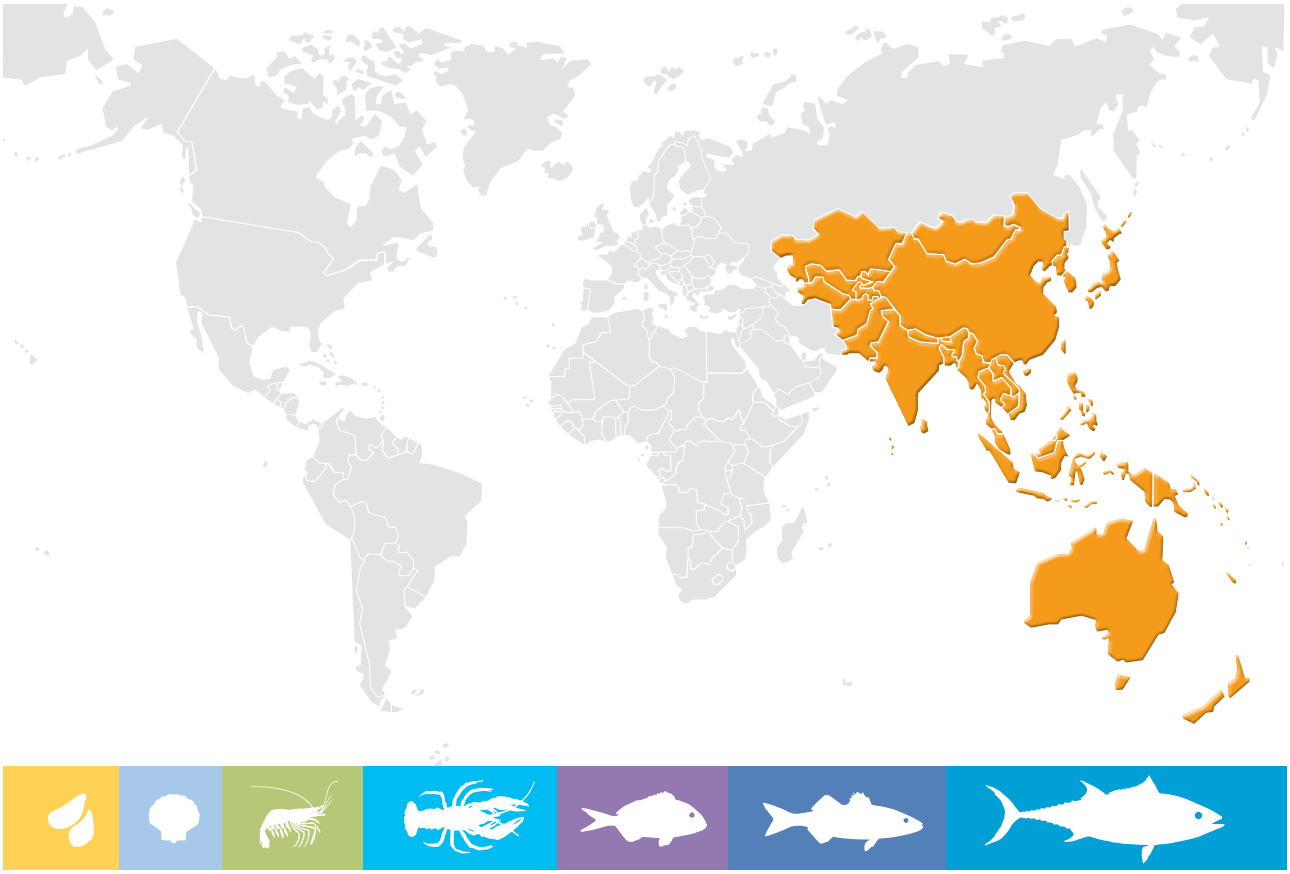
Food and Agriculture Organization of the United Nations

FIAA / C1135/5 (En)

FAO Fisheries and Aquaculture Circular

ISSN 2070-6065

REGIONAL REVIEW ON STATUS AND TRENDS IN AQUACULTURE DEVELOPMENT IN ASIA-PACIFIC – 2015



REGIONAL REVIEW ON STATUS AND TRENDS IN AQUACULTURE DEVELOPMENT IN ASIA-PACIFIC – 2015

by
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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2017

ISBN 978-92-5-109657-4

PREPARATION OF THIS DOCUMENT

The present document “Regional review on status and trends in aquaculture development in Asia-Pacific – 2015” was prepared by FAO/FIAA as one of the six regional reviews commissioned in 2016. The review was compiled by Rohana Subasinghe, an FAO Senior Consultant, and edited by Brian Harvey. Francis Chopin, Ruth Garcia, Mohammad R. Hasan, Weimin Miao and Melba Reantaso are acknowledged for their critical review of the document. Finalization of the document, including technical editing, review and linguistic quality, was carried out by Malcolm Beveridge (FAO/FIAA). Xiaowei Zhou, FIAS, developed the main FAO statistical datasets with different levels of details used for the analysis in the document, and provided clarification to specific questions that arose in the course of its writing. The document was edited and formatted in line with FAO house style by Danielle Rizcallah who also assisted in the preparation of the final layout.

FAO. 2017.
Regional review on status and trends in aquaculture development in Asia-Pacific – 2015, by Rohana Subasinghe. FAO Fisheries and Aquaculture Circular No. 1135/5. Rome, Italy.

ABSTRACT

Aquaculture is still the fastest growing food producing sector in the world. In 2014, aquaculture produced 73.8 million tonnes of aquatic animals, with an estimated first-sale value of US$160.2 billion and 27.3 million tonnes of aquatic plants worth US$5.6 billion. Almost all fish produced from aquaculture are destined for human consumption, although by-products may be used for non-food purposes. Thirty-five countries produced more farmed than wild-caught fish in 2014 and four top producers in Asia-Pacific, namely, the People's Republic of Bangladesh, the People's Republic of China, the Republic of India and the Socialist Republic of Viet Nam are included in this group. Historically, the Asia-Pacific region (in particular the People's Republic of China, South Asia and South-East Asia sub-regions) has dominated global aquaculture production, both in quantity and value; the region contributed 65.2 million tonnes of aquatic animals, amounting to 88 percent of the global total in 2014. The value of Asia-Pacific regional aquatic animal production in 2014 was 79 percent of the global total, amounting to US$127 billion.

Between 2010 and 2014, Asia-Pacific region registered 5.7 percent growth with notable negative annual percent rate of growth (APR) in both Other Asia and Oceania sub-regions. The production in Asia is expected to increase in order to meet the growing global and regional demand for fish in the coming decade. The sector will increase and improve its sustainability providing more and more aquatic food that is safer to eat, while providing significant social benefits with reduced environmental impacts.

In 2014, 84 percent of the global population engaged in the fisheries and aquaculture sector was in Asia. In terms of resources, Asian aquaculture still does not overly suffer from lack of major resources. Support services have been improving and kept phase with sectoral development. As the sector is continually being intensified, more and more advances and support services are necessary to increase sector efficiency. Intensification of aquaculture in Asia will continue in the coming decades. Over the past decade, intensification has decreased the use of land and freshwater per unit of farmed fish produced, but has also led to an increase in the use of energy and commercial aquafeed as well as an increase in water pollution per unit of farmed fish produced. In terms of consumption, it is apparent that more fish and shrimp are now consumed in Asia than ever. While this trend is continuing, the demand for improved high quality, nutritious, safer to eat and easy to cook (precooked) aquatic products will continue in the region.

Asia suffered serious disease outbreaks, particularly in the shrimp farming sector, during the last five years. It appears that for Asian aquaculture to be more efficient and sustainable, continuing efforts towards intensification of the sector should pay more attention not only to increasing resource efficiency but also to reducing environmental impacts to a minimum. If the benefits of aquaculture should also be made equitable it is paramount that both small-scale and large-scale aquafarmers and industrialists coexist, sharing profits and enjoying benefits. In a market economy world, this can only be achieved through better governance by enacting people-centred and poverty-addressing policies and regulatory frameworks.

While many countries in Asia-Pacific have made commendable efforts to set up policies, administrative, legal and regulatory frameworks to properly develop and manage aquaculture, some countries in the region still lag behind. And in some of the countries that have made conducive policies, their implementation is delayed by the lack of financial and skilled human resources. This issue must be addressed as a priority if the aquaculture sector in Asia-Pacific is to continue to develop sustainably.

For complementary views on aquaculture in the Region, please see the Report from the COFI Sub-Committee on Aquaculture, Brasilia, Brazil, 3–9 October 2015, available at the following link: www.fao.org/cofi/43341-04a74a5d167de0034251e8eaf83de443e.pdf

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
AHPND	Acute Hepatopancreatic Necrosis Disease
AMR	Antimicrobial Resistance
APEC	Asia-Pacific Economic Cooperation
APFIC	Asia-Pacific Fishery Commission
APR	annual percent rate of growth
BMPs	better management practices
BOB-IGO	Bay of Bengal Inter Governmental Organization
CACFish	Central Asian and Caucasus Regional Fisheries and Aquaculture Commission
CCRF	Code of Conduct for Responsible Fisheries
EEZs	exclusive economic zones
EHP	*Enterocytozoon hepatopenaei*
EIAs	Environmental Impact Assessments
EUS	Epizootic Ulcerative Syndrome
FAO	Food and Agriculture Organization of the United Nations
GAPs	Good Aquaculture Practices/Global Action Plan
GDP	gross domestic product
GEF	Global Environmental Facility
GIFT	Genetic Improvement of Farmed Tilapia
IEEs	Initial Environmental Examination
IFPRI	International Food Policy Research Institute
IMTA	integrated multitrophic aquaculture
IUU	Illegal, Unreported and Unregulated (Fishing)
MDGs	Millennium Development Goals
NACA	Network of Aquaculture Centres in Asia-Pacific
NGOs	Non-Governmental Organizations
OECD	Organisation for Economic Co-operation and Development
PICTs	Pacific Island Countries and Territories
PPP	Public, Private Partnership
RFMO	Regional Fisheries Management Organization
SDGs	Sustainable Development Goals
SEAFDEC	Southeast Asian Fisheries Development Center
SMEs	Small to Medium sized Enterprises
SPC	South Pacific Commission
SPF	specific pathogen-free
SPR	specific pathogen-resistant
SPS	sanitary phyto sanitary
TiLV	tilapia lake virus
UNDP	United Nations Development Programme
VAC	integrated garden [V], fishpond [A] and livestock [C] system
VASEP	Viet Nam Association for Sea Food Exports
WHO	World Health Organization
WTO	World Trade Organization

1. INTRODUCTION

Global production of aquatic animals and plants through aquaculture has been steadily increasing over the past three decades. Historically, Asia-Pacific region has dominated global aquaculture production, and this trend is continuing. Two comprehensive Asia-Pacific regional aquaculture reviews (APFIC, 2014 and FAO/NACA, 2011) and a global review of the status of fisheries and aquaculture (FAO, 2016a) have recently been published by FAO.

As these reviews are comprehensive and robust, the current review attempts to update the existing data, information and knowledge by appraising the regional and national trends during the period 2010 to 2015, as appropriate.

In keeping with the three recent reviews (APFIC, 2014; FAO, 2016a; FAO/NACA, 2011), and considering the diverse economic and development landscape of the Asia-Pacific region, the region has been geographically regrouped into five sub-regions for the current review. They are:

***South Asia*:** the People's Republic of Bangladesh, the Kingdom of Bhutan, the Republic of India, the Republic of Maldives, the Federal Democratic Republic of Nepal, the Islamic Republic of Pakistan and the Democratic Socialist Republic of Sri Lanka.

***Southeast Asia*:** Brunei Darussalam, the Kingdom of Cambodia, the Republic of Indonesia, the Lao People's Democratic Republic, Malaysia, the Republic of the Union of Myanmar, the Republic of the Philippines, the Republic of Singapore, the Kingdom of Thailand, the Democratic Republic of Timor-Leste and the Socialist Republic of Viet Nam.

***China*:** the People's Republic of China, China, Hong Kong Special Administrative Region, China, Macao Special Administrative Region and Taiwan Province of China.

***Other Asia*:** Japan, the Republic of Kazakhstan, the Democratic People's Republic of Korea, Mongolia, the Republic of Korea, the Kyrgyz Republic, the Republic of Tajikistan and the Republic of Uzbekistan.

***Oceania*:** American Samoa, Australia, the Cook Islands, the Republic of Fiji, French Polynesia, Guam, the Republic of Kiribati, the Republic of the Marshall Islands, the Federated States of Micronesia, the Republic of Nauru, New Caledonia, New Zealand, Niue, Territory of Norfolk Island, the Commonwealth of the Northern Mariana Islands, the Republic of Palau, the Independent State of Papua New Guinea, Pitcairn Island, the Independent State of Samoa, Solomon Islands, Tokelau, the Kingdom of Tonga, Tuvalu, the Republic of Vanuatu, and Wallis and Futuna Islands.

Oceania includes the 22 Pacific Island Countries and States (PICTs), the Independent State of Papua New Guinea, Australia and New Zealand. PICTs are, in particular, significantly different in both demography and economics from other Asian counties, Australia, New Zealand and the Independent State of Papua New Guinea. This fundamental difference is reflected in the disparity in regional aquaculture development. Thus, in this review, although the term Asia-Pacific is used to describe the region as a whole, where necessary and as applicable this disparity between the PICTs and the other countries has been addressed in the text.

This review of aquaculture status and trends covers the states, entities and areas of Asia and the Pacific region that report aquaculture statistics to the Food and Agriculture Organization of the United Nations (FAO), and is based on the data provided in the FAO FishStat database (FAO, 2016b).

2. SOCIAL AND ECONOMIC BACKGROUND OF THE REGION

The Asia-Pacific region is vast, varied and rich in development experiences. Consequently, the development challenges faced by the region are diverse. Although the impact of low economic growth in developed economies that started in 2008 lingers in the region, relatively strong economic growth was witnessed in the Asia-Pacific over the last decade. Significant increases in productivity, particularly in labour productivity, also took place throughout the region (ESCAP, 2016).

The population in Asia and the Pacific is growing at a rate less than one per cent per annum. In 2013, the total population of the Asia-Pacific region stood at 4.3 billion, which was 60 per cent of the world's population. The region hosts the two most populous countries in the world: the People's Republic of China with 1.4 billion people and the Republic of India with 1.25 billion people. Overall population growth in the region is slowing with an average growth rate of 0.96 per cent per annum in 2013 compared to the one percent growth during the first decade of the millennium; different speeds of population growth in the sub-regions are apparent (ESCAP, 2013).

