

them to provide the relevant information which could lead to better understanding of situation on LRFFT, and come up with the appropriate measures and incentives that could enhance the sustainable utilization of LRFF resources.

Deep sea and offshore aquatic species, *e.g.* deep sea shrimps, oceanic squids, are another group of fishery resources that have potentials for utilization, but knowledge on the status of these resources is still inadequate due to difficulties in undertaking resource surveys and data collection. Although many of these species could be considered underutilized at this stage, activities toward their exploration, identification of fishing grounds, and promoting the utilization of these resources should be undertaken with extreme caution, considering that without adequate knowledge on the resources and measures to ensure proper management for their sustainable utilization, such resources could be overharvested and degraded to the extent that their stocks could not recover anymore.

2. INLAND FISHERY RESOURCES

2.1 Status, Issues, and Concern

Inland capture fisheries play an important role in sustaining food security requirements, employment, and income generation for people living along the inland waters in the Southeast Asian region. Specifically, inland fisheries provide high quality protein, essential nutrients, and minerals that are often difficult to obtain from other sources of food. Inland fisheries also provide economic opportunity and a “safety net” that allows for continued food production when other sectors may fail (Bartley and Jorgensen, 2010).

In the Southeast Asian region, inland capture fisheries comprise a large number of small-scale fishers, who are mostly subsistent and engaged only in part-time fishing activities. Therefore, most of those engaged in these fishing activities are also having other occupations like farming or even livestock-raising, and as such, many of them could not be categorized solely as fishers. Most activities related to inland capture fisheries are highly seasonal, which could peak during flood receding periods or at the end of the rainy season, the period when fish growing in floodplains would usually move back to rivers and streams, enhancing the fish stocks but risking to be caught by readily-installed stationery fishing gears. Production of inland capture fisheries is also highly diversified, where most of the catch although large in number and quantity, could be small in size and with high species diversity. Furthermore, in rural areas, there are no designated fishing ports, especially for non-commercial activities. Thus, production from inland fishery resources is not only freely accessed at any time but could also be landed anywhere without any recording, and goes to various channels, with a large portion meant for household consumption (Pongsri, 2014).

Based on the Fishery Statistics Bulletin of Southeast Asia (SEAFDEC, 2005a; 2006; 2008a; 2008b; 2009a; 2010a; 2010b; 2011; 2012a; 2013; 2014; 2015a; 2016a), the total production from inland capture fisheries in the region has continuously increased for more than double over the past 15 years, from 1.36 million metric tons in 2000 to 3.03 million metric tons in 2014 (**Table 5** and **Table 20**). The top inland capture fisheries producing country in Southeast Asia in 2014 was Myanmar accounting for 46% of the total production from inland capture fisheries of the region followed by Cambodia, Indonesia, Philippines, Thailand, and Viet Nam (**Figure 17**). Although fishery statistics data indicated an increasing production trend from inland capture fisheries, the sub-sector has been facing with several issues that threaten its sustainability. One of the main challenges is the rapid growth of human activities, which impacts the inland-water environment including fish habitats, fish migration, water quality, and the inland fishery resources as a consequence (FAO and MSU, 2016). The impacts of climate change also led to changes in water regimes and all activities involving the inland water resources.

2.1.1 *Inland Fisheries for Food Security and Poverty Alleviation*

Inland fisheries involve large numbers of not only small-scale fishers but also those people engaged in all the stages of the commodity chain of the sub-sector. Thus, inland fisheries operations could be one of the very important measures for reducing poverty especially in rural areas, *e.g.* in the lower Mekong River Basin, as well as in remote, rural areas of the Southeast Asian region. Especially for landlocked country like Lao PDR where all its capture fishery production is derived from inland areas, this sub-sector is very significant for sustaining livelihoods and providing the nutritional requirements of its people.

2.1.2 *Data Collection on Inland Capture Fisheries*

The unique characteristics of inland capture fisheries, *i.e.* comprising large numbers of small-scale and/or part-time fishers, high seasonality and complexity of fishing activities, diversity of species composition, lack of designated ports, and large portion of the production going directly to household consumption, make collection of data and information on fish production a laborious effort to pursue. As a result, most inland capture fisheries statistics are recognized as underestimated. In addition, reporting systems used by enumerators do not seem to cover all fishers and landing sites, as the distribution and consumption pattern of inland fishery products are external to the usual major commodity chains (Welcomme, 2011). Data collection is also hard to undertake considering that inland fisheries use various types of fishing gears, activities, and methods.

The insufficient data therefore does not provide enough information on the status and trend of inland fisheries, leading to little awareness and understanding of the public, stakeholders and policy makers on the importance of inland capture fisheries. This is one of the big challenges in the sustainability of inland capture fisheries. Thus, it is necessary that data collection systems and methods that are applicable to various conditions and background of inland capture fisheries in the region should be improved, which should also incorporate not only quantity but also species composition of the catch, so that the contribution of this sub-sector to the sustainability of fisheries in the region could be visualized.

