.2.4 Other social and economic services of aquaculture**

In addition to major social and economic services such as providing employment opportunities, generating income, providing nutritious food, contributing to poverty alleviation both directly and indirectly, and enhancing gender equity, aquaculture development also generates other important services at macro and micro levels.

From an economic development perspective, export-oriented aquaculture provides an important source of foreign exchange to developing countries. For top aquaculture producers, such as Indonesia, Thailand and Viet Nam, export revenue from aquaculture accounts for a substantial proportion of total export revenues. Export revenues generated by aquaculture in other countries in Africa, Asia and Latin America investigated in this study have also been increasing. Aquaculture development also supports infrastructure development and economic growth in general.

From a human development perspective, aquaculture also provides cultural, religious and regulating services to people in developing countries. In some countries, fish are used for ritual practices. For example, in Viet Nam, common carp is used for the kitchen god worship practised at the end of the lunar year, and all carp used for rituals now come from aquaculture. In other countries, aquaculture operations show the prestige and status of operators (for example, in the Lao People's Democratic Republic and Zambia, as illustrated by Belton and Little, [2011]). In places where community-based aquaculture is promoted, aquaculture

development can be a vehicle for strengthening community relationships. In addition to cultural and religious services, aquaculture development can offer environmental regulating services, for example, waste recycling offered by fish, clams and seaweed culture. Aquaculture ponds can store water to help producers in water-scarce regions such as countries in SSA to cope with drought and increase farm productivity.

### 4.3 MAJOR AQUACULTURE DEVELOPMENT TRENDS AND INFLUENCES

Some of the key development trends occurring in the global aquaculture sector are discussed below. These trends have significant implications for poor and small-scale actors involved in aquaculture production and associated value chains, which are explored further in Chapter 4.

#### 4.3.1 Major trends in the global aquaculture sector

In the last four decades, aquaculture has been the fastest-growing food-producing sector in the world, driven by the high and increasing demand for fish and seafood in domestic and international markets. Aquaculture's contribution to total food fish supply increased from 9 percent in 1980 to 48 percent in 2011 (FAO, 2013). Global markets for fish and fishery products are expanding, and 38 percent of fish produced globally was exported in 2010 (FAO, 2012). The share of trade from developing country exporters is rising and 67 percent (by value) of fishery exports by developing countries go to developed countries (FAO, 2012). Globally, the principal markets for fish and seafood products are the European Union (Member Organization), the United States of America, and Japan. A significant increase in regional trade between developing countries is also occurring, driven in part by rising costs of exporting to the European Union (Member Organization) and the United States of America, and by increasing population and purchasing power in many regional markets. Global aquaculture production has also been expanding in different directions including cultured species diversification and technological intensification as well as introduction and expansion of new culture species (e.g. in African countries). The fastest supply growth is expected for tilapia, carp and *Pangasius* catfish, for example global tilapia production is expected to almost double from 4.3 million tonnes to 7.3 million tonnes between 2010 and 2030 (World Bank, 2013).

Geographically, aquaculture production and development has been concentrated in Asia with less impact in Africa, the Caribbean and South America. Evidence from Asia, suggests that population growth and technological improvements have had positive effects on raising aquaculture production (e.g. Jiang, 2010). High demand for fish in domestic markets is a critical factor for successful aquaculture development in Asia. In addition, increasing international trade has promoted export-led aquaculture development in Asia and other parts of the world as evidenced by the rapid growth of some aquaculture commodities such as striped catfish in Viet Nam and farmed shrimp in Asia and Latin America. The dominant source of supply in many Asian countries is from traditionally based

pond aquaculture, often integrated into wider farming systems, contributing to increased household food security and income generation. However, intensive aquaculture has also developed in Asia, especially coastal shrimp farms and larger-scale freshwater and marine fish farming using ponds, tanks and cages. Overall, in the past 15 years a dynamic small and medium-sized enterprise (SME) aquaculture sector targeting both domestic and export markets has emerged in a number of Asian countries, particularly China, Viet Nam, Thailand, Indonesia and the Philippines (Allison, 2011). The Bangladesh country case study also noted the emergence of an entrepreneurial pond culture that has been growing in importance and scale since the late 1990s, and the China country review indicates that the number of small-scale farms has been decreasing in rural areas and is being replaced by larger-scale operations.

Despite suitable and favourable natural resource conditions, aquaculture in Africa contributes only 2 percent of global fish supply and currently makes a minor contribution to economic growth, employment, and rural development. International donors have invested hundreds of millions of dollars to promote aquaculture development, particularly small-scale aquaculture, for food security and poverty alleviation in SSA. However, donor-driven projects have not produced the food security and economic growth impacts expected by development and funding agencies (Brummett, Lazard and Moehl, 2008). Nonetheless, in recent years aquaculture SMEs have been growing in a number of African countries such as Angola, Cameroon, the Democratic Republic of the Congo, Ghana, Kenya, Nigeria, South Africa, Uganda and Zambia, and these are making a substantial contribution to aquaculture production in SSA despite little attention from African governments and international donors. Thus, aquaculture plays dual roles in African economies, contributing to both commercial and rural development (Brummett, Lazard and Moehl, 2000). Between these two extremes, there are small-scale entrepreneurial producers who operate small farms, purchase most of their inputs and sell the majority of their final products for cash income. This in-between group of farmers can be viewed as in transition from the rural development sector to commercial aquaculture. Evidence from Ghana suggests that increased aquaculture production from this group has the potential to generate higher economic multiplier effects and thus higher poverty impacts, than increased production from poor farmers or more commercial SMEs (Kassam, 2013).