The Asia-Pacific region stands out for its economic growth achievements, albeit in a somewhat uneven manner. Real per caput incomes in developing economies of the region have doubled on average since the early 1990s. Chinese per caput income has increased seven fold since 1990, while the Kingdom of Bhutan, the Kingdom of Cambodia and the Socialist Republic of Viet Nam tripled their per caput income during the same period (1990–2015). These impressive economic growths coupled with other policy changes have helped the region lift millions of its people out of extreme poverty – ahead of the 2015 Millennium Development Goals (MDGs) deadline – and reduced by half the proportion of people whose income is less than US$1.00 a day. With expectation of only a slight increase in economic growth rate in 2015 and 2016, the region has to be more vigilant in ensuring that it does not lose sight of the goals of reducing extreme poverty and working towards ensuring that the gains of prosperity are evenly shared. This is critically important; even during the high growth period there was pervasive, sharp and growing inequality of incomes and opportunities. Rural-urban and geographical gaps in socioeconomic development remain, and inequalities among women and men are enhancing the vulnerabilities of those on the margins of society (ESCAP, 2016).

The developing country economies of the Asia-Pacific region grew an average 7.6 percent a year between 1990 and 2010, far exceeding the 3.4 percent global average. The rise in affluence, in conjunction with growing populations (the latter at a reduced rate), continue to drive greater demand for more protein-rich food and better nutrition. This has enormous implications for the intensity of production. Food consumption in Asia and the Pacific has grown steadily, from 2 379 kilocalories per caput per day in 1990 to 2 665 in 2009. But some 733 million people in the region still live in absolute poverty (defined as living on less than US$1.25 a day, in 2005 purchasing power parity); 537 million remain undernourished. These are the two faces of Asia-Pacific – one of progress and prosperity, the other of continued poverty (ADB, 2013).

The region as a whole has registered a reduction in the proportion of the undernourished population from 22 percent in 1990–1992 to 13 percent in 2010–2012. If the trend continues, the region is likely to achieve target 1.C of the MDGs, which is to halve, between 1990 and 2015, the proportion of people who suffer from hunger (ESCAP, 2013).

According to OECD (2016), the size of the "global middle class" will increase from 1.8 billion in 2009 to 3.2 billion by 2020 and to 4.9 billion by 2030. The bulk of the growth will come from Asia: by 2030 Asia will represent 66 percent of the global middle-class population and 59 percent of middle-class consumption, compared to 28 percent and 23 percent respectively in 2009.

As the global population moves towards nine billion, it has been estimated that global food production must increase by at least 60 percent by 2030. The increase in food production includes an estimated 200 million tonnes of fish, mostly to be produced through aquaculture. According to World Bank (2013), in order to bridge the supply demand gap for aquatic foods in the world by 2030, global aquatic

animal production must almost double and the increase can only come from aquaculture. Since the bulk of food will be consumed in Asia in the coming decades, fish will continue to a major component of Asian diets in the coming decades.

Fisheries and aquaculture play an important role in Asia-Pacific regional economies and food security. For example, fisheries and aquaculture are important economic sectors in the Socialist Republic of Viet Nam, contributing nearly eight percent to the national gross domestic product (GDP). Aquaculture alone contributes over one percent to the GDP in the People's Republic of Bangladesh, the Republic of Indonesia and the Lao People's Democratic Republic. Fisheries and aquaculture together contribute about one percent to Chinese GDP and a little over one percent of the Thai GDP. However, the PICTs in the Oceania sub-region still lag in achieving the potential of aquaculture for improving national economies and food security, although capture fisheries is an important economic activity. Table 1 shows the estimated percent contribution of capture fisheries and aquaculture to the GDP of several Asia-Pacific countries.

Table 1. Estimated percent contributions of capture fisheries and aquaculture to the gross domestic product (GDP) in selected Asian countries, 2013–2014

Country	Capture*	Aquaculture
Bangladesh	0.382	2.807
China	0.208	0.730
Indonesia	0.441	1.187
Lao People's Democratic Republic	0.000	1.387
Malaysia	0.247	0.305
Philippines	0.436	0.750
Thailand	1.683	0.652
Viet Nam	4.030	3.853

*Capture values used the global commodities production exports values of 2013.
Source: World Bank (2016) and FAO (2016b).

Aquaculture has over three thousand years of history in the People's Republic of China and Asia has been contributing the lion's share to global production. This trend is continuing and is predicted to do so for the next decades. These aspects are dealt with in detail elsewhere in this review.

3. GENERAL CHARACTERISTICS OF THE SECTOR

3.1 Farming systems

As the region producing the lion's share of global aquaculture, Asia and the Pacific features an array of aquatic farming systems operated as extensive, semi-intensive and/or intensive production practices, in all major aquatic environments including freshwater, brackishwater and marine. Systems range from small-scale backyard-type low technology operations to sophisticated, high technology industrial ones, reflecting an increasing trend of modernization and intensification of aquaculture throughout the region. The aquaculture systems include ponds, cages, pens, raceways and other systems, depending on the species cultured and the availability of land and water in the locality. Pond culture has been the dominant production system in the region for most species of finfish and crustaceans (mostly shrimps and prawns).

The Asia-Pacific region reports a staggering list of 225 cultured organisms at the family or species level, indicating the diversity of the aquaculture sector in the region (APFIC, 2014):

- 33 molluscs
- 18 aquatic plants
- 129 finfish
- 31 crustaceans (crabs, shrimp prawns, lobsters, crayfish)

- 2 amphibians (frogs)
- 2 reptiles (turtles)
- 10 other invertebrates (jellyfish, sea urchins, sea cucumber)

Culture of freshwater fish (carps and especially tilapias) in cages is also common in some parts of the region (particularly in Southeast Asia). High technology industrial-level offshore cage systems have recently been introduced for culturing high value marine species such as Asian seabass/barramundi (*Lates calcarifer*), groupers (*Epinephelus* spp., *Cromileptes altivelis* and *Plectropomus leopardus*) and cobia (*Rachycentrum canadum*) in some Southeast Asian countries. However, offshore cage farming may not become widespread in Asia, as its development is clearly hampered by availability of local capital investment and the hydrography of the surrounding seas, which does not allow the technology to be easily transferred (De Silva and Phillips, 2007; FAO/NACA, 2011). Pond-based shrimp aquaculture practices are also being improved, and penaeid shrimp are now farmed in polystyrene-lined earthen ponds and/or indoor tanks, especially in the People's Republic of China. All these high technology systems require considerable capital investment, the availability of which has become a major constraint to the general intensification of aquaculture in the region.

In the Socialist Republic of Viet Nam, besides major traditional aquatic production systems, a small, highly productive integrated farming system called VAC (integrated garden [V], fishpond [A] and livestock [C] system) continues to be operated by small farm households. These systems are important for household and community food security and family income (FAO/NACA, 2011). Similar VAC-like systems are practiced in some islands of Oceania, for rearing tilapia and carps as monocultures or in polyculture, along with the staple root crop of taro, other vegetables and livestock. These integrated systems, which sometimes include giant river prawn *Macrobrachium rosenbergii*, play an important role in national food security in these island countries (FAO/SAP and SPC, 2010).

Integrated rice-fish culture is practiced in traditional freshwater agriculture systems in Southeast Asia, particularly in the People's Republic of China, the Republic of Indonesia and the Republic of the Philippines. In a few countries like the People's Republic of Bangladesh and the Socialist Republic of Viet Nam, alternate cropping of rice and shrimp is practiced in some coastal areas, maximising year-round productivity in keeping with the natural climatic conditions. In the People's Republic of Bangladesh, most shrimp (*Penaeus monodon*) farmers practice very low technology pond aquaculture with marginal unit production (less than 250 kg per ha per year). Some interesting results have emerged in the People's Republic of Bangladesh, demonstrating that clustering farmers into groups and empowering them with technical advice, better management practices (BMPs) and minimal financial support could increase production up to one tonne per ha per year.

Driven by the need to adapt to climate change and reduce greenhouse gas emission, integrated multitrophic aquaculture (IMTA) systems in the coastal areas of the People's Republic of China are being expanded. These systems include extensive culture of *Laminaria* seaweed, molluscs (abalone and scallops), sea cucumber and some other species low in the food chain, and are expected to contribute to climate change adaptation (FAO/NACA, 2011).

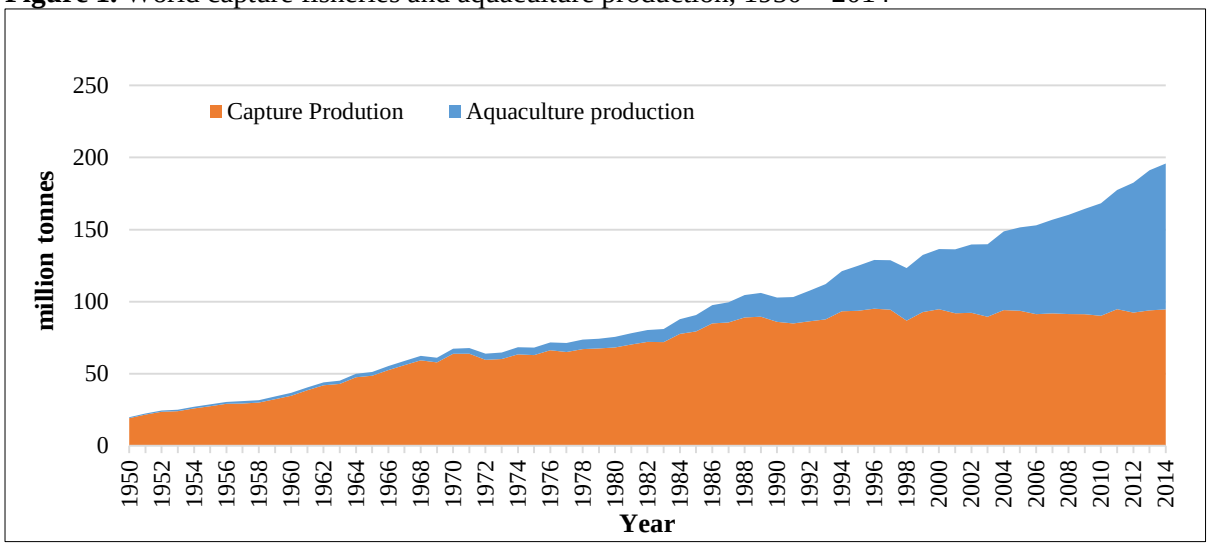
Global aquatic plant (mostly seaweed) production in 2014 was 27.3 million tonnes (a little over a quarter of the total aquaculture – animals and plants – production) valued at US$5.6 billion (less than 5 percent of the global total value). Once again, Asia is the main producer of seaweed in the world, with the Republic of Indonesia alone producing 10 million tonnes (FAO, 2016a).

Pacific Island Countries and Territories contribute small quantities of tilapia, shrimp, seaweed and several ornamental species (pearl oysters, giant clam, etc.) to Asia-Pacific regional aquaculture production.

3.2 Status and trends

With capture fishery production relatively static since the late 1980s, aquaculture has been responsible for the impressive growth in the supply of aquatic animal food for human consumption (Figure 1). Status and trends in aquaculture in Asia-Pacific are best regarded in the context of overall global production.

Figure 1. World capture fisheries and aquaculture production, 1950 – 2014

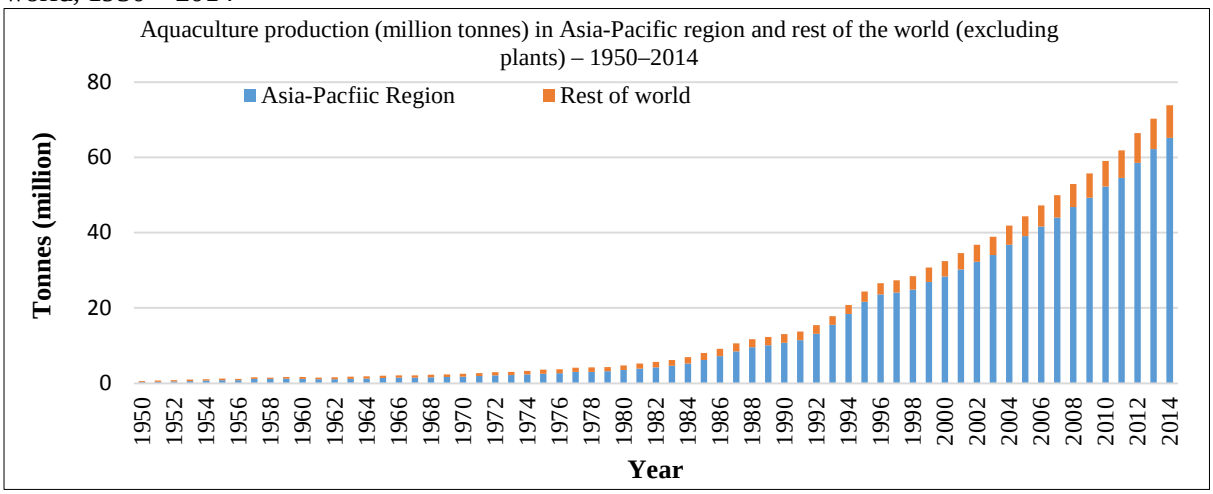


Source: FAO (2016b).

Total global capture fishery production in 2014 was 93.4 million tonnes, of which 81.5 million tonnes was from marine waters and 11.9 million tonnes from inland waters. Production of aquatic animals from aquaculture in 2014 amounted to 73.8 million tonnes, with an estimated first-sale value of US$160.2 billion. World aquaculture production of aquatic animals accounted for 44.1 percent of total production (including for non-food uses) in 2014, up from 42.1 percent in 2012 and 31.1 percent in 2004 (FAO, 2016a). Aquatic plant farming, overwhelmingly of seaweeds, has been growing rapidly and in 2014 world produced 27.3 million tonnes of seaweed (FAO, 2016b). In terms of global production volume, that of farmed fish and aquatic plants combined surpassed that of capture fisheries in 2013. FAO recently declared that, in terms of food supply, aquaculture provided more fish than capture fisheries for the first time in 2014 (FAO, 2016a). According to FAO (2016a), globally, all continents have shown a general trend of an increasing share of aquaculture production in total fish production, although in Oceania this share has declined in the last three years.

Historically, the Asia-Pacific region (in particular the People's Republic of China, South Asia and South-east Asia sub-regions) has dominated global aquaculture production, both in quantity and value; the region contributed 65 186 257 tonnes of aquatic animals, amounting to 88 percent of the global total in 2014 (FAO, 2016b). The value of Asia-Pacific regional aquatic animal production in 2014 was 79 percent of the global total, amounting to US$127 billion. As in the past, the Asia-Pacific region contributed significantly to the global total of seaweed by producing 27 million tonnes, valued at US$5.60 million (99 percent of the global value). Figure 2 shows the comparative trends in aquatic animal production through aquaculture in the world and Asia-Pacific region.