Aquaculture offers a significant development opportunity in Latin American countries. Key aquaculture commodities grown in the region include salmon in Chile and brackish-water shrimp in a number of countries such as Brazil, Colombia, Ecuador and Mexico. There is currently growing interest in commercial tilapia culture, molluscs (oysters and scallops) and seaweed culture as well as culture of domestic fishes such as catfish in the region. Despite having favourable environmental and climatic conditions for aquaculture development, Latin America currently contributes only about 3 percent of global aquaculture production. Unlike aquaculture in Asia and SSA, Latin American aquaculture is dominated by medium- and large-scale producers. However, there is a trend of

increasing involvement of small and independent producers in the aquaculture industry in some Latin American countries such as Chile.

Findings from community consultations in the case study countries and a review of relevant secondary literature suggest that global aquaculture is experiencing dynamic and complex development trends, influenced by a number of internal and external factors. In countries where the aquaculture sector is mature, such as Thailand, the number of people employed in aquaculture value chains, especially small-scale stakeholders, has been decreasing. The Thailand country case study indicates that there is an increasing process of vertical integration to increase efficiency and close aquaculture value chains in order to address stringent food safety and environmental standards required by international markets (discussed in more detail below).

In transition and developing countries, such as Bangladesh, Indonesia and Viet Nam, aquaculture has been developing rapidly with an increasing area of land being devoted to aquaculture, increasing aquaculture production as well as increasing numbers of people employed along aquaculture value chains. However, the large numbers of people involved tend to make aquaculture value chains fragmented and vulnerable to stringent market and trading requirements raised by domestic and export markets. Thus, in these countries, there are different processes transforming the aquaculture industry into global value chains coordinated by large players. For example, between 1996 and 2006, the *Pangasius* catfish industry in Viet Nam was transformed from household-based cage and pen aquaculture into highly intensive pond-based commercial aquaculture systems generating billions of dollars in export revenue annually.

In all regions, but especially in those where aquaculture is relatively newer and less developed, such as in SSA and Latin America, it appears that aquaculture is experiencing some dynamic local development trends in the expansion of commercial SME aquaculture.

The aquaculture development trends outlined above have substantial influences and effects on employment opportunities for poor and small-scale stakeholders involved in aquaculture value chains. The section below discusses some of the key drivers of change in the aquaculture sector: global value chain formation, dynamic local development, and climate change.

#### **4.3.2 Transformation of global aquaculture production and trade**

Important factors affecting global aquaculture development are: the development and vertical integration of global and local aquaculture value chains; the increasing stringency of product quality and trading standards; and demand for certification of aquaculture products associated with the increasing awareness of consumers and regulators of sustainable aquaculture production. These related factors are leading to increased coordination and governance of local and global aquaculture value chains. Trends towards industrialization and consolidation of value chains are especially strong for species that are internationally marketed. International value chains are affecting small-scale producers in Asia, for example, those in

the Vietnamese catfish industry, where consolidation has been mainly driven by western quality standards in processing and production (Bostock *et al.*, 2010). Findings from several of the country case studies also suggest that local and global aquaculture value chains are becoming increasingly buyer-driven. However, while many aquaculture value chains are becoming highly integrated and well coordinated due to the need for control over specific production practices, there are others which are fragmented, involving many small companies and value chain players, with limited coordination. Local and global aquaculture value chains originating from small-scale aquaculture production tend to be more fragmented and involve a higher number of stakeholders as illustrated by the case studies from Bangladesh, Indonesia and Viet Nam. In contrast, aquaculture value chains oriented around large- and commercial-scale production are better organized, less fragmented and better able to address food safety, product quality and environmental standards imposed by buyers in domestic and export markets.

An emerging and increasing factor influencing aquaculture development and small-scale producers is the proliferation of private party standard and certification schemes. On the one hand, growing interests in aquaculture certification schemes are driven by their potential for product differentiation in consumer markets. On the other hand, certification favoured by environmental non-governmental organizations (NGOs) envisions certification schemes as instruments to address social, environmental and food safety externalities created by some forms of aquaculture development. A WWF report (WWF, 2007) documented more than 30 certification schemes active in the aquaculture sector. Most private party certification systems are voluntarily implemented subject to the interests of stakeholders involved in local and global aquaculture value chains.

These new developments bring new opportunities and threats to stakeholders involved in aquaculture value chains, especially poor and small-scale stakeholders. Connecting to global and local value chains provides involved stakeholders opportunities to upgrade and enhance their comparative advantage and place them in a better position in the market. However, due to unequal power relationships among value chain players, poor and small-scale stakeholders are often at a disadvantage compared with larger, more powerful actors. Small-scale farmers are also not as able as larger-scale producers to meet the requirements of international markets. The effect of these developments in the global aquaculture sector, particularly on the employment of poor and small-scale value chain players, is discussed further in Section 4.2.

### 4.3.3 Dynamic development at local level

Global aquaculture has been developing in different directions including increasing intensification and productivity levels, expanding into new farming areas and regions, and introducing and acclimatizing new cultured species. Natural resource planning and use at the local level has a strong influence on aquaculture development. When constraining institutional factors such as land-use plans change, they can provide great impetus for rapid aquaculture development. For example in

Viet Nam, aquaculture growth increased sharply after the government launched a resolution (09/2000/TTg) allowing farmers to convert saline and low-productivity rice fields and unused land into aquaculture ponds. The aquaculture sector in the country became a significant source of export revenue and transformed hundreds of thousands of small-scale agricultural farmers into small-scale, entrepreneurial aquaculture producers. Employment in the coastal aquaculture sector has been growing in Viet Nam as a result of shifting development interests at local level to respond to increasing demand for fish in domestic and export markets. Change in land-use purpose here is just one example showing that local development priority setting has a strong influence on the development pace of the aquaculture sector.

In many other countries in the world, there are institutional and governance factors that can influence aquaculture development. How natural resources such as land and open waterbodies are mobilized for aquaculture development is subject to local development priorities. To direct aquaculture development for poverty alleviation and small-scale stakeholder employment, especially in new aquaculture expanding areas, special attention should be paid to policy, institutional and governance factors. As experienced in some Asian aquaculture producing countries, the sector is dominated by small-scale and locally based producers. The government can set land size limits to ensure that local farmers have access to land and waterbodies for earning livelihoods dependent on aquaculture and agriculture activities.

#### **4.3.4 Climate change and other factors**

Aquaculture operations are often located in lowland areas along rivers and estuaries and in coastal and marine areas. These areas are highly vulnerable to the effects of climate change such as sea-level rise, increasing intensity and frequency of storms and floods as well as changes in average temperature and precipitation. Climate change and variability affects aquaculture in different ways and aquaculture is also a factor contributing to climate change via releasing greenhouse gases from aquaculture intensification and conversion of natural wetlands into aquaculture systems. Among the case study countries, Bangladesh and Viet Nam are among hotspot countries with regard to climate change impacts. In Bangladesh, Viet Nam and many other countries in Asia, the majority of aquaculture production is undertaken in the delta areas of the main rivers such as the Ganges delta, the Mekong delta and the Red River delta. Rising sea levels could result in serious inundation of aquaculture areas, while extreme floods caused by upstream water flows during rainy seasons can have serious effects on aquaculture practices.

Climate change and variability is likely to affect aquaculture stakeholders involved in the sector in different ways. Climate change can hamper farmed aquatic species by exposing them to a range of pests and pathogens while decreasing their disease-resistant capacity. Direct impacts could be damage to aquaculture facilities and reduction in aquaculture productivity and revenue. Indirect impacts include increasing aquaculture production costs and modifying food chains and food webs in aquaculture-based aquatic ecosystems. Climate change can also create



opportunities for aquaculture development. For example, areas inundated due to sea-level rise may be no longer suitable for agricultural-based farming systems and could be used for aquaculture. In some areas in Africa, IAA can be viewed as a strategy to cope with drought and water scarcity due to climate change, increasing overall farm sustainability and resilience to shocks. Therefore, aquaculture can also provide options for climate change adaptation.



**PLATE 4**

Harvesting fish in a small-scale aquaculture pond in Bangladesh. Photo credit: Md Masudur Rahaman/WorldFish

## 5. Discussion and policy implications

This section summarizes key findings of the report and explores the implications of these for aquaculture policy and planning. It discusses the potential impact of aquaculture development trends on poor and small-scale stakeholders and proposes a set of indicators to enable better monitoring of social and economic services generated by aquaculture.

### 5.1 SUMMARY OF KEY FINDINGS

The main objective of this study is to assess social and economic services of global aquaculture from a human development perspective, especially the employment generated by the aquaculture industry, with a particular emphasis on small-scale stakeholders in Africa, Asia and Latin America. The findings of the study are based on an analysis of case studies of the aquaculture sectors in 9 countries (2 in Africa, 4 in Asia and 3 in South America). In total, 11.4 million people were found to be employed in aquaculture value chains in these countries, of whom about 8.3 million at farm level and 3.1 million at other links along aquaculture value chains up to the exporting stage. These nine countries account for about 16 percent of global aquaculture production. Of the 10 million “units” in the aquaculture sectors studied, 9.1 million are grow-out production operations dominated by households who have ponds and operate aquaculture as an integrated component of their larger farming systems. Most of the people employed in the aquaculture sectors in the nine case study countries are in Bangladesh, Indonesia and Viet Nam. The findings suggest that previous estimates of total employment generated by the global aquaculture sector based on data reported to FAO are likely to be underestimates.

Poor and “small-scale” stakeholders, although difficult to classify from the data provided, enter aquaculture value chains at almost all segments. Of the 11.4 million people indicated above, an estimated 6.5 million are employed in small-scale aquaculture value chains, compared with 4.9 million in medium- and large-scale value chains. Employment at farm level and related jobs in small-scale value chains (5.3 million) is estimated to be much higher than at the same level in medium and large scale value chains (2.9 million). Employment at other links along small-scale value chains (1.2 million) is much lower than employment at other links along medium- and large-scale aquaculture chains (2 million). While small-scale aquaculture value chains generate higher overall levels of employment, small-scale aquaculture contributed only 29 percent to total production documented in the case study countries (3.4 million tonnes from small-scale production versus 8.3 million tonnes from medium- and large-scale production).

While fisheries statistics do not disaggregate aquaculture employment by gender, the country case studies show that women play a significant role in the aquaculture sector. Employment of women in aquaculture value chains in Indonesia, Viet Nam and Zambia was found to range between 40 and 80 percent, especially in post-harvest activities and household-based aquaculture production activities such as feeding, managing ponds and marketing.

Employment generated by domestic and export-oriented aquaculture value chains in the nine country case studies was estimated to be 73 and 27 percent, respectively. Freshwater aquaculture value chains for domestic markets consist of a variety of carps and catfish produced in IAA systems. A substantial portion of freshwater aquaculture production also enters value chains for export markets. Freshwater value chains from IAA systems are simpler and contain fewer segments than monoculture value chains producing for export. Brackish-water aquaculture value chains are structured around a few commodities such as shrimps, milkfish and mud crabs, and the most important of these in the nine country case studies was found to be shrimp. The case studies showed that, in general, brackish-water shrimp value chains are buyer-driven and export-oriented with unequal power relationships among actors involved in the various chain segments.