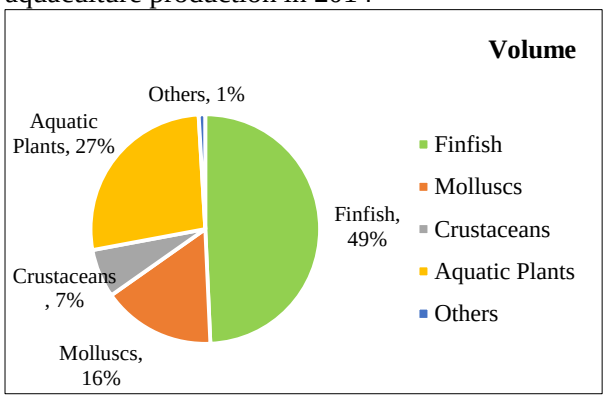
Figure 2. Aquaculture production (excluding aquatic plants) in Asia-Pacific region and the rest of the world, 1950 – 2014



Source: FAO (2016a).

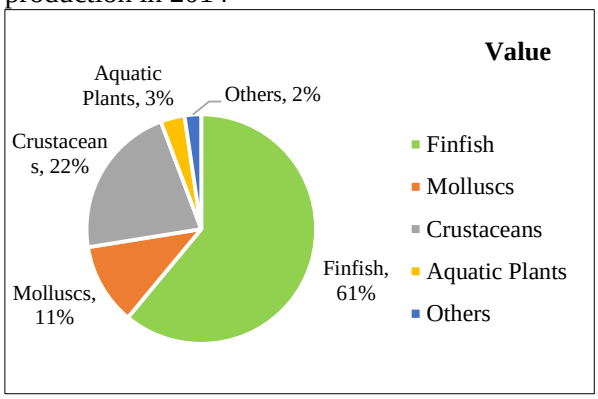
Global aquaculture production is divided into five main species categories: finfish, molluscs, crustaceans, aquatic plants and others. "Others" include amphibians and niche species. Figure 3 shows the comparative contribution of these five species categories to the global aquaculture production in 2014 by volume (Figure 3a) and by value (Figure 3b). Figures 4a and 4b provide the comparison of volume and value of the five aquatic species categories produced in Asia-Pacific region in 2014. Nearly 50 percent of the global aquatic animal production in 2014 was finfish, representing a little over 60 percent of the total value. In contrast, a little over 25 percent of seaweeds represents only 3 percent of the total value. It is also interesting to note the relative value of crustaceans (22 percent) against its relative volume (7 percent) in the global context.

Figure 3a. Contribution of different aquaculture species categories by volume to the global aquaculture production in 2014



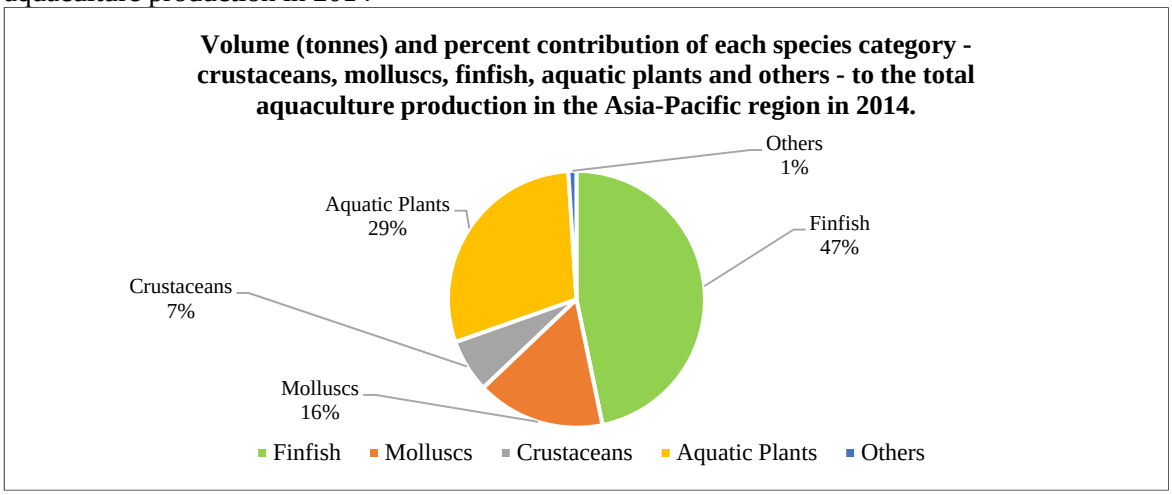
Source: FAO (2016a).

Figure 3b. Contribution of different aquaculture species categories by value to global aquaculture production in 2014



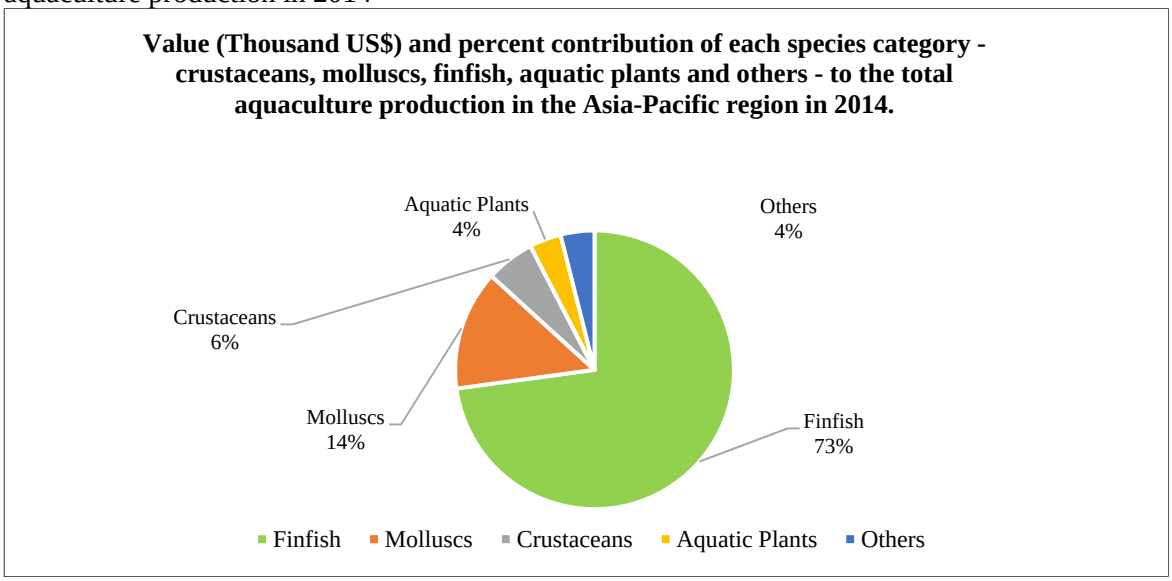
Source: FAO (2016a).

Figure 4a. Contribution of different aquaculture species category by volume to the Asia-Pacific aquaculture production in 2014



Source: FAO (2016a).

Figure 4b. Contribution of different aquaculture species categories by value to the Asia-Pacific aquaculture production in 2014



Source: FAO (2016a).

In 2014, the relative volumes and values of aquaculture species categories in the Asia-Pacific region generally reflected their world status (Table 2).

Table 2. Contribution of different aquaculture species categories by volume (million tonnes) and value (billion US$) to the Asia-Pacific regional aquaculture production over the past 25 years

Category	1990		2000		2010		2014	
	Volume	Value	Volume	Value	Volume	Value	Volume	Value
Finfish	7.25	11.61	17.95	21.18	33.42	56.21	43.16	72.25
Molluscs	2.87	2.78	8.77	7.64	12.93	11.62	14.94	13.79
Crustaceans	0.62	1.77	1.51	2.88	4.98	5.62	6.15	5.59
Aquatic plants	3.71	0.06	9.21	0.50	18.84	3.07	27.14	3.66
Others	0.05	0.68	0.16	0.92	0.88	3.31	0.94	3.89
Total	14.49	16.90	37.60	33.12	71.05	79.82	92.33	99.17

Source: FAO (2016a).

Table 3. Aquaculture production(excluding aquatic plants) in the Asia-Pacific region, 2014

Countries	Production (tonnes)
China	**45 470 943**
India	4 881 019
Indonesia	4 298 290
Viet Nam	3 397 064
Bangladesh	1 956 925
Myanmar	962 156
Thailand	934 758
Philippines	788 029
Japan	657 020
Republic of Korea	480 394
Taiwan Province of China	339 609
Malaysia	275 682
Pakistan	148 381
Cambodia	120 055
New Zealand	109 874
Lao People's Democratic Republic	108 360
Australia	74 914
Democratic People's Republic of Korea	64 150
Nepal	43 400
Sri Lanka	34 211
Uzbekistan	24 020
Singapore	4 971
China, Hong Kong SAR	3 897
Papua New Guinea	2 150
French Polynesia	2 087
New Caledonia	1 656
Brunei Darussalam	711
Tajikistan	444
Kazakhstan	410
Fiji	220
Bhutan	134
Guam	110
Vanuatu	80
Timor-Leste	56
Northern Mariana Islands	26
American Samoa	20
Palau	11
Cook Islands	8
Samoa	6
Tuvalu	3
Kiribati	2
Solomon Islands	2
Marshall Islands	1
Tonga	0
Nauru	0
Micronesia (Federated States of)	0

Source: FAO (2016b).

It is worth noting the massive aquaculture growth in the Asia-Pacific region, increasing its volume of aquatic production from a mere 14.5 million tonnes in 1990 to an impressive 92.0 million tonnes in 25 years. All species categories have shown the same increasing trend during the period.

3.2.1 Relative contributions of countries: the People's Republic of China

Because the Asia-Pacific region is so large (fifty countries/states) with economic, cultural and demographic differences as well as different priorities for aquatic production and consumption, there are significant differences in aquatic production among countries (Table 3). There are five countries in the Region that produce over a million tonnes of aquatic animals a year. The People's Republic of China produced 69.7 percent of the Asia-Pacific regional production in 2014 while 22.3 percent was produced by the next four countries in the list (the Republic of India, the Republic of Indonesia, the Socialist Republic of Viet Nam and the People's Republic of Bangladesh). For decades, the People's Republic of China has been contributing the lion's share of aquaculture production, of both animals and plants, in the region (Table 4 and Figure 5).

The People's Republic of China's contribution to Asia-Pacific regional aquaculture production, by volume, increased from 8.3 million tonnes in 1990 to 59 million tonnes in 2014. Although the Chinese aquaculture production by volume increased over the past 25 years, the People's Republic of China's percentage contribution to the Asia-Pacific regional production declined from 75 percent in 2000 to 64 percent in 2014.

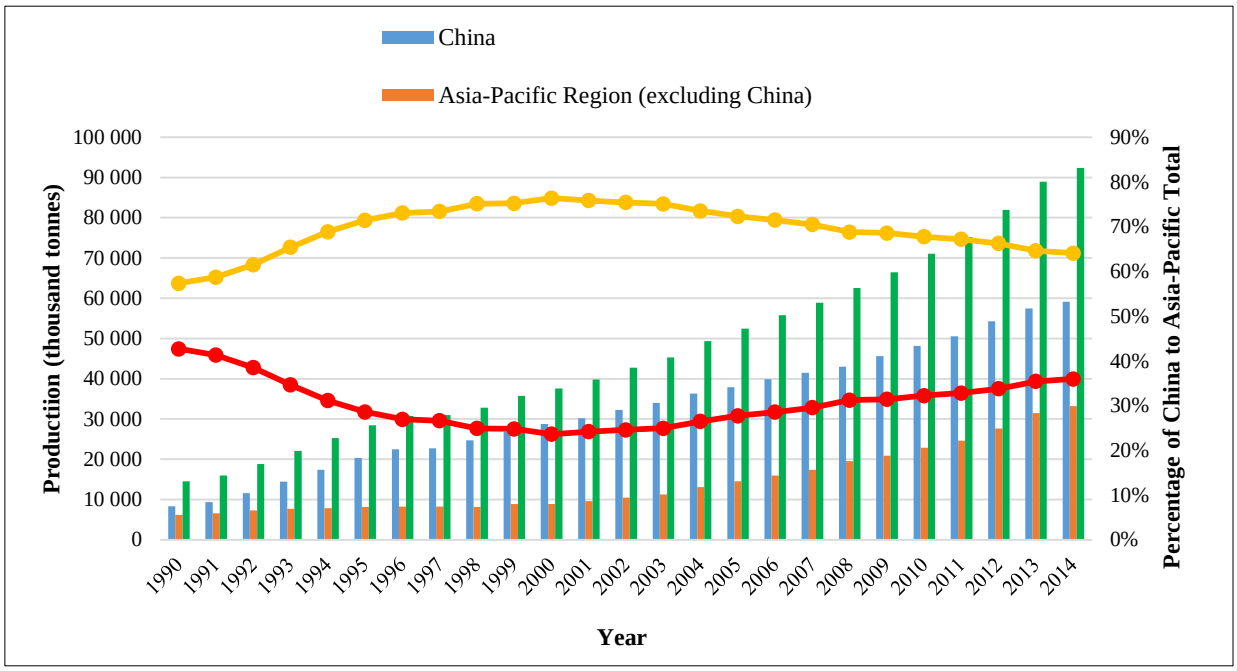
In terms of species categories, the People's Republic of China's finfish contribution to the region fell from 78 percent in 1998 to 64 percent in 2014. Aquatic plants fell from 76 percent in 2003 to 49 percent in 2014. Although mollusc production contribution has been nearly static, Chinese shrimp production increased its contribution to the region, despite the disease epizootics that occurred during the past few years (Figure 6). This downward trend of relative contribution over the past 15 years has been due to declining production of certain species (aquatic plants and freshwater finfish – carps) in the People's Republic of China.