The case studies highlighted aquaculture's role in generating social and economic services (aside from value chain employment) including: direct and indirect poverty alleviation; benefiting women; and enhancing food and nutrition security. The case studies showed that a large number of aquaculture producers are small-scale and poor stakeholders e.g. subsistence farmers in Zambia, homestead aquaculture farmers in Bangladesh, and farmers in the VAC system in Viet Nam. Thus, aquaculture directly contributes to poverty alleviation through generating self-employment and enhancing income and livelihoods of poor and small-scale farmers. Findings from Chile and Ecuador show that a growing number of small producers are currently operating seaweed and freshwater aquaculture ponds. The case studies suggest that aquaculture also contributes indirectly to poverty alleviation through the high number of small-scale players involved in various aquaculture value chains. While many of these players may not be poor, they are likely to be vulnerable, and aquaculture can help to improve their livelihoods and protect them from falling into poverty. Women were also found to play critical roles in different stages in aquaculture value chains, with their functions and roles differing between countries, farming systems and value chains.

The study found that overall per capita fish consumption has been increasing, supported by the increase in aquaculture production. The majority of the growth in aquaculture production is from entrepreneurial and commercial aquaculture operated by SMEs and large-scale producers. The country case studies suggest that, on average, aquaculture development increases fish consumption. However, there is limited information to analyse disaggregated impacts on different stakeholder groups such as the poor, women and children.

The study also identified some of the key development trends occurring in the global aquaculture sector, many of which have significant implications for

poor and small-scale actors involved in aquaculture production and associated value chains. The rapid growth of the sector in terms of both production of and trade in aquaculture products was found to be an overarching trend that provides significant opportunities for the sector in all regions under analysis. The key drivers of change identified include the increasing consolidation and vertical integration of export-oriented value chains, driven in part by increasing stringency in product quality, trading standards and increasing demands for certification of aquaculture products. Dynamic local development trends were also identified as being important, and climate change and variability were suggested as creating both threats and opportunities for the aquaculture sector, although the effects are complex and uncertain.

## **5.2 MAJOR TRENDS INFLUENCING SMALL-SCALE EMPLOYMENT GENERATED THROUGH AQUACULTURE VALUE CHAINS**

Some of the key trends in the global aquaculture sector are: consolidation of global value chains; increasing stringency in product quality; and demand for certification in international markets. The impact of these trends on poor and small-scale farmers and value chain players is uncertain. The literature from global commodity chain studies predicts that small-scale farmers will be displaced and marginalized due to the increasing globalization and consolidation of large-scale and powerful players (e.g. transnational corporations and retailers) in global markets. However, the impacts of these developments are very dynamic and likely to differ between contexts; thus, they need to be further investigated. One possible scenario is that small-scale and marginal stakeholders could be displaced from aquaculture value chains, and the global aquaculture industry will be concentrated in the hands of a few large-scale players located in developed countries (e.g. supermarkets and large retailers) and in developing countries (e.g. exporting and processing companies, large-scale aquaculture producers). However, empirical studies suggest that small-scale farms, although facing great challenges, will continue to exist because of the specific characteristics of aquatic animal farming systems that are risky for larger scale production. Another development scenario is that small-scale and household players may still remain in the aquaculture industry but, due to market stratification and differentiation, will be forced to specialize in lower quality markets with less-stringent product requirements. For example, larger-scale players will connect to value chains producing for export markets that demand high-quality, while small-scale and household players will focus on lower quality and less-demanding domestic markets.

Findings from the country case studies on the impacts of these trends on small-scale stakeholders are mixed. For example, the China review found that, while employment in the agriculture and fisheries sectors has been decreasing over time, the number of people engaged in aquaculture has been increasing, rising from 3.3 million in 2004 to 10 million in 2008. However, findings from other country case studies show that employment in certain global value chains has been decreasing. For example, the consolidation of the shrimp value chain in Thailand

has had a negative impact on small-scale producers as the number of small-scale shrimp farms dropped sharply during the transition from tiger shrimp culture to high-demand, intensive white-leg shrimp culture. A large number of small-scale stakeholders are being displaced or forced to work as contractors for larger stakeholders. Overall, the number of people employed in aquaculture value chains in Thailand, especially small-scale stakeholders, has been decreasing, and it is very difficult for the poor to benefit from involvement in commercial and vertically integrated aquaculture value chains other than in insecure and unstable jobs, such as on-farm labourers or as workers in processing factories.

Similarly, in Viet Nam, while the overall production and area under aquaculture cultivation nationally have been steadily increasing, the globalization and consolidation of the catfish value chain has had negative impacts on small-scale farmers. Catfish has become one of the key aquaculture species in Viet Nam, contributing more than 39 percent to national aquaculture production and 33 percent to total fisheries export values. Until recently, the catfish sector was dominated by small-scale, household production; however, an increasing number of catfish processing and export companies are developing their own larger-scale production operations and integrating processing and production activities, displacing small-scale and family based players. Traditional family-operated fish ponds in the VAC system have also been decreasing due to pressures of industrialization, modernization, and residential settlements. Similar processes have been occurring in Bangladesh, where more commercially oriented aquaculture is growing and larger enterprises are contributing significantly to production. While small-scale poor farmers might not be as involved directly in production, they are benefiting from employment on aquaculture farms and the many other services required by the sector. Such farms are also contributing to food supplies for growing urban populations and, where cheap fish is concerned, may be benefiting poorer consumers.

It appears therefore that the general trend of increasing aggregation and commercialization in the sector as a whole, particularly in more commercial and export-oriented value chains, is resulting in efficiency gains and longer-term market relationships of larger producers, so making smaller producers increasingly uncompetitive and vulnerable to takeover in many cases (Muir, 2005). It is unclear whether employment generation along the value chain from larger-scale commercial production can make up for the displacement of small-scale farmers (e.g. overall employment in Thailand has decreased). The often insecure and poor quality of employment created along value chains cannot make up for loss of aquaculture based livelihoods of small-scale producers. This trend is thus of concern due to the potential for social inequity and also due to the wider system impacts of increasing intensive aquaculture development (Muir, 2005). The social dimensions of aquaculture's growth are thus complex, and there is a need for more-detailed analysis and understanding of the types of people involved, and how they participate and benefit from the changing aquaculture sector, using a value chain approach.

A related trend and driver of change in the global aquaculture sector identified in Section 3.3 is the increasing demand for certification of aquaculture products. While these international standards may appear not to affect smallholder systems in many countries, especially those where domestic and regional trade dominate such as in SSA, there is an increasing risk that they could create substantial barriers to development, by denying them access to wider markets (Bostock *et al.*, 2010). The more stringent demands of export markets mean that small-scale operators will face increasing difficulties in producing products for export and, as noted above, evidence from Asia suggests that some are leaving the sector as they are becoming uncompetitive and unprofitable. Several of the country case studies from Asia highlighted the risks and challenges small-scale farmers face in being able to comply with these international standards and the overall uncertainty as to their ability to do so. The case study noted that the increasingly strict international standards for aquaculture products, including certification schemes being adopted by the major global buyers, represent a major challenge given the very large number of small-scale farmers and other upstream and downstream value chain players involved in the sector, and its weak governance conditions. Similarly, the Thailand case study found that a common expectation is that tilapia for export will be a growing market segment, but it is not clear that small-scale farmers will be able to participate in this expansion, given current lack of interest in certification and quality management standards. The Viet Nam case study highlighted that export-oriented marine and brackish-water aquaculture, which connects small-scale aquaculture producers in Viet Nam to world markets via complex commodity systems, will also face higher risks and challenges from the emergence of tighter mandatory food safety regulations and voluntary standards such as certification schemes. It appears that small-scale aquaculture in many places may no longer be able to compete with larger producers both in terms of efficiency and export market access. Thus, it will have to transform to adapt to these emerging challenges.

Therefore, it seems that the impacts of both consolidation of global value chains and certification trends on small-scale aquaculture producers and value chain players are currently presenting significant challenges to the small-scale sector that are likely to continue. It is beyond the scope of this study to explore these impacts in depth, or predict how the quantity and quality of employment along aquaculture value chains will change as a result. What is clear however is that these trends have the potential to affect a significant and most probably growing proportion of those involved in the aquaculture sector, especially considering almost 30 percent of employment in aquaculture is estimated here to be in export-oriented value chains (see Table 6), which are those primarily affected by these global market trends.

Section 3.3 also discussed the effects of climate change on the aquaculture sector, indicating that climate change and variability present both threats and opportunities. The potential impacts of climate change on the aquaculture sector and the employment of poor and small-scale stakeholders along aquaculture value

chains are very uncertain. The inherent unpredictability of climate change and the strong links between aquaculture livelihoods and other livelihood strategies and economic sectors make identifying all pathways between climate change and employment and livelihoods in the aquaculture sector extremely complex. However, it is clear that poor and small-scale stakeholders in the global aquaculture sector are less advantageously placed than larger-scale commercial actors to take advantage of new opportunities and adapt to the threats. Thus, a strong focus should be placed on building general adaptive capacity that can support poor and small-scale aquaculture producers and value chain actors to make the most of new opportunities and cope with the coming challenges related to climate change.

### 5.3 IMPLICATIONS FOR FUTURE AQUACULTURE PLANNING AND POLICY FORMULATION

This study has shown the importance of taking a value chain perspective to understanding the social and economic services, particularly employment generation, of the aquaculture sector. Focusing only on the social and economic services generated by aquaculture production alone would yield an incomplete picture. The study has found that the data available to monitor the social and economic services generated by aquaculture are currently limited. The study found the few existing estimates of employment generated by the global aquaculture sector using official national statistics to be underestimates, and many of the individual country case studies were unable to explore the full range of social and economic services generated from aquaculture value chains due to the lack of suitable data. As noted above, it is uncertain how the development trends occurring in the aquaculture sector will affect the services it generates such as employment generation along the value chain, and the livelihoods of small-scale and poor stakeholders. Therefore, as the aquaculture sector continues to develop, it is important that more comprehensive data become available to enable successful monitoring of the sector and to inform aquaculture planning and policy in the future.

Tables 7 and 8 suggest some indicators to monitor these social and economic services from aquaculture, distinguishing between macro and micro level indicators, which can be applied at national/local and household levels. The proposed indicators also incorporate indicators to monitor social and economic services generated by the aquaculture sector generally, and indicators that can be used specifically to monitor such services generated by small-scale aquaculture development. The national-level indicators (Table 7) are based on those developed by Cai *et al.* (2010) and include additional indicators for measuring employment along aquaculture value chains. The indicators for monitoring small-scale aquaculture and its contribution to sustainable rural development and poverty alleviation (Table 8) are based on the outcomes of an FAO workshop on measuring the contribution of small-scale aquaculture (Bondad-Reantaso and Prein, 2009). The indicators for small-scale aquaculture are informed by the Sustainable Livelihoods Framework (Carney, 1998) and categorized by their