Table 4. Contribution of the People's Republic of China to Asia-Pacific regional aquaculture production by volume (million tonnes) from 1990 to 2014

Region/Country	1990	2000	2010	2014
Asia-Pacific	6.18	8.88	22.91	33.18
China	8.31	28.72	48.15	59.14
Total	14.49	37.60	71.65	92.33

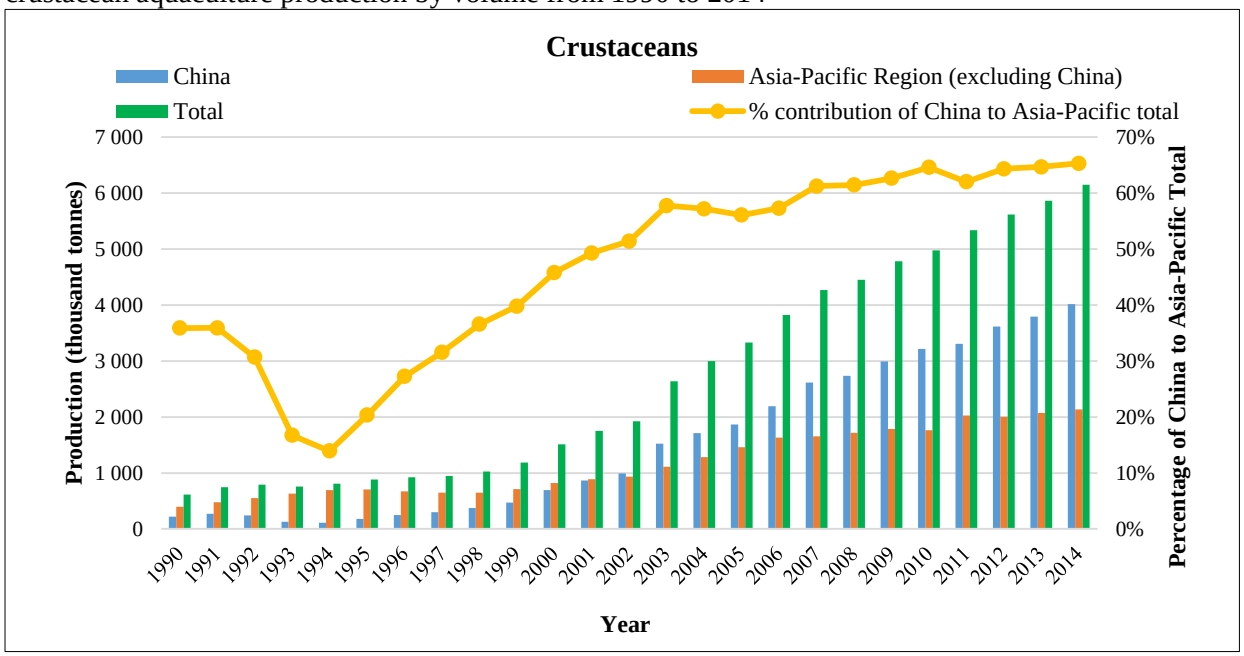
Source: FAO (2016b).

Figure 5. Contribution of the People's Republic of China to Asia-Pacific regional aquaculture production by volume from 1990 to 2014



Source: FAO (2016b).

Figure 6. Contribution of Chinese crustacean aquaculture production to Asia-Pacific regional crustacean aquaculture production by volume from 1990 to 2014



Source: FAO (2016b).

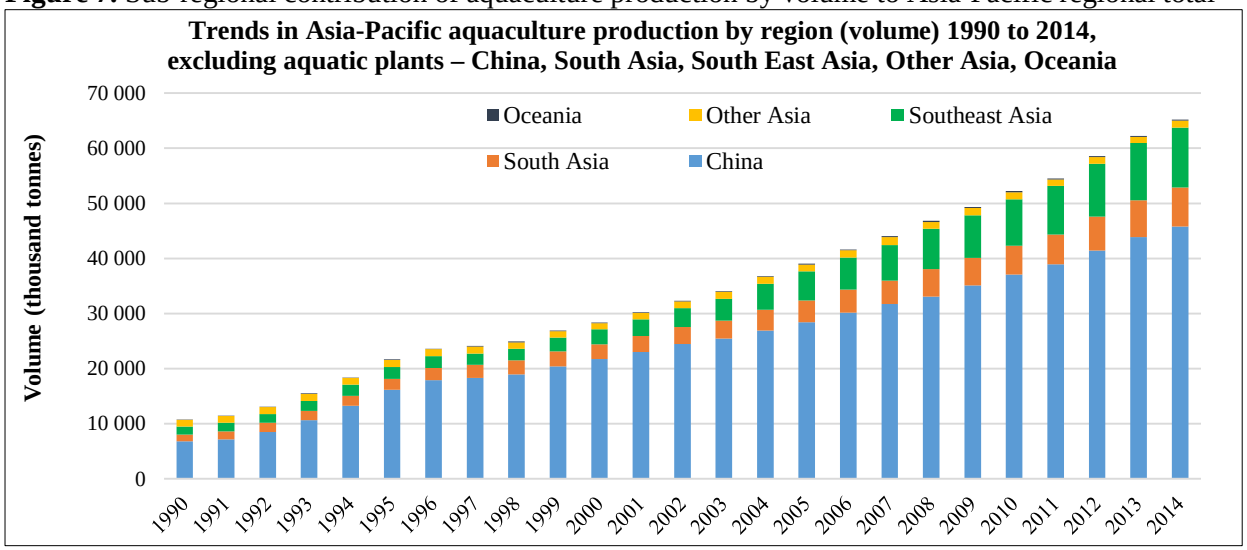
In 2014, the People's Republic of China contributed 59 million tonnes valued at US$77 billion to the Asia-Pacific regional total (64 percent in volume and 61 percent in value). Table 5 presents the top 10 global aquaculture producers (excluding aquatic plants) in 2014. Asia-Pacific accounts for seven of those 10 countries. Although seven countries in Asia-Pacific are listed among the top 10 aquaculture producers in the world, sub-regional production within Asia-Pacific is highly variable (Table 6). Figures 7 and 8 show the trends in sub-regional contributions to Asia-Pacific aquaculture production (excluding aquatic plants) by volume (Figure 7) and by value (Figure 8) during the past 25 years.

Table 5. Top 10 aquaculture producers in the world by value and volume

Country	Value (million US$)	Country	Volume (thousand tonnes)
China	73 296	**China**	45 471
India	10 768	**India**	4 881
Chile	10 276	**Indonesia**	4 298
Indonesia	8 915	**Viet Nam**	3 397
Viet Nam	7 173	**Bangladesh**	1 957
Norway	7 068	**Norway**	1 332
Bangladesh	4 853	**Chile**	1 215
Japan	3 728	**Egypt**	1 137
Thailand	2 636	**Myanmar**	962
Egypt	2 025	**Thailand**	935
Other	29 645	**Other**	8 247
Total	160 383	**Total**	73 832

Source: FAO (2016b).

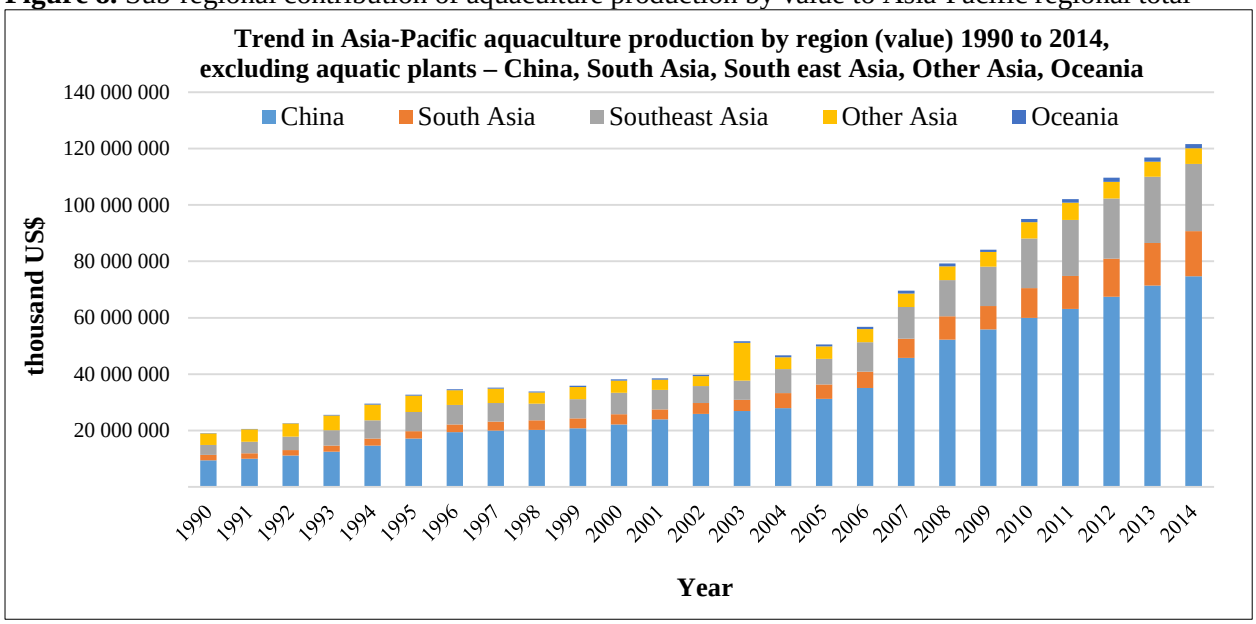
Figure 7. Sub-regional contribution of aquaculture production by volume to Asia-Pacific regional total



Source: FAO (2016b).

It is clear that the overall contribution of Chinese aquaculture to Asia-Pacific regional production has been declining over the past fifteen years. However, as species categories, percentage share of Chinese crustaceans and other species in Asia-Pacific regional production is still increasing, although a slight decrease is registered in 2012 and 2013 due to the outbreak of AHPND (Acute Hepatopancreatic Necrosis Disease) in whiteleg shrimp aquaculture. The main reason for the general decline in Chinese contribution to the Asia-Pacific regional production appears to be the continuing increase in aquaculture production in the South and Southeast Asian sub-regions. South and Southeast Asia are important regions, which contribute 7 and 22 percent in volume to Asia-Pacific regional production. As mentioned earlier, the contribution of Oceania to regional production has not been impressive (Table 6).

Figure 8. Sub-regional contribution of aquaculture production by value to Asia-Pacific regional total



Source: FAO (2016b).

Table 6. Asia-Pacific sub-regional percent contribution to regional production by volume

Region/Sub-Region/Country	1990	2000	2010	2014
China	8.31	28.72	48.15	59.14
South Asia	1.23	2.63	5.27	7.07
Southeast Asia	1.80	3.67	14.38	22.78
Other Asia	3.09	2.43	3.04	3.12
Oceania	0.05	0.14	0.21	0.22
Asia-Pacific Total	14.49	37.60	71.05	92.33

Source: FAO (2016b).

Positive overall growth of aquaculture (5.7 percent) was registered in Asia-Pacific region during 2010–2014. It is interesting to note the significantly reduced APR (annual percentage rate) in Southeast Asia, possibly owing to the reduction in shrimp production due to disease outbreaks witnessed during the past five years (Table 7). The People's Republic of China increased its APR to 7.6 percent during 2010–2014, an almost one percent increase from that of 2006–2010. However, Other Asia and Oceania both showed negative growth. The overall regional growth decline of 0.12 percent during the past five years may have resulted in the decreased APR in Other Asia and Oceania.

Table 7. Rates of growth of aquaculture (excluding aquatic plants) in different sub-regions of the Asia-Pacific region between 2010 and 2014

Region/Sub-region/Country	APR (2001–2005)	APR (2006–2010)	APR (2010–2014)
South Asia	5.44	5.30	5.45
Southeast Asia	14.63	9.85	6.60
China	7.98	5.68	7.60
Other Asia	1.83	-0.99	-0.78
Oceania	7.30	4.11	-0.07
Asia Pacific Region	6.60	5.82	5.70

Source: FAO (2016b).
APR = year X to year Z = [(value in year Z/value in year X) ^ (1/N)-1] x 100

It is also interesting to note the unprecedented decline of Other Asia's contribution to regional total, from 21 percent in 1990 to 3 percent in 2014 (Table 8).

Table 8. Percentage contribution of aquaculture production (volume and value) by the sub-regions to the Asia-Pacific total

Region/Sub-Region/Country	1990		2000		2010		2014	
	%Vol	%Val	%Vol	%Val	%Vol	%Val	%Vol	%Val
China	57	33	76	46	68	50	64	49
South Asia	8	3	7	5	7	3	8	9
Southeast Asia	12	22	10	23	20	28	25	27
Other Asia	21	41	6	24	4	17	3	12
Oceania	0	1	0	2	0	3	0	3
Asia-Pacific Total	100	100	100	100	100	100	100	100

Source: FAO (2016b).

The Asia-Pacific region, Asia sub-region in particular, remains an important production area for aquaculture, showing a steady growth in all culture environments. Inland aquaculture production tripled from 10.8 million tonnes in 1994 to 43.3 million tonnes in 2014 and marine production increased by over 5.4 percent APR (7.6 million tonnes in 1994 to 21.9 million tonnes in 2014 over the same period). These increases far exceed the growth of aquaculture in the rest of the world. The rates of growth of aquaculture (animals only) between 2000 and 2014 in different environments (freshwater, brackishwater and marine) are 6.3, 7.0 and 3.9 respectively (FAO, 2016b).

Oceania's total aquaculture production amounted to 186 759 tonnes worth US$1.2 billion in 2012. There was a slight decrease in production from 2010 to 2012 (0.53 percent in volume) but over the last ten years (2002 to 2012) there was an average yearly growth of 4.43 percent. Oceania's production is dominated by the production of high value molluscs together with freshwater and diadromous fish. The biggest producers by far in 2012 were New Zealand (100 161 tonnes) and Australia (80 004 tonnes). Third in the sub-region is French Polynesia with a production of 2 654 tonnes in 2012 (APFIC, 2014).

3.2.2 Production by species

Table 9. Top 15 culture species in the Asia-Pacific region in 2014 by quantity (thousand tonnes) excluding aquatic plants

Inland waters		Marine waters	
Grass carp (=white amur)	5 498	Cupped oysters nei	4 371
Silver carp	4 822	Japanese carpet shell	3 974
Common carp	3 860	Whiteleg shrimp	2 260
Bighead carp	3 231	Scallops nei	1 649
Catla	2 770	Marine molluscs nei	1 134
Carassius spp	2 768	Milkfish	977
Nile tilapia	2 617	Sea mussels nei	806
Roho labeo	1 670	Constricted tagelus	787
Pangas catfishes nei	1 615	Giant tiger prawn	629
Chinese mitten crab	797	Pacific cupped oyster	494
Wuchang bream	783	Blood cockle	461
Tilapias nei	761	Sea snails	233
Torpedo-shaped catfishes nei	760	Freshwater fishes nei	
Whiteleg shrimp	721	Japanese sea cucumber	
Red swamp crawfish	660	Yesso scallop	217
Freshwater fishes nei	*2 034*	*Marine fishes nei*	*690*

Source: FAO (2016b).