TABLE 7

**Indicators for monitoring social and economic services from aquaculture at the national level**

Social/economic service	Indicator
<b>Contribution to GDP</b>	Share of aquaculture's value added in GDP
	Aquaculture sectors' contribution to GDP growth
	Share of aquaculture's value added in agriculture value added
	Aquaculture's contribution to agriculture value added growth
	Economic multiplier effect* (national and local)
<b>Employment</b>	Share of aquaculture employment in total employment
	Aquaculture's contribution to total employment growth
	Share of aquaculture's employment in total agriculture employment
	Aquaculture's contribution to agriculture employment growth
	Employment multiplier**
	Total employment in aquaculture value chains
	Share of small-scale aquaculture value chain employment in total aquaculture value chain employment
<b>Labour income</b>	Share of aquaculture's labour income in total labour income
	Share of aquaculture value chain's labour income in total labour income
	Aquaculture's contribution to total labour income growth
<b>Foreign exchange</b>	Net foreign exchange earnings from aquaculture
<b>Productivity</b>	Aquaculture's labour productivity
	Aquaculture's land productivity
	Aquaculture's total factor productivity
<b>Food availability</b>	Share of aquaculture's protein supply in total protein supply
	Share of aquaculture's protein supply in total animal protein supply
	Aquaculture's direct protein supply (aquaculture production minus aquaculture exports)
	Ratio of aquaculture's net foreign exchange earnings to total value of food imports (indirect contribution to food availability)
<b>Food access</b>	Aquaculture value chain's contribution to labour income
	Aquaculture's average wage rate
	Wage level comparison between aquaculture and agriculture
	Total employment in aquaculture value chains
	Share of female employment in total aquaculture value chain employment

Source: Adapted from Cai *et al.* (2010).

\* The multiplier effect is defined here as the amount of added income or value added generated locally and/or nationally by an extra dollar of income or value added from aquaculture (see Cai *et al.* [2010] and Kassam [2013] for methodology). This report has highlighted the importance of capturing the whole value chain when assessing the services generated by aquaculture. The employment, wage and income effects in aquaculture value chains occur through backward and forward production linkages (e.g. from supplying aquaculture inputs and marketing outputs). Indirect effects not addressed in this report are the employment, wage and income effects of aquaculture in other sectors through consumption linkages. Consumption linkages occur when increased income from aquaculture stimulates demand for locally produced goods and services. The combined effect of both production and consumption linkages creates an economic multiplier effect that boosts local and national economic growth.

\*\* Similar to the value-added multiplier, the employment multiplier is defined as the increase in total employment for the entire economy corresponding to one extra job provided by aquaculture, and can be used to measure aquaculture's total contribution to employment (see Cai *et al.* [2010] for methodology).

TABLE 8  
**Indicators for monitoring the social and economic services of small-scale aquaculture to sustainable rural development**

SOCIAL/ECONOMIC SERVICE	INDICATOR
<b>Natural capital</b>	
Efficient use of materials and energy saving	Types and number of nutrient flows
Efficient use of water	Number of farm production uses of water
<b>Physical capital</b>	
Build up of SSA farms and farm assets in rural area	Number of small-scale aquaculture farms and farm areas increased over 3 years in the study area
Build up of rural physical assets	Types and number of rural infrastructure investments induced by small-scale aquaculture
More efficient use of built physical assets in rural area	Types and number of rural infrastructure investments induced not purposely for small-scale aquaculture but which benefit small-scale aquaculture
<b>Human capital</b>	
Food and nutrition security	Per capita annual consumption of fish in SSA household (only fish for their own small-scale aquaculture harvest.)
Seasonal food security	Season of the year when household relies more on their own harvest than on fish from other sources
<b>Financial capital</b>	
Household cash income	Percentage of cash income from small-scale aquaculture to total household cash income
SSA serves as a source of household economic security	Economic returns from small-scale aquaculture to household
Contribution to provincial economy	Percentage of economic value from small-scale aquaculture production to the value of production from all aquaculture in the province
<b>Social capital</b>	
Social participation	Percentage of farm households who are active members of small-scale aquaculture programs/ associations/ organizations
Women empowerment	Percentage of number of small-scale aquaculture farm activities in which women take the major decision-making role
Fostering social harmony	Number of small-scale aquaculture households that share fish products and other farm resources
	Number of activities in which farmers work together so as to improve the shared resources in the community (such as water system, roads and reservoirs)
Providing social safety net	Ratio of family labourers who previously worked solely or mainly in non small-scale aquaculture (including off-farm jobs) but now work in small-scale aquaculture (X) to total family labour (Y)

Source: Bondad-Reantaso and Prein, 2009.

contribution to the development of livelihood assets and forms of capital (natural, physical, financial, human and social).

While the national-level indicators can be seen to be “traditional” indicators, those for monitoring small-scale aquaculture can be seen as “sustainability” indicators (Bueno, 2009). Traditional indicators, such as income or wages, measure changes in one part of a system while sustainability indicators treat economic, social and environmental progress as interconnected and provide a more holistic

view and understanding of the sustainability of an entity such as a farm, a community or a commodity sector. Although this study has not focused explicitly on environmental and ecosystem services provided by aquaculture (these have been addressed elsewhere, e.g. Soto, Aguilar-Manjarrez and Hishamunda, 2008), social and economic services provided by aquaculture depend on aquatic ecosystems and a range of other natural resource inputs, and thus require continuous support from the natural resource base. Aquaculture also has the potential to have a negative impact on the natural resource base, reducing environmental quality and societal benefits. Thus, the success of aquaculture and the social and economic services it generates depend upon its ability to produce fish while also maintaining the sustainability of its resource base. The social, economic and environmental services of aquaculture are therefore closely connected, and indicators that reflect this connectedness are important.

It is hoped that the indicators suggested will be used to help monitor the aquaculture sector and assist local, regional and national policy-makers to account for the level of performance of the sector, understand the risks and the threats to the sector, and thereby assist in determining appropriate interventions, setting priorities and allocating resources. By incorporating sustainability indicators, an integrated and holistic approach to planning the development of the aquaculture sector, including small-scale aquaculture development, is possible.

The data required to measure many of the national level indicators in Table 7 can be gathered from national statistics supplemented by farm surveys (see Cai *et al.* [2010] for a full discussion of data sources and methodology).

The data needed to measure the indicators in Table 8 will require local farm-level / household surveys and a more holistic approach to research and data collection, i.e. participatory approaches, to understand local contexts and adapt indicators accordingly. Indicators also need to be able to capture negative impacts of aquaculture – social, economic and environmental, such as social conflict, gender inequality, risks such as low profits and financial loss from investing in aquaculture and environmental degradation.

It is important that indicators not only focus on the quantity of people affected by social and economic services generated by aquaculture but also the quality of those impacts. For example, while small-scale producers may be displaced by larger producers in global value chains, additional employment opportunities created along the value chain, including those for women, may appear to compensate this displacement if only numbers are taken into account. However, some of the country case studies have shown that the poor quality of employment, vulnerability to global trading conditions, and potentially adverse impacts on women is also a concern.

Future policy development will thus need to move beyond simple objectives of economic development and employment, and provide support to take advantage of the new opportunities for segmentation and innovative approaches to sustainable aquaculture; this to ensure that poor and small-scale stakeholders in aquaculture value chains are included in the growth of the sector in coming years.



**PLATE 5**  
Rice-fish culture in Indonesia. Photo credit:  
Miao Weimin, FAO

## 6. Conclusions and recommendations

This study has found that previous estimates of employment generated by the global aquaculture sector based on official statistics are likely to be underestimates. The study findings also suggest that employment generated at farm level is likely to be much higher than employment generated at other links in the value chain, and that the majority of fish farms are small-scale integrated household operations. Value chains oriented around small-scale producers were estimated to generate more employment than those from medium- and large-scale producers. Employment at farm level was also found to be much higher in small-scale value chains than in medium- and large-scale ones, although employment at other links along small-scale value chains is much lower than for medium- and large-scale ones. Overall, therefore, these findings indicate that aquaculture, particularly small-scale aquaculture, generates important social and economic services in the form of direct and indirect employment. These findings also highlight the importance of understanding the social and economic services generated throughout the whole aquaculture value chain and not just at the level of production. The study findings draw attention to the limited nature of available “official” data to be able to fully measure the social and economic services generated by aquaculture, and the need for more detailed and comprehensive data upon which to monitor the performance of the aquaculture sector and its social and economic services at a variety of levels, including the global, national, community and household levels.

Without accurate data, it is unlikely that aquaculture planning, policy development and resource allocation will provide the appropriate support to enable the sector to maximize its social and economic services, especially those generated by and beneficial to the small-scale aquaculture sector. Aquaculture planning and policies are likely to differ by country context and according to the stage of development of the aquaculture sector in these countries. For example, policies to support aquaculture development in countries in SSA, where aquaculture is just taking off, may well focus on supporting SMEs as a means of increasing national fish supplies as well as generating economic growth and employment. Countries in Asia, such as Bangladesh, where the aquaculture sector is developing and value chains are globalizing, may focus on supporting small-scale farmers to meet market requirements and certification standards while also facilitating the growth of SME commercial aquaculture as a way of generating employment along value chains. Policies may also focus on improving the quality of employment generated in value chains. The focus of policies will also depend on which social and economic services are priorities for those countries, whether they are increasing fish production and decreasing fish prices for national consumption, maximizing

foreign exchange earnings through exports or enhancing livelihoods of poor and small-scale producers being displaced by consolidation of export value chains. Regardless of national aquaculture policy priorities, accurate, comprehensive and disaggregated data on the aquaculture sector and its associated value chains are a necessary but not sufficient condition for effective policy development. The indicators suggested in this study provide a sound basis for data collection in the aquaculture sector.

An important priority, particularly for developing countries, should be to ensure the inclusion of poor and small-scale stakeholders in the development of the aquaculture sector, either directly through production or indirectly through value chain employment. While the globalization of value chains and demands for certification from global buyers appear to be marginalizing small-scale farmers in many countries, significant social and economic benefits could be generated by a small-scale sector that is able to participate effectively in certified export value chains. Thus, key recommendations are that small-scale farmers should be involved in the development of certification procedures, and standards and policies should be developed to support small-scale farmers to become certified. While this may seem unrealistic given the considerable constraints facing individual small-scale farmers, one approach that has had success in a number of countries is to provide support to, and promote group certification of, farmers organizations or clusters of farmers (Kassam, Subasinghe and Phillips, 2011). This approach can enable them to connect with lucrative export markets and take advantage of the growing interest of buyers in sourcing high-quality aquaculture products from small-scale farmers. Supporting the small-scale sector to access services, technical knowledge and training to utilize better management practices is also required in order to develop a sector that will be both productive and sustainable.

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# Appendix 1: Summary of aquaculture production and employment in case study countries and worldwide

Country	Aquaculture production (tonnes)	Employment at farm	Employment at other value chain links	Total employment
<b>Case study countries:</b>				
Viet Nam	2 233 000	1 744 900	900 056	2 644 956
Bangladesh	1 305 048	3 153 120	641 805	3 794 925
Thailand	1 370 000	217 883	145 190	363 073
Indonesia	4 780 100	2 797 005	1 215 258	4 012 263
Chile	870 000	49 694	27 375	77 069
Ecuador	159 976	109 085	96 820	205 905
Mexico	285 019	30 690	18 107	48 797
Egypt	705 490	157 991	79 000	236 991
Zambia	3 130	14 865	450	15 315
<b>Developing countries (extrapolation based on labour productivities estimated from the case studies):</b>				
P.R. China	32 735 944	26 737 463	9 806 810	36 544 273
India	3 478 690	2 841 261	1 042 122	3 883 383
Philippines	741 142	605 336	222 026	827 363
Myanmar	674 776	551 131	202 145	753 276
Republic of Korea	473 794	386 977	141 936	528 913
Taiwan Province of China	323 982	264 616	97 056	361 672
Brazil	290 186	41 811	31 402	73 213
Malaysia	243 081	198 539	72 821	271 360
Iran	154 979	126 581	46 428	173 008
Turkey	152 260	124 360	45 613	169 973
Nigeria	143 207	34 933	16 056	50 989
Pakistan	135 098	110 343	40 472	150 815
Rest of the world	1 539 669	1 087 891	410 700	1,498 591
<b>Total including P. R. China</b>	<b>52 798 571</b>	<b>41 386 474</b>	<b>15 299 648</b>	<b>56 686 122</b>
<b>Total excluding P.R. China</b>	<b>20 062 627</b>	<b>14 649 011</b>	<b>5 492 838</b>	<b>20 141 849</b>