In 2014, grass carp and silver carp accounted for more than ten million tonnes in freshwater sector; cupped oyster and Japanese carpet shell oyster accounted for over eight million tonnes in marine sector. Table 9 shows the top fifteen cultured species in Asia-Pacific region by quantity. The top five species produced in the sub-regions of Asia-Pacific are given in Table 10. The People's Republic of China produced 5.3 million tonnes of grass carp while South Asian production was topped by Indian major carp species *Catla catla* (catla) and *Labeo rohita* (rohu) with production of 3.6 million tonnes, mainly in the Republic of India. Southeast Asian production was dominated by pangasiid catfishes (striped/tra catfish [*Pangasianodon hypophthalmus*] and basa catfish [*Pangasius bocourti*]) (1.6 million tonnes), while the sub-region also recorded 1.3 million tonnes of tilapias.

Table 10. Top five species production in the Asia-Pacific sub-regions in 2014

	Top five Species	2014 (tonnes)
China	Grass carp (=white amur)	537 7965
	Cupped oysters nei	435 269 4
	Silver carp	422 604 6
	Japanese carpet shell	396 705 1
	Bighead carp	320 382 5
Southeast Asia	Pangas catfishes nei	161 621 5
	Nile tilapia	139 282 4
	Whiteleg shrimp	108 592 7
	Milkfish	969 787
	Freshwater fishes nei	851 268
South Asia	Catla	269 998 7
	Roho labeo	107 363 3
	Silver carp	556 821
	Freshwater fishes nei	539 126
	Mrigal carp	3714 77
Other Asia	Pacific cupped oyster	283 232
	Yesso scallop	192 300
	Pacific cupped oyster	184 100
	Japanese amberjack	135 800
	Silver seabream	615 00
Oceania	New Zealand mussel	97 438
	Atlantic salmon	41 591
	Flat and cupped oysters nei	11 403
	Chinook salmon	10 840
	Southern bluefin tuna	7 544

Source: FAO (2016b).

Although tilapia production is disaggregated into Nile tilapia and tilapia nei (other tilapia species) in the FAO database, as a group, tilapia was the fourth highest species (3.38 million tonnes) produced in Asia-Pacific in 2014 (Table 11). The People's Republic of China and the Republic of Indonesia produced over 50 percent of this group, amounting to 2.7 million tonnes. In the brackishwater/marine sector, production of *P. vannamei* (whiteleg shrimp) has increased from 1.27 million tonnes in 2008 to 2.30 million tonnes in 2014, the highest production in the region in history. Ranking and composition of species produced in 2014 in Asia-Pacific remains the same as in 2008.

Table 11: Top eight tilapia-producing countries in the Asia-Pacific region, 2014

Country	Production (tonnes)
China	1 698 483
Indonesia	1 040 594
Bangladesh	283 937
Philippines	259 198
Viet Nam	244 483
Thailand	188 946
Taiwan Province of China	69 726
Myanmar	47 699

Source: FAO (2016a).

There are six species of marine finfish cultured in Oceania, with Atlantic salmon being the most important. All of this production was from Tasmania, Australia, where some large and modern salmon farms operate. Second was chinook (spring or king) salmon (*Oncorhynchus tshawytscha*) and thirdly barramundi or giant seaperch (*Lates calcarifer*). There is also some production of freshwater and diadromous finfish, including Nile tilapia (*Oreochromis niloticus*), freshwater fish nei, common carp (*Cyprinus carpio*) and silver perch (*Bidyanus bidyanus*).

Special note on Oceania

Considering the vast diversity of economies in the Asia-Pacific, it may be opportune to consider the Pacific sub-region (Pacific Island Countries and Territories – PICTs) in two blocks when discussing fisheries and aquaculture issues. The first includes Australia, New Zealand, French territories (French Polynesia, New Caledonia, Wallis and Futuna Islands) and United States of America Territories (American Samoa, Guam, the Commonwealth of the Northern Mariana Islands); the second includes other countries and islands.

In examining aquaculture production in PICTs, it is clear that both French and United States of America territories enjoy a high degree of economic support from France and the United States of America, including large subsidies targeting aquaculture. The Independent State of Papua New Guinea should perhaps also be considered separately due to its relatively large population (over twice as many people as all the other 21 countries of the region combined). Australia and New Zealand are the developed countries of the sub-region and their economies are distinctly different from those of the developing countries of the sub-region. Clearly, these islands and territories have aquaculture conditions that are very different to the rest of the region.

Aquaculture interests and aspirations of the islands of the Pacific seem to be high although production in most Pacific Island Countries and Territories (PICTs) is still marginal. Two French territories were responsible for over 93 percent of the value of all aquaculture production in the region in 2014 (Gillett, 2016). French Polynesia produced pearls worth US$87.9 million while New Caledonia produced shrimp worth US$17.9 million. The total value of Pacific sub-regional aquaculture production in 2014 was US$116 005 524, about 3.6 percent of the value of all fisheries and aquaculture in the sub-region (Gillett, 2016).

Gillett (2016) described several Pacific islands as “atypical islands”, due to the high degree of economic support by France and substantial French subsidies targeting aquaculture. If the few atypical islands and the Independent State of Papua New Guinea are eliminated, the remaining “typical Pacific islands” produce significant volumes from aquaculture, from a limited range of species such as blacklip pearl (*Pinctada margaritifera*), shrimps (*Penaeus monodon*, *P. vannamei* and *P. stylirostris*), giant clams (*Tridacna* spp. and *Hipoppus* spp), red seaweed (*Kappaphycus alvarezii*), tilapia (*O. niloticus*), milkfish (*Chanos chanos*), groupers (*Epinephelus* spp.) and hard and soft corals. Gillett (2016) identified a number of notable features regarding the status of PICTS:

- aquaculture production is significant (i.e. worth more than US$50 000) in only about half of PICTs;
- five countries or territories have aquaculture production worth more than US$1 million, with three of those being the aforementioned atypical ones; and
- giant clam culture is important in the sub-region, but several producers have the perception that over-production from subsidised operations in French Polynesia is placing a major constraint on the trade (Gillett, 2016).

The contribution of aquaculture to PICTS regional GDP in 2007 was 12 percent (Gillett, 2009). Although it appears unrealistic, the contribution in 2010 was reported as 22 percent by Ponia (2010).

Fish and vegetable production using aquaponics is attracting more attention among SPC member countries and territories in the Pacific Islands. Because there is not yet much of a track record with aquaponics under local conditions, it can be difficult for people not familiar with the subject to separate fact from fad and make sound decisions (SPC Aquaculture Portal, 2014).

Some PICTs are engaged in successful pearl culture, which, although not directly contributing to food security supports livelihoods of many. The region specializes in black pearls, which come from the blacklip pearl oyster, *Pinctada margaritifera*. French Polynesia dominates the market at the moment, and earns significant income annually, making pearls its second largest earner after tourism. The

Cook Islands has an established industry and the Republic of Fiji and the Kingdom of Tonga are also involved in pearl production.

Special note on Central Asia (Other Asia)

Although the total fish production in the in the five Central Asian republics had started to show signs of recovery and development in the recent past, their total inland fisheries and aquaculture production still accounted for a negligible share in global inland and aquaculture productions. Changes in aquaculture species diversity have been small and the main aquaculture species continue to be common carp, grass carp, silver carp, bighead carp and black carp.

It has been recognized that the Central Asian region needs technological infrastructure improvements and capacity building for sustained development through efficient institutional and operational frameworks, which might be facilitated through regional cooperation. In an effort to develop fish production through aquaculture and inland fisheries, the Central Asian and Caucasus Regional Fisheries and Aquaculture Commission (CACFish), a Regional Fisheries Management Organization (RFMO), was established in 2010 under article XIV of the FAO Constitution to promote the development, conservation, rational management and best utilization of living aquatic resources, as well as the sustainable development of aquaculture in Central Asia and the Caucasus.

3.3 Highlights of regional and sub-regional trends in aquaculture production in the Asia-Pacific region

- Asia-Pacific aquaculture production (animals and plants) continued to increase from 37.6 million tonnes in 2010 to 92.3 million tonnes in 2014.
- Asia-Pacific aquaculture production (excluding aquatic plants) continued to increase from 28.4 million tonnes in 2010 to 65.2 million tonnes in 2014.
- Total value of Asia-Pacific regional aquaculture (aquatic plants and animals) in 2014 was US$127.2 billion.
- The annual percent rate of growth (APR) of aquaculture (excluding aquatic plants) in the region between 2010 and 2014 was 5.7.
- Southeast Asia recorded the highest annual percent rate of growth (7.6) of aquaculture (excluding aquatic plants) between 2010 and 2014.
- The People's Republic of China's percentage contribution to the regional production (excluding aquatic plants) reduced from 77 percent in 2010 to 70 percent in 2014.
- Five countries in the region produced over a million tonnes of aquatic animals in 2014.
- Seven out of the ten highest aquaculture producers in the world are in the Asia-Pacific region.
- Much of the aquaculture growth in South Asia is based on freshwater species while Southeast Asian culture growth has been based on shrimps and catfishes (mainly pangasiid catfish species).
- Annual percent rate of growth of aquaculture in the People's Republic of China during 2010-2014 (7.60 percent) nearly regained the APR during 2001–2005 (7.98 percent), after a reduced rate of growth during 2006–2010 (5.68 percent).
- The People's Republic of China produced 1.7 million tonnes of tilapia in 2014 to remain as the world leader.
- Southeast Asia's growth continued to be dominated by seaweeds followed by molluscs and high-value marine finfish.
- Oceania, while registering negative APR, produced 0.19 million tonnes of aquatic animals in 2014. This production mostly came from New Zealand and Australia.
- South Asia's aquaculture production has seen major increases in the last 25 years, from 1.1 million tonnes in 1988 to 7.1 million tonnes in 2014. The majority of production comes from freshwater herbivorous finfish.
- Shrimp production in the People's Republic of China and Southeast Asia declined during 2010–2013 due to an outbreak of a new disease, AHPND. Production in the People's Republic of

China, the Kingdom of Thailand, Malaysia and the Socialist Republic of Viet Nam are now achieving almost pre-AHPND levels.

- The production of aquatic plants has shown strong growth. *Kappaphycus* sp. is still the most widely cultured aquatic plant in the region, with a production of 9 million tonnes in 2014.
- Highest seaweed-producing countries in the region are the Republic of Indonesia and the Republic of the Philippines.
- Highest production of shrimp in the region was recorded in 2014, owing to an increase of *P. vannamei* (whiteleg shrimp) production between 2008 and 2014 by about a million tonnes.
- No notable change in top culture species in the region.

3.4 Outstanding issues and success stories

Aquaculture development in Asia is a success story, although very few PICTS have reached the level of their Asian counterparts. The sector in Asia progressively improved and matured over the past four decades and has remained ahead of the rest of the world. Use and utilization of land and water in different environments has been impressive. Species composition in Asia-Pacific aquaculture is diverse, reflecting the huge regional diversity. Research into aquaculture and the application of scientific findings in practice has improved massively, with strong private sector participation. Environmental impacts of aquaculture in Asia-Pacific have been reduced significantly and sectoral sustainability, shrimp aquaculture in particular (Portley, 2016), has been increased significantly. The sector is being intensified, looking for higher per unit productivity and reduced costs of production.

There are several outstanding issues concerning the future. There is a need to accelerate the development and expansion of mariculture in the region. Mariculture sector growth is not as impressive as that of freshwater finfish and crustaceans. The major reasons include (a) insufficient hatchery-produced seed; (b) lack of affordable formulated feed; (c) inadequate investment; and (d) low levels of technology transfer, state priority and patronage. Although Asia produces nearly 90 percent of global aquaculture, the efficiency of aquaculture is low and this should be improved through intensification and applying novel technologies. There is a need to protect small-scale aqua farmers by providing technical and financial support and empowering them to improve their production systems and practices to be competitive with those of larger producers. There is also a need to further improve data and statistics on aquaculture to enable the planning that is vital for its sustainability.

3.5 The way forward

Asian aquaculture is poised to expand (in countries where land and freshwater are not scarce) and intensify (in countries where aquaculture is well established), with increased involvement of the private sector. Unfortunately, similar development, expansion and intensification of aquaculture did not happen at the same level in the Pacific sub-region over the past two decades, owing to many identifiable reasons. Ponia (2010) in his review of aquaculture in the Pacific Islands concluded that that growth in aquaculture is continuing in PICTs, although slow, and provided the following indicators as evidence:

- commercial harvesting of pearls in the Independent State of Papua New Guinea and increased production of pearls in the Republic of Fiji;
- recovery of New Caledonia shrimp from the 2007 slump; and increased exports of shrimp to the United States of America from the Commonwealth of the Northern Mariana Islands and to the Republic of Fiji from the Independent State of Papua New Guinea;
- widespread uptake of Nile tilapia in inland Independent State of Papua New Guinea;
- increasing exports of cultured corals;
- the Republic of Fiji has begun exporting artificial live rock; and
- increases in export of *Kappaphycus* seaweed from Solomon Islands (400 tonnes/year) and the Republic of Fiji.

Production in Asia is expected to increase in order to meet the growing global and regional demand for fish in the coming decade. The sector will increase and improve its sustainability providing increasing quantities of aquatic food that is safer to eat, while providing significant social benefits with reduced environmental impacts.

4. RESOURCES, SERVICES AND TECHNOLOGIES

4.1 Status and trends

4.1.1 Land and water resources

Land and freshwater resources available for aquaculture in Asia-Pacific region are becoming increasingly scarce. The main reason has been the expansion of aquaculture itself as well as the demand for land and water for other human activities (FAO/NACA, 2011). Available freshwater resources are also becoming polluted through pesticide runoff and other land-based activities, while coastal and nearshore brackish and marine areas are becoming congested by artisanal fisheries and human populations. Many countries in the region prioritise agriculture as the main use of their freshwater resource (second to drinking) thus making freshwater availability a continuing issue for expansion of aquaculture. As a consequence, some countries, the People's Republic of China in particular, are moving some aquaculture offshore where appropriate.

4.1.2 Feed

Although the world produces an array of aquatic animal herbivores, omnivores and carnivores, the current trend is to provide supplementary feed to many species grown in commercial systems. In the coming decades, not only feeding the world, but also feeding aquaculture, has become an important issue. Since nearly 90 percent of global aquaculture production is from the Asia-Pacific region, the issue of aquaculture feeds is an important regional subject.

Asia is the largest user of farm-made and industrially produced aquafeeds in the world. There are many controversies associated with feeds, primarily regarding the use of fishmeal and fish oil in aquaculture (Han *et al.*, 2016). Asian aquaculture has its share of these, given its large and increasing utilization of fishmeal and trash/low-value fish (De Silva and Turchini, 2009).

In nutritionally wholesome aquafeed, the protein component is the costliest, often accounting for more than 60 percent of the cost of feed. Of all the protein sources, fishmeal is the preferred protein source for feeds of aquatic animals because of the balanced amino acid profile, phospholipid and favourable fatty acid composition, palatability and easy digestion and absorption. A recent study in the People's Republic of China indicated that imported fishmeal usage in Chinese aquaculture has been stable from 2000 to 2014, despite the sharp increase of aquafeed production in the country (Han *et al.*, 2016).