**PLATE 6**  
Mollusc culture in Viet Nam. Photo credit:  
Rohana Subasinghe

## Appendix 2: Methodology for estimating the number of people employed in global aquaculture value chains

In order to extrapolate employment in global aquaculture, the study computed the labour productivity of the nine case study countries, the average labour productivity of these nine case study countries, and the average labour productivity of country groups representing Africa (Egypt and Zambia), Asia (Bangladesh, Indonesia, Thailand and Viet Nam) and Latin America (Chile, Ecuador and Mexico). Table 4 of the main report presents the estimated aquaculture labour and farm-level productivity of each case study country. Total labour productivity is the ratio of total aquaculture production in tonnes and the total number of people employed in aquaculture value chains. Farm-level labour productivity is the ratio of total aquaculture production in tonnes and the number of people employed at the farm level.

The values reported in Table 4 of the main report are used for extrapolating the level of employment in aquaculture value chains in other countries around the world. It is assumed that aquaculture employment in Africa, Asia and Latin America follows average employment patterns experienced in the case study countries in Africa, Asia and Latin America reported above. Using the estimates reported in Table 4, the number of people employed in the principal aquaculture-producing and developing countries in the three regions is extrapolated and presented in Appendix 1. As Asia dominates global aquaculture and also presents high heterogeneity in terms of industrial and aquaculture development, it is further assumed that the principal aquaculture-producing countries in Asia follow different employment patterns. Specifically, it is assumed that the Republic of Korea, Taiwan Province of China, and Malaysia follow Thailand's employment pattern / labour productivity, and other main aquaculture producers follow average "Asia" aquaculture employment patterns experienced in Asian case study countries.

By applying the average labour productivity of the nine case study countries and the average labour productivities of the country groups representing Africa, Asia and Latin America, it is estimated in Appendix 1 that, including China, there were about 56.7 million people employed along aquaculture value chains all over the world, of whom 41.4 million were employed at farm level, and 15.3 million at other links along aquaculture value chains. If China is excluded, total employment in global aquaculture value chains was about 20.1 million people,

of whom 14.6 million were employed at farm/production level and 45.5 million employed at other links in aquaculture value chains. Following FAO's assumption that each person employed in global aquaculture value chains comes from a different family and that each family has five members on average, it is estimated that about 206.9 million and 283.4 million people have livelihoods that depend on aquaculture at farm level and aquaculture value chains, respectively.

As China accounts for about 60 percent of world aquaculture production, its aquaculture employment pattern has a strong impact on total employment levels in world aquaculture. In the table in Appendix 1, it is assumed that China has an "Asia" average pattern of employment in aquaculture (labour productivity was estimated at 1.22 at farm level employment and 0.90 at the whole-value-chain employment level). With this assumption, using aquaculture production in China in 2008 reported by FAO (2010), total employment in aquaculture value chains in China is estimated at 36.5 million people, of whom 26.7 million and 9.8 million were employed at farm level and at other links along aquaculture value chains, respectively. However, if China's aquaculture labour productivity of 6 tonnes/FTE (FAO, 2010) and the Far East average indirect employment multiplier effect of 0.38 (Valderrama Hishamunda and Zhou, 2010) are used, the total number of people employed in aquaculture value chains in China is estimated to be about 7.5 million, of whom 5.5 million and 2.1 million are employed at farm level and at other links along value chains respectively. In this case, the estimate for total employment in world aquaculture value chains drops from 56.7 million to 27.7 million people, of whom 20.1 million employed at farm production level.

As China's aquaculture employment has a very strong bearing on global aquaculture employment estimates, and given the lack of good quality aquaculture employment data for China, there is a need for the China case to be thoroughly investigated. By assuming that aquaculture in China takes the employment pattern of "Asia's" average labour productivity estimated from the case studies in this report, it is probable the study is overestimating the number of people employed in aquaculture value chains in China. However, this number is likely to be underestimated if one adopts FAO's suggestion that aquaculture labour productivity in China is about 6 tonnes per person and employment multiplier is 0.38. It should also be noted that as the extrapolations in this report are based on labour productivities mainly based on all those employed (both full- and part-time), this lower estimate for China (which is based on full-time equivalent [FTE] labour productivity) leads to even more of an underestimate relative to other country estimates. This inconsistency between using FTE estimates for some countries and full- and part-time employment estimates for others is an unavoidable limitation due to a lack of good-quality country data for aquaculture employment.



This document provides some baseline information on the present status of the aquaculture sector, small-scale aquaculture sector in particular, from a human development perspective.

The research findings presented here are based on a global synthesis of information from various sources and 9 country case studies undertaken in Africa, Asia and Latin America. The

findings suggest that previous employment estimates of the global aquaculture sector based on official statistics are likely to be underestimates. Employment generated at farm level is found to be much higher than employment at other links in the value chain. The findings highlight the limited nature of available “official” data. A key recommendation of the study is that small-scale farmers should be involved in the development of certification procedures and appropriate standards and policies should be developed to support small-scale farmers to become certified. One approach that has had success in a number of countries is to support and promote group certification of farmer organizations or clusters of farmers. Supporting the small-scale sector to access services, technical knowledge and training to utilize better management practices is required in order to develop a sector that is productive and sustainable.