The Asia-Pacific region will continue to produce more fish and fish feed and will certainly utilise more feed resources than it does now. However, research into replacement of scarce and expensive ingredients, such as fishmeal and fish oil, is producing less costly alternatives. Thus the use of fisheries resources for feeding the fish will not grow exponentially.

The People's Republic of China is moving away from monoculture of species high in food chain toward producing fish through polyculture and ecological aquaculture in wetland culture systems (Han *et al.*, 2016). These options will provide alternate pathways to bring cheaper food fish for humans at a reduced overall use of fishmeal from wild fisheries in the People's Republic of China (Wang *et al.*, 2016). This scenario is being increasingly practiced elsewhere in the region. In the future, world aquatic food will come mostly from aquaculture (FAO, 2016a), and aquaculture is now destined to reduce demand on wild fisheries even further by reducing the use of low-value fish as feed.

4.1.3 Seed

The availability of hatchery-produced, good quality fish, shrimp and prawn seed in Asia-Pacific has, on the whole, been on the rise over the past two decades. Although quality, quantity and availability may not be even across the region, in general, as hatchery produced seed is becoming more and more accessible, use of wild caught seed is becoming minimal. Exceptions include seed for eels, southern bluefin tuna, some grouper species and milkfish, which are still sourced from the wild. Use of wild-caught shrimp seed is almost non-existent. In fact, it has now become almost general practice to use not only hatchery produced shrimp (both *Penaeus monodon* and *Penaeus vannamei*) but also hatchery-produced, specific pathogen-free (SPF) post-larvae in shrimp culture, to avoid several important viral diseases during culture period.

Life cycles of the important crab and lobster species have been experimentally closed but commercial production of their seed is still rudimentary. Hatchery production of giant clam seed in several Pacific Islands is well established and is used for the commercial production of the clam for export as well as for stock enhancement programmes. Seed production of sea cucumber is also well established in several Pacific Island states and the technology has been successfully transferred to several other Asian countries.

Research into genetics and the application of genetics in aquaculture have contributed considerably to seed quality and quantity in Asia-Pacific. Both the GIFT (Genetic Improvement of Farmed Tilapia) tilapia and domesticated SPF shrimp (*P. monodon* and *P. vannamei*) now play important roles in the continued increase in regional aquaculture production.

Aquaculture seed production in many countries in the region (mainly the lower-producing countries in South and Southeast Asia) is still practiced as a state sector activity. Seed is produced in government hatcheries and distributed and/or sold to private farmers or stocked in lakes and reservoirs. This practice is changing. Aquaculture seed production is currently being privatised in some of those countries. FAO, as part of its Blue Growth programme supporting aquaculture intensification in the Asia-Pacific, is currently assisting the government of the Democratic Socialist Republic of Sri Lanka in developing appropriate hatchery systems for tilapia, to be operated by reservoir fishers to stock their waterbodies; the initiative is a part of the national reservoir fisheries co-management programme. The trend is expected to continue in several other countries in the region in the coming years.

4.1.4 Aquatic animal health management

Epizootic-level incursion and spread of disease is not a novel phenomenon in Asian aquaculture. Many reviews and analyses are available on diseases in Asian aquaculture, although reliable and accurate data and information on economic impacts are still scarce. Diseases affecting aquaculture can be categorized into three kinds: (1) diseases that are important to trade (OIE list of diseases) and governed by international standards, which includes diseases of important traded species (e.g. finfish, crustaceans, molluscs) for which reporting/notification is required during an outbreak; (2) diseases that consistently affect aquaculture species at the hatchery, nursery and grow-out levels (e.g. bacteria, parasites, fungi, virus); and (3) emerging diseases, which are often known diseases that are spreading to new geographical areas or infecting new susceptible species or diseases of yet unknown aetiology. Countries need to be able to manage and contain the impacts of these diseases.

One of the earliest epizootics in the region was Epizootic Ulcerative Syndrome (EUS) in freshwater fish. It and subsequent shrimp viral diseases have greatly increased awareness of the importance of aquatic animal health management in the region and helped to develop regional human capacity and infrastructure; however, such developments have never kept pace with the expansion and intensification of aquaculture. A significant addition to the long list of aquatic diseases/pathogens severely affecting the aquaculture sector is Acute Hepatopancreatic Necrosis Disease (AHPND), which devastated shrimp aquaculture in several Asian countries (e.g. the People's Republic of China, Malaysia, the Republic of the Philippines, the Kingdom of Thailand) more than five years ago. The loss of revenue due to

AHPND in Southeast Asia has so far been estimated at over four billion United States of America dollars. The causative agent is a virulent strain of *Vibrio parahaemolyticus*, an aquatic bacterium commonly found in coastal waters.

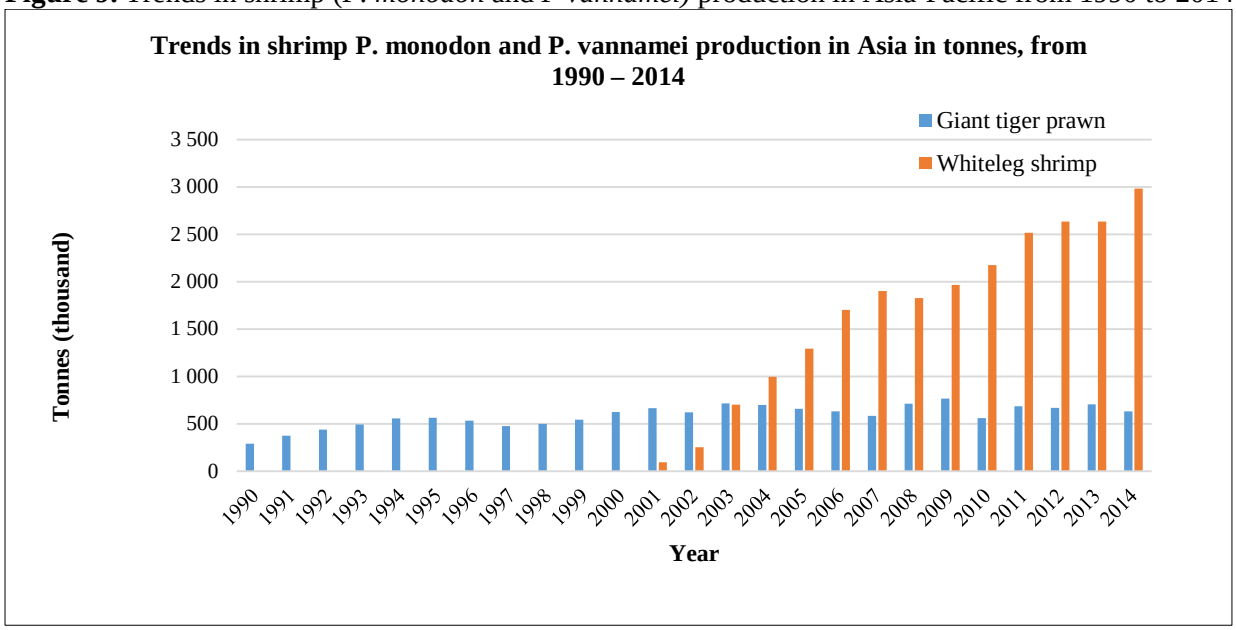
Countries must be vigilant regarding other emerging diseases (e.g. *Enterocytozoon hepatopenaei* (EHP) in shrimps and tilapia lake virus (TiLV) in Nile tilapia) with the potential to severely impact the sector if not diagnosed and contained in a timely manner. Prevention, supported by good aquaculture and biosecurity practices, is still the key. Strengthening biosecurity governance at all levels of the aquaculture value chain is essential to deal with aquatic animal disease emergencies. It is less costly to detect, identify and prevent the emergence or spread of diseases than to eradicate them.

Other important emerging issues that countries need to be aware of include the misuse and abuse of antimicrobials and other veterinary drugs, concerns about residues and development of drug resistant pathogens. With the recent approval of the Global Action Plan on Antimicrobial Resistance (AMR), spearheaded by WHO, it is now appropriate for countries to initiate development action plans on aquatic AMR to be integrated into the global action plan.

4.1.5 Technology

The scientific and business communities, not only in Asia-Pacific but also at the global level, have been responding to the challenges and opportunities inherent in the growing aquaculture sector with research efforts generating novel technologies that mirror the diversity of the industry. For example, the introduced species *P. vannamei* is now overtaking regional shrimp production that has been dominated by the native shrimp, *P. monodon* (Figure, 9).

Figure 9. Trends in shrimp (*P. monodon* and *P vannamei)* production in Asia-Pacific from 1990 to 2014



Source: FAO (2016b).

Remarkable improvements have been made in genetics and breeding, both in finfish and shrimp. SPF and SPR shrimp (*P. monodon* and *P. vannamei*), GIFT tilapia, some carp species with better growth performance, and also commercial-scale production of various species of grouper, pompano and cobia could be listed as success stories. There have also been significant technological improvements in the feed and nutrition sector and in health management and disease control, including a new vaccine for *Streptococcus* infections in tilapia. Advancements in production systems, including recirculation technologies, cages and integrated multi-trophic aquaculture, are also contributing to intensification, industry expansion and sustainability.

One of the most promising experiences in the field of aquatic animal health management in Asian aquaculture is the overwhelming response to the recent outbreak of AHPND in penaeid shrimp. Although the disease was first observed in 2009 in the People's Republic of China, the aetiology and the causative agent were confirmed only in 2013 and several diagnostic procedures and tools subsequently developed. Stringent international trading regulations, strict food safety standards, government policies and regulations and massive awareness campaigns on the importance of food safety have reduced antibacterial use in aquaculture remarkably. Organizing small-scale shrimp farmers into clusters and empowering them to follow certain technical standards and BMPs have resulted in significantly reducing disease incidents in shrimp culture in the People's Republic of Bangladesh and the Republic of India in particular. These developments have not only improved final product quality, but have also tripled production and increased profit from shrimp aquaculture in regions of the People's Republic of Bangladesh.

4.2 Outstanding issues and success stories

While the Asia-Pacific regional aquaculture sector has performed well with the available resources and services (Asia sub-region in particular), all aquaculture service sectors (seed, feed and health in particular) require continued improvement. In particular, the growing direct use of low-value fish/trash fish for marine aquaculture should be seriously addressed and more efficient formulated feed, targeted to specific species and affordable to farmers, should be produced. Research into further commercialization of marine seed should be prioritised as continued collection of wild marine fish seed will further deplete the wild resource.

4.3 The way forward

Asian aquaculture still does not overly suffer from lack of major resources. Support services have been improving and kept phase with sectoral development. As the sector is continually being intensified, further advances and support services are necessary to increase sector efficiency. More research into seed, feed, health, engineering, etc. is essential to keep phase with sectoral development. In particular, aquatic animal health should be considered vital to the sector and all efforts should be made to reduce risks of disease in Asian aquaculture. Aquaculture development in the PICTs is considered important for their economy and food security; thus concerted action is necessary to move forward.

5. AQUACULTURE AND ENVIRONMENTAL INTEGRITY

5.1 Status and trends

Aquaculture is still the fastest growing food producing sector in the world. Cultured production has increased six fold over the past 25 years, and it is envisaged that current production will double by 2050. The Asia-Pacific region is expected to continue its contribution of the lion's share of global aquaculture production. The impressive growth of aquaculture in Asia-Pacific has had its costs. During the 1990s, some negative social and environmental impacts of aquaculture took place in isolated pockets in the world and stimulated a serious environmental lobby against aquaculture, particularly targeting shrimp aquaculture. Consequently, aquaculture policies and regulatory frameworks of the region have been gradually strengthened and refined to reduce negative environmental impacts. These policy and regulatory improvements have been supported by various technological advancements.

According to Hall *et al*. (2011), environmental impacts of aquaculture varied by level of production intensity. Although recent efforts and trends in intensification visibly resulted in decreased use of land and freshwater per unit of farmed fish produced, intensification has also led to an increase in the use of energy and feed, as well as an increase in water pollution per unit of farmed fish produced. More disease impacts have been observed. These experiences led FAO to promote "sustainable intensification of aquaculture" in Asia-Pacific region, which has now become one of the major regional programmes of FAO, aiming at mitigating the negative impacts of intensification.

Waite *et al.* (2014), responding to the question "how can the world lift constraints to aquaculture's growth while minimizing associated environmental impacts?" listed four categories of factors that have improved aquaculture's productivity and environmental performance:

- technological innovation and adoption (in breeding, feeds, production systems, disease control and environmental management);
- market forces (related to resource scarcity and price signals);
- public policy (regulation and standards spatial planning and zoning fiscal incentives publicly funded research, extension, and training), and
- private initiatives (certification programs, purchasing standards, codes of conduct, research, advocacy, service delivery).

Aquaculture has, from an ecological efficiency and environmental impact point of view, clear benefits over other forms of animal food production for human consumption. Where resources are stretched, the relative benefits of policies that promote aquaculture over other forms of livestock production should be considered.

Aquaculture in the Asia-Pacific region has generally become more environmentally friendly, a result of two decades of increasing awareness and publicity regarding the adverse impacts and perceived impacts of aquaculture on natural resources and the backlash of bad practices on the productivity and sustainability of farms. Farmers have learned that being environmentally friendly makes good business sense. Regulations have been instituted or tightened, but the most important development has been the increasing uptake of BMPs, codes of conduct or practices, and certification schemes. Almost all countries in the region now require licensing to practice aquaculture. All commercial aquaculture establishments must undertake EIAs or IEEs and register with the state authorities before commencing farming.

It has been recognised that producing fish in an environmentally sustainable (and socially acceptable) manner will generally improve market access (to international markets in particular), and increase profit, by improving compliance to WTO/SPS agreement, international trade requirements, and food safety. It is also evident that environmentally sustainable production is more cost-effective. FAO aquaculture certification guidelines (FAO, 2011) are being increasingly incorporated into third party and state aquaculture certification standards, and benchmarking systems have been developed to look into the compliance of certification schemes with these guidelines. As environmental integrity is one of the minimum substantive criteria, increasing certification will undoubtedly further improve the environmental integrity and responsibility of aquaculture in the region.

5.2 Outstanding issues and success stories

In general, environmental performance in Asia during the past decade has been impressively improved, except for the few serious disease outbreaks in the shrimp sector. According to Waite *et al.* (2014), if aquaculture is to double its production by 2030, and for growth to be sustainable, the sector must improve its productivity while at the same time improving its environmental performance. Aquaculture is continuously being intensified in Asia-Pacific region. To achieve "sustainable intensification," aquaculture must: (a) advance socioeconomic development; (b) provide safe, nutritious food; (c) increase production of fish relative to the amount of land, water, feed, and energy used; and (d) minimize water pollution, fish diseases, and escapes. All these are relevant to Asian aquaculture. Aquaculture in the PICTs is still in its infancy, and environmental performance has not yet become an issue of concern. However, it is important that aquaculture development in PICTs takes due consideration of maintaining sector sustainability and addressing the potential impacts of climate change.

5.3 The way forward

Intensification of aquaculture in Asia will continue in the coming decades. As mentioned by Waite *et al.* (2014), intensification has pulled impact indicators in two directions. It has decreased the use of land and freshwater per unit of farmed fish produced, but also led to an increase in the use of energy and commercial aquafeed including fish-based feed ingredients, as well as an increase in water pollution per unit of farmed fish produced. Disease risks have also risen in intensive systems. However, new evidence suggests that use of fish-based feed ingredients may not increase exponentially (discussed earlier). We have also witnessed considerable improvements in disease risk reduction strategies throughout the region. For Asian aquaculture to be more efficient, effective and sustainable, continuing efforts towards intensification of the sector should pay more attention not only to increasing resource efficiency but also to reducing environmental impacts to a minimum.

6. MARKETS AND TRADE

6.1 Status and trends

Fish and fishery products are considered the most-traded food commodity in the world. About 78 percent of seafood products are estimated to be exposed to international trade competition. Fish and fishery product trading has been expanding considerably in recent decades, driven by the growing demand for fishery products as food, combined with the increasing trend of globalized trading.

Asia-Pacific region is an important part of the global fish trade. The People's Republic of China is not only the largest producer of fish, but has also been the largest exporter of fish and fishery products since 2002. The People's Republic of China's imports of fishery products are also growing, and currently the world's third-largest importing country (FAO, 2016a). The increase in the People's Republic of China's imports is partly a result of outsourcing of processing to the People's Republic of China by other countries, but it also reflects the country's growing demand for domestic consumption of species not produced locally.

In 2014, the Socialist Republic of Viet Nam became the third major fish exporter, overtaking the Kingdom of Thailand. The Kingdom of Thailand's fish export substantially declined during the 2012 – 2013 period owing to reduced shrimp production due to disease problems (discussed in Section 4). After some recovery in 2014, its exports further declined in 2015 (by 14 percent in United States of America dollar terms and by 10 percent in terms of Thai baht) mainly because of its reduced shrimp production and lower shrimp prices (FAO, 2016a). Both these Asian countries have important processing industries, which contribute significantly to their economies through job creation and trade.

Fishery trade represents a significant source of foreign currency earnings for many developing countries, in addition to the sector's important role in income generation, employment, food security and nutrition. Increasing aquaculture production in Asia-Pacific clearly shows the increasing contribution of foreign exchange to national economies through the fish trade.

The major internationally traded species originating in Asia are marine shrimps, tilapias and pangasiid catfishes. Other commodities with sizable trade volume are seaweed and marine fish, especially reef species such as groupers and wrasses that are shipped live to China, Hong Kong Special Administrative Region and southern the People's Republic of China markets. New species such as cobia (*Rachycentron canadum*) and pompano (*Trachinotus* spp.) are also coming into international and regional markets as their production in Southeast Asia increases.

The internationally traded seaweed (*Kappaphycus* spp.) is a carageenan-yielding species, almost all of it originating in the Republic of the Philippines and the Republic of Indonesia. A small volume comes from the PICTs, mainly the Independent State of Papua New Guinea, the Republic of Kiribati and the Solomon Islands. Dried seaweed is traded regionally, and the People's Republic of China has continued

to increase its imports from the Republic of the Philippines over past years; this has induced the establishment of more seaweed farms but also created concerns among local processors about the shortage of material as a result of the People's Republic of China's increasing demand. Dried raw seaweed is tariff-free in the People's Republic of China, while processed products have a high import duty (Ricohermoso, 2008).

Carp is generally not exported, although the Republic of the Union of Myanmar exports Indian carps, targeting South Asian communities in countries in the Middle East and Europe. Milkfish in small but increasing volume is exported to countries with sizeable Filipino expatriate populations. The major products exported by the PICTs are the blue shrimp (*L. stylirostris*) from New Caledonia, giant clams for the aquarium trade and cultured pearls (mainly *Pinctada margaritifera* and, in much lower quantity, *Pteria penguin* or "mabe" ("half pearl" in Japanese). Live rock and corals, the latter cultured in land-based facilities or harvested from the reefs, are also exported by Pacific Island countries. Cultured aquarium fish are gaining more importance in Asia (e.g. in the Republic of India, the Republic of Indonesia, Malaysia, the Republic of the Philippines, the Kingdom of Thailand and the Democratic Socialist Republic of Sri Lanka) and are beginning to be explored for commercial purposes in the Pacific Island countries (FAO/NACA, 2011).

6.2 Outstanding issues and success stories

During the past decade, aquaculture products from Asia have found new markets while global seafood also found new markets in Asia. Successful regional and international trading is based on market access, where price is an important factor. Consumer demand will make products more marketable; however, both food quality and food safety are paramount in achieving market access. Asian aquaculture should further concentrate on improving food safety and hygiene of the products, especially those coming from the small-scale sector.

Pacific Island nations have many attributes that favour development of aquaculture and stock enhancement in the coastal zone. However, there are several constraints on such enterprises in the Pacific; they include limited domestic markets, high added-value export markets, transport problems, socio-economic factors, fragile habitats, limited fresh water, and cyclones. Some of the best opportunities for aquaculture development in the Pacific are in the aquarium trade (coral reef fish, hard corals, soft corals), the live seafood markets (e.g. groupers, spiny lobsters, abalone, crabs) and the pharmaceutical industry (e.g. algae, sponges, soft corals). In all cases, the products are of high value and can be grown in small areas with relatively simple technology.

6.3 The way forward

It is apparent that more fish and shrimp are now consumed in Asia than ever. While this trend continues, the demand for improved high quality, nutritious, safer to eat and easy to cook (precooked) aquatic products will continue in the region. Asian aquaculture producers should be aware of this inevitable phenomenon. Sustainable intensification of shrimp aquaculture production could be the way forward for achieving these targets.

7. CONTRIBUTION OF AQUACULTURE TO FOOD SECURITY, SOCIAL AND ECONOMIC DEVELOPMENT

Aquaculture's contribution to global food security has been highlighted many times. As the bulk of aquaculture is produced in Asia and most aquaculture employees are in Asia, the importance of aquaculture to food security and social and economic development of the region is clear. There are three major recent reviews on the subject: World Bank (2007), WorldFish (2011) and IFPRI (2015).

7.1 Status and trends

The contribution of aquaculture to food and nutrition security and social and economic development in Asia has been addressed in this volume in several previous chapters. Aquaculture contributes to better livelihoods by creating employment in the aquaculture value chain, thus increasing income and providing a nutritious and affordable animal food source to the world.

The importance of fish and fishery-based activities to food security in less-developed countries is particularly prominent in those communities engaging in small- to medium-scale operations in Africa and Asia (IFPRI, 2015). This is the result of both the consumption of fish that takes place in the households engaged in fishing and fish farming operations as well as the income that these households generate. According to FAO (2016a) 56.6 million people were engaged in the global primary sector of capture fisheries and aquaculture in 2014. From 1990 to 2014, the percentage employment in the farming sector (aquaculture) increased from 17 to 33. Small-scale operations continue to play a critical role in supporting livelihoods, particularly rural livelihoods, contributing to food security and alleviating poverty. In 2014, 84 percent of the global population engaged in the fisheries and aquaculture sector was in Asia (FAO, 2016a). More than 18 million (33 percent of all people employed in the sector) were engaged in fish farming, and 94 percent of all aquaculture engagement was in Asia. These statistics clearly indicate the important and increasing contribution of aquaculture to Asia regional food and nutrition security and socio-economic development.

Bondad-Reantaso and Prein (2009) in a series of case studies in Asia listed a number of significant contributions of small-scale aquaculture: (i) alternative employment opportunity for underemployed or otherwise idle rural labour (Vietnamese shrimp farming), (ii) additional community livelihood (seaweed farming in the Republic of the Philippines), (iii) fall-back employment to displaced labour from the commercial and industrial sector (the Kingdom of Thailand inland integrated farms), and (iv) magnet for investments from government and private sector into the rural community (shrimp farming in the Socialist Republic of Viet Nam, tilapia cage culture and seaweed culture in the Republic of the Philippines).

The role of women in aquaculture is well known in Asia (World Bank, 2007 and FAO/NACA, 2011). Women in Asia are not only directly engaged in selling fish, but are also increasingly becoming involved in fish farming. Recent examples from countries such as the People's Republic of Bangladesh clearly indicate that the number of women involved in fish farming has risen over the years and aquaculture plays an important role in rural poverty reduction and welfare (WorldFish, 2011). Aquaculture also improves nutritional status of rural poor, especially among mothers and young children (Thilsted *et al.*, 2016). Considering the increasing global population and importance of feeding the future world with a heathy diet, Bene *et al.* (2015) stressed that fish should be in everyone's plate and access to fish is a key issue in creating healthy populations, especially among rural poor, worldwide. This trend is continuing, although some issues and concerns are brewing.

One of the important factors that help in improving small-scale aquaculture and subsequent food security and income is growing local markets for fish and fishery products. It is evident from recent studies that local markets for fish are increasing worldwide, and in Asia local demand for fish has increased in almost all countries in the region (FAO, 2016c). This demand appears to be not only for the low value species, but also for high value species such as shrimp. Demand from local markets will undoubtedly improve market access for the somewhat disorganised small-scale producer sector, ensuring that they too will continue to enjoy the benefits of aquaculture.

7.2 Outstanding issues and success stories

While local markets are increasing and small-scale producers are gaining better access to markets, overall costs of production in the aquaculture sector is increasing. Fuel, feed, seed and other services are becoming expensive and small-scale farmers are finding difficulties in competing in the markets with

integrated aquaculture industrialists. Although efficient intensification is now considered the future for sustainable aquaculture, many small-scale producers are finding it difficult to move in this direction.

Certain high value commodities such as shrimp, in particular, are providing large streams of export revenue; thus, there is a trend towards increasing production of shrimp in Asia. Farming shrimp requires more feed, especially fishmeal, and is therefore more input intensive. Considering the increasing cost of fishmeal, there is also a trend in sourcing fishmeal locally using small local species that would otherwise have been consumed directly a trade-off exists between export value and local nutrition (IFPRI, 2015).

There have been increased efforts towards organizing small-scale fish farmers by developing cluster farming systems and applying better management practices (BMPs) in several countries in Asia (the People's Republic of Bangladesh, the Republic of India, the Kingdom of Thailand and the Republic of Indonesia in particular), with considerable success (FAO, 2016c). Public-Private-Partnership arrangements in the Republic of Kiribati on giant clam farming and trade are continuing and provide an interesting example of how PPP could be used in the context of food security (FAO/NACA, 2011).

7.3 The way forward

As mentioned earlier, aquaculture will continue to grow, expand and intensify in Asia. If the sector is to be sustainable, not only should environmental impacts be minimised and resource efficiency maximised, but also the benefits from aquaculture should be made equitable. It is paramount that both small-scale and large-scale aquafarmers and industrialists coexist, sharing profits and enjoying benefits. In a market economy world, this can only be achieved through better governance by enacting people-centred and poverty-addressing policies and regulatory frameworks. This is of course the responsibility of the state.

8. EXTERNAL PRESSURES ON THE SECTOR (CLIMATIC CHANGES, DISASTERS, ETC.)

8.1 Status and trends

Asia-Pacific region has faced several major natural, biological and economic hazards in the past decade. These include the tsunami of 2004 which affected several countries in Asia-Pacific as well as the tsunami in Japan in 2011, cyclones, flooding, drought, severe acute respiratory syndrome (SARS), avian influenza pandemics in livestock, and the global financial crisis of 2008 (FAO/NACA, 2011). According to a recent assessment conducted by FAO for the period 2003–2013, the agriculture sector – including fisheries and aquaculture – absorbs 22 percent of the economic impact caused by medium- and large-scale natural disasters in developing countries. More specifically, disease outbreaks have reportedly cost the aquaculture industry tens of billions dollars in the last 20 years. The fisheries and aquaculture sector is particularly vulnerable to natural disasters. Storms, floods, cyclones and droughts have cost millions of dollars and significantly affected livelihoods of many people in the Asia-Pacific region during the past few years.

Climate change has also been considered to have a range of impacts on aquaculture. Warming of waterbodies, sea-level rise, ocean acidification, weather pattern changes and extreme weather events have been listed as major drivers of such impacts (FAO/NACA, 2011). Projections indicate higher vulnerability of tropical ecosystems to climate change, with negative impacts on their dependent communities. Climate change will affect food security in Asia by the middle of the twenty-first century, with South Asia most severely affected (FAO, 2016a). Almost 90 percent of aquaculture production takes place in Asia, most of it in the tropical and subtropical belts. Using a series of indicators of exposure, sensitivity and adaptive capacity in a GIS model, one study identified the People's Republic of Bangladesh, the Kingdom of Cambodia, the People's Republic of China, the Republic of India, the

Republic of the Philippines and the Socialist Republic of Viet Nam as the most vulnerable countries worldwide (FAO, 2016a).

Bell and Taylor (2015) suggested that an integrated analysis of the vulnerability of coastal PICT communities to food insecurity is required to raise awareness of the range of food production systems at their disposal and to prioritize the production of food from agriculture, fisheries and aquaculture. The analysis would integrate village population size, the area available for growing various types of root crops, fruit and vegetables (access to fresh water, soil type, topography, rainfall), area of coral reef available per capita, the distance to the nearest area suitable for deploying fish aggregating devices, suitable local conditions for pond aquaculture, distance to the nearest market and availability of social and physical capital needed to produce food and earn income.

8.2 Outstanding issues and success stories

Although disaster preparedness has not been adequate in the region, the collective efforts towards responding to the disasters that have happened are considerable. All concerned have collectively supported the rehabilitation processes of the 2004 tsunami and the results are evident (Bennett *et al.*, 2006). However, what is important is to learn from past lessons and increase disaster preparedness for more efficient response to the possible events in the coming decades. This requires significant government involvement and it should increasingly be considered as state responsibility. Assistance from relevant international and regional agencies should be continued.

While there are clear indications that disasters have impacts on the fisheries and aquaculture sector, the sector tends to be under-reported in post-disaster needs assessments. Further efforts are needed to quantify and report damage and losses to the sector in order to understand and address the main challenges. At the global level, FAO is taking steps to develop a methodology to monitor damage and losses suffered by agriculture, including fisheries and aquaculture. The overall objectives are to gain a more complete and comprehensive understanding of disaster impacts on the agriculture sector and to provide appropriate responses.

Some countries are already taking action. For example, in the Socialist Republic of Viet Nam, there are efforts to select for salinity-resistant catfish strains and in the People's Republic of Bangladesh the government and its partners are exploring options such as using salinity-resistant species, deepening aquaculture ponds, using depth-adjustable cages, and integrating fish farming with agriculture.

Some areas to be addressed towards improving climate change adaptations of aquaculture in the region are aquaculture zoning, better health management, improving and enforcing ecosystem approach to aquaculture, and development and implementation of BMPs in aquaculture. These aspects as well as other nationally important areas towards improving climate change adaptations in several countries in the region are now being addressed through several Global Environmental Facility (GEF) projects executed by FAO.

8.3 The way forward

As FAO (2016a) pointed out, promoting sustainable aquatic resource management through the development and implementation of ecosystem-friendly and participatory policies, strategies and practices should be given priority in order to reduce, prevent or mitigate impacts from disasters. Asia Pacific region should recognize the importance of aquaculture (and fisheries) in resilience-building and in food security and nutrition, and the sub-regions and countries should develop good practices in climate change adaptation, disaster risk reduction and management, which also involve investment. The concept, which was used during the 2004 tsunami rehabilitation – Building Back Better – is still valid and should be promoted in the efforts for rapid recovery (FAO, 2016a).

9. GOVERNANCE AND MANAGEMENT OF THE SECTOR

9.1 Status and trends

Aquaculture can no longer be considered an infant economy or sector in Asia. It has been forty years since the first international conference on aquaculture, organised by FAO and UNDP, was held in Kyoto, Japan. Following the Kyoto Conference, many countries in the Asia-Pacific region and the world at large started to explore aquaculture potential at national levels and initiated policy changes and institutional and regulatory frameworks, providing opportunities for aquaculture development and better management. FAO's Code of Conduct for Responsible Fisheries (CCRF) in 1995 further strengthened this process, representing a practical tool for improving aquaculture governance worldwide. Since the turn of the century, regional governments have promulgated policy and regulations for aquaculture, harmonized laws and regulations heretofore under enforcement by separate government authorities into a coherent set of regulations that apply to aquaculture, and formulated aquaculture development strategies and plans to implement policy and achieve development goals. This is important in the region as aquaculture is highly diverse and is practiced by farmers at all levels, from small-scale resource-poor individuals and families to technically qualified workers and employees of commercial and industrial aquaculture establishments.

Several strong inter-governmental agencies have been established in support of fisheries and aquaculture development in Asia-Pacific. Dedicated international technical and financial agencies such as FAO, WorldFish, ADB, and the regional agencies such as APEC, APFIC, BOB-IGO, NACA, SEAFDEC, SPC, etc. continuously provide technical and financial assistance for the development and better management of the aquaculture sector in the region. Dedicated NGOs such as the Asian Fisheries Society have also contributed immensely through bringing science and scientific knowledge into the aquaculture sector. Many countries established private or semi-private aquaculture associations/partnerships focussing on overall aquaculture development and/or specific aspects such as trade (e.g. the Socialist Republic of Viet Nam Association for Sea Food Exports (VASEP), a semi-governmental authority facilitating marketing of cultured shrimp and catfish). Many bilaterally assisted programmes have also contributed to this endeavour and these efforts are continuing.

As aquaculture governance has improved and production increased in the region, many products have found markets internationally. Examples include marine shrimps and pangasiid catfishes. Over a period of less than 20 years, over a million and a half pangasiid catfishes, mainly from the Socialist Republic of Viet Nam, have reached international markets worldwide. As international trading in cultured aquatic products has increased, requirements for complying with international trading standards, including compliance to WTO/SPS agreement, became critical. Consequently, policy, institutional and regulatory frameworks have been developed and implemented in many states of the region, including certification of aquaculture establishments and aquatic products.

Application of BMPs, practicing GAPs, empowering small-scale farmers through organizing them into clusters, etc., have become prominent in the region, especially in South and Southeast Asian countries over the past 5–10 years. Under the FAO's regional blue growth initiative, several countries have embarked on programmes aimed at aquaculture intensification, reduction of greenhouse gas emission, use of renewable energy in aquaculture, etc., although no specific policies have been enacted. Some countries have initiated policies and regulatory frameworks providing tax rebates for importation of goods and services for aquaculture development. Policies and laws to reduce environmental impacts of aquaculture have also been strengthened over the past 5–10 years. Overall, many Asia-Pacific regional countries enjoy established strong aquaculture governance structures (policies, institutions, regulations, etc.) in support of sustainable development and management of aquaculture at all levels.

9.2 Outstanding issues and success stories

Asia-Pacific region may be somewhat complacent about the improvements to aquaculture governance over the past decade. Aquaculture governance will become even more important in the future, as the

sector marches ahead. All four facets of sustainability – economic, environmental, social and technical – will face challenges in the coming decades. As described by Hishamunda *et al.* (2012), some of the likely challenges that are intrinsic to the industry as it grows include the emergence of oligopolies in the production of certain species, reconciling competing claims to water and land, the need to manage aquaculture within a deteriorating ecosystem, vocal opposition from well-funded NGOs and funding of local research. These all are fully relevant to the Asia-Pacific region and should be addressed when changing/improving appropriate policies and regulatory frameworks that govern better aquaculture.

In Asia-Pacific, currently most marine aquaculture operations occur in areas under the sovereignty or national jurisdiction of the coastal state. Countries may endeavour to expand aquaculture further offshore. Although this may not happen in the immediate future, the sector will compete with other activities, particularly those related to the utilization of living and mineral resources, and to navigation and communication. Thus, one of the biggest challenges facing policy-makers in Asia-Pacific will be to establish international policy, institutional, legal and regulatory frameworks/regimes for aquaculture operations in waters beyond national jurisdiction.

9.3 The way forward

While many countries in Asia-Pacific have made commendable efforts to set up policies, administrative, legal and regulatory frameworks to properly develop and manage aquaculture, some countries in the region are still lagging behind. Moreover, in some of the countries that have made conducive policies, implementation is delayed by the lack of financial and skilled human resources. Policies and regulations may be enacted, but unless there are sufficient government personnel with adequate skills and financial resources to monitor and enforce them, they will remain ineffective. This issue must be addressed without delay if the aquaculture sector in Asia-Pacific is to develop sustainably.

10. AQUACULTURE CONTRIBUTION TO THE FAO STRATEGIC OBJECTIVES, TO THE SDGS AND THE BLUE GROWTH INITIATIVE

10.1 Status and trends

Achieving food security for all is the heart of FAO's efforts – to ensure people have regular access to enough high quality food to lead active healthy lives. FAO's five strategic objectives pave the way for achieving this broad goal of the organization. The five strategic objectives of FAO are:

- Help eliminate hunger, food insecurity and malnutrition.
- Make agriculture, forestry and fisheries more productive and sustainable.
- Reduce rural poverty.
- Enable inclusive and efficient agricultural and food systems.
- Increase the resilience of livelihoods to threats and crises.

Fisheries and aquaculture are embodied in all these strategic objectives; thus the activities of the Fisheries and Aquaculture Department contribute to achieving the overall objective of global food security.

The 2030 Agenda for Sustainable Development and the new Sustainable Development Goals (SDGs), which succeed the MDGs, have the ambitious aim of ending poverty and hunger by 2030. Food security goes beyond guarding against hunger and malnutrition as it exists when "all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life." The fisheries and aquaculture sector plays and can continue to play a prominent role in world food security. Fish is a vital source of food including micronutrients, particularly for many low-income populations in rural areas, and the sector also contributes to economic growth and development by being a source of employment, livelihoods and income to millions of people engaged in fish harvesting, culturing, processing and trade.

With the stabilization of total capture fisheries production at 90–95 million tonnes since the mid-1990s and the rapid increase in global aquaculture production, reaching about 74 million tonnes in 2014 and outpacing all other food-producing systems, fish as a commodity and aquaculture as a production sector directly contribute to achieving the MDGs, in particular the MDG2, reducing hunger.

The FAO Blue Growth Initiative, endorsed by FAO member countries in 2014, aims to secure or restore the potential of oceans, lagoons and inland waters by introducing responsible and sustainable approaches that reconcile economic growth and food security with conservation of aquatic resources. The concept of a "blue economy" came out of the 2012 Rio+20 Conference and emphasizes conservation and sustainable management, based on the premise that healthy ocean ecosystems are more productive and a must for sustainable ocean-based economies. To support a shift to this new approach, FAO launched the Blue Growth Initiative, through which it will assist countries in developing and implementing blue economy and growth agendas. Fisheries and aquaculture is an integral part of FAO's Blue Growth Initiative.

The blue growth approach emphasizes improved health of aquatic ecosystems through the development, testing and application of new and innovative technologies in control and management of fishing and aquaculture operations. These approaches can minimize damage to aquatic and atmospheric environments and harness the potential benefits of improved habitats to increase biodiversity and enhance ecosystem services. A key pathway to accessing these benefits is through enhanced partnerships between FAO and key regional and sub-regional organizations to accelerate action and uptake of Blue Growth initiatives.

Blue growth looks to further harness the potential of oceans, seas and coasts to:

- Eliminate harmful fishing practices and overfishing and instead **incentivize approaches which promote growth, improve conservation, build sustainable fisheries** and end illegal, unreported and unregulated fishing
- Ensure tailor-made measures that **foster cooperation between countries**
- Act as a **catalyst for policy development**, investment and innovation in support of food security, poverty reduction, and the sustainable management of aquatic resources
- **Aquaculture** – promote policies and good practices for farming of fish, shellfish and marine plants in a responsible and sustainable manner
- **Capture fisheries** – support implementation of the Code of Conduct for Responsible Fisheries (CCRF) and related instruments to restore fish stocks, combat IUU and promote good fish production practices and growth in a sustainable manner
- **Seafood systems** – promote efficient seafood value chains and improved livelihoods
- **Eco-system services** – Promote regulatory regimes and approaches to restore vital coastal habitats, biodiversity and eco-system services (incl. carbon capture, storm and wave defences, tourism etc.)

10.2 Outstanding issues and success stories

Although PICTs are included in the Asia-Pacific region, aquaculture is of little commercial significance to many Pacific Islands. Exceptions include black pearl farming in the Cook Islands and eastern Polynesia. However, there is significant interest in aquaculture in the sub-region with visible development in several PICTs over the past decade. Shrimp (*Penaeus* spp.) farming has been a focus of commercial development in several islands with varying degrees of success; tilapia (*Oreochromis niloticus*) aquaculture has entered the subsistence economy in some areas, and seaweed (*Kappaphycus* spp.) is a future commercial export prospect. The culture of other marine and freshwater species is, however, generally still at the experimental or "backyard" stage. The expansion of aquaculture in the Pacific will depend on providing better production methods for species currently being farmed, and techniques for propagating and growing the "new" species described above. These methods and techniques should be simple and flexible so that they can be adapted to the context of the Pacific Islands environment and to market constraints (local and export markets). This approach should favour systems integrating fisheries and mariculture with low investment and operating costs and simple technical

production processes. This should be done in association with pilot commercial-scale operations to test and demonstrate the economic viability of the methods proposed. The task will require research combined with assistance, training and education programmes.

A critical bottleneck facing the region is inducing the private sector to invest in aquaculture. Outside the French territories, growth to date has been fuelled by only a handful of entrepreneurs. The lesson learned from French territories is that long-term approaches and a high level of government policy support are required to attract investors and stabilise production. Such support will be difficult for PICTs with small economies. Key decisions for the region involve, first, getting the balance right between government-led development of aquaculture and providing incentives for the private sector, and second, identifying the appropriate scale of operations for the region. The government-led approach is beginning to pay dividends for large-scale commercial aquaculture in developed countries.

There is a contrasting model in Asia (which accounts for 90 per cent of the world's production), where economies of scale are achieved through numerous small-scale producers able to dynamically alter their product according to market shifts. The strategy for the Pacific is still evolving, but a middle-of-the-road approach where government maintains regulatory oversight and provides an investment climate focusing on small to medium sized enterprises (SMEs) as a way to 'break out' commercially is probably a prudent approach for the immediate future (Ponia, 2010).

The 22 Pacific Island Countries and Territories (PICTs) span much of the tropical and subtropical Pacific Ocean and their exclusive economic zones (EEZs) exceed 27 million square kilometres. Because of their wide geographical range, the PICTs encompass approximately 28 percent of global EEZs, and include some of the most productive tuna fisheries in the western and central Pacific Ocean. Several PICTs are interested in developing the tropical Pacific tuna fishery within the limits set by regional and international agreements. FAO shows that "there is potential for improved sustainable revenue sharing benefits to PICTs from access fees paid by vessels from Distant Water Fishing Nations, trans-shipment fees, export duties and taxes." In addition, there is associated economic development from Pacific island-owned or joint-venture industrial fishing operations and onshore processing plants as well as the employment opportunities that these create (FAO, 2016a).

10.3 The way forward

Blue Growth is securing increasing recognition and popularity among the regional countries. At the 32nd FAO Regional Conference for Asia and the Pacific held in Ulaanbaatar, Mongolia in March 2014 (APFIC, 2014), member countries endorsed the regional initiative on sustainable intensification of aquaculture for blue growth – improving fish supply for food and nutrition, increasing livelihood opportunities and contributing to blue growth of economy through more efficient and sustainable use of aquaculture resources. The objectives of the regional initiative are:

- Improve the utilization efficiency to aquaculture resources.
- Improve production efficiency with reduced impacts on the environment.
- Increase the resilience of farmers and the sector.
- Improve the equity and social acceptability along the aquaculture value chain.

Major areas of work of the regional initiative include:

- Support member countries in identifying options for addressing key governance issues in achieving sustainable aquaculture growth through appropriate regional and national consultation process; develop relevant regional and national policy, strategy and action plans.
- Increase farmers' adaptability to climate change impact and resilience to natural disasters and socioeconomic risks through development and promotion of innovative aquaculture management concepts and practices.
- Reduce negative environmental and social impacts of aquaculture intensification.
- Through promoting innovative farming technologies and management practices, establishing effective aquaculture bio-security and disease surveillance and control system, and applying appropriate planning and management tools and responsible use of resources.

- Support member governments in improving the access of poor rural aquaculture farmers to quality production inputs, sustainable production technology and markets for improved productivity and economic efficiency.
- Improve management of forestry (mangrove), water, land and tenure that will contribute to sustainable intensification of aquaculture.

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ISBN 978-92-5-109657-4 ISSN 2070-6065

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I6875EN/1/02.17