2.1.3 Impacts of Water Barrier Construction on Inland Fisheries

Sustaining the production of inland capture fisheries requires that inland aquatic habitats and ecosystems should be maintained so that the biological and ecological requirements of aquatic species that inhabit inland waters could be fulfilled. Nevertheless, rapid development creates impact on the connectivity of aquatic habitats, *e.g.* construction of dams and weirs affects upstream and downstream migration of aquatic species, construction of other obstacles such as roads also impedes larval dispersal, threatens the survival of aquatic organisms, and eventually affects the productivity and sustainability of inland capture fisheries. In the Southeast Asian region, several infrastructure-construction projects are approved every year for power generation and/or irrigation, *e.g.* hydropower projects in the Mekong River Basin and other riverine systems and irrigation dams to improve agriculture production in several watersheds of the region. The accumulated impacts from these development projects would result in decreasing fishery resources and productivity from inland waters impinging the cultural, social, and economic values of people in the region (Baumgartner, 2014). Only a few of the many development plans takes into consideration the appropriate mitigation measures that could minimize the impacts of constructing such structures on inland aquatic habitats and fishery resources. Promoting the adoption of appropriate designs of facilities, *e.g.* fishways, is therefore necessary to mitigate the impacts of these constructions and operations of cross-river obstacles to fishery resources, particularly during the peak migration of the aquatic species.

2.1.4 Complexity of Inland Capture Fisheries and Linkages with Other Sectors

Inland fisheries in the Southeast Asian region are characterized by “diversity” and “complexity” in relation with the variation of targeted aquatic species, fishing methods, aquatic environment, life styles of fishers and residents, developmental stages of each

area or country, roles of inland fisheries in each area or community, and also the complicated relationships with other sub-sectors surrounding inland fisheries and fishers’ livelihood (IFRDMD, 2016). Taking into consideration such complexity, several types of fisheries management measures have been developed and could be used in each country or area corresponding to the specificity of the areas, climatic conditions, fishing methods, and also policies of the respective Southeast Asian countries.

Recognizing that human activities such as urban development, industrialization, massive plantations, agricultural intensification, tourism, and other development constructions are among the major causes that affect the status and sustainability of inland capture fisheries in the Southeast Asian region, it is necessary that operations as well as activities related to the use of inland waters by all components and sectors should be harmonized keeping in mind the need to strike a balance between prosperity and sustainability of the resources and environment. Nevertheless, insufficient data and information that could justify the importance of inland capture fisheries makes it difficult for the fisheries sector to convince the public and policy makers on the significance of conserving the aquatic habitats and balancing the needs and trade-offs between fisheries and the other sectors.

2.1.5 Inland Capture Fisheries Compared with Aquaculture

In addition to inland capture fisheries, freshwater aquaculture also contributes to fish production and nutritional requirements of people in the Southeast Asian region. Therefore, it is necessary to understand the strong link between inland fisheries and aquaculture, especially the interaction of these two sub-sectors, *e.g.* the use of inland fishery resources in capture-based aquaculture, the role of hatcheries in supporting culture-based fisheries (Bartley and Jorgensen, 2010). Aquaculture also provides alternative livelihoods and food resources to fishers leaving the capture fisheries sub-sector. However, the total production and recent growth rates of inland capture fisheries and freshwater aquaculture show differences in the trends. While the total production from inland capture fisheries in Southeast Asian region has grown from by 2.2 times over the past 15 years from 1.36 to 3.03 million metric tons with value reaching 3.7 billion US\$ in 2014, that of the region’s freshwater aquaculture has grown by 5.9 times in the last 15 years from 1.29 to 7.56 million metric tons valued at 7.4 billion US\$ in 2014. Although such production trends (**Figure 64**) seem to signify the increasing important roles and the potentials of freshwater aquaculture compared with that of inland capture fisheries, such a situation should not mislead the public as there are several aspects that freshwater aquaculture could not provide the production

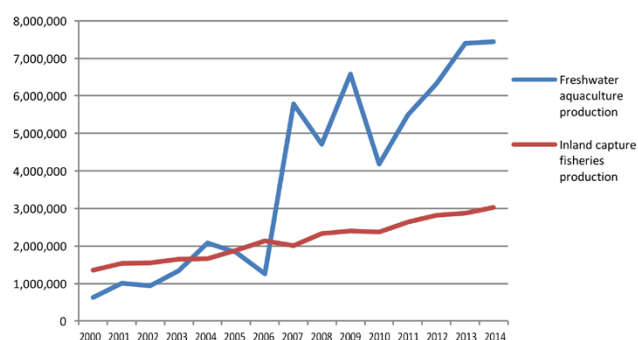


Figure 64. Production trend of inland capture fisheries and freshwater aquaculture in Southeast Asia

Source: SEAFDEC (2005a; 2006; 2008a; 2008b; 2009a; 2010a; 2010b; 2011; 2012a; 2013; 2014; 2015a; 2016a)

substitutes from inland capture fisheries. For example, in terms of its contribution to food security for the poor and disadvantaged groups of people dependent on the harvest of natural resources, inland capture fisheries serve as important sources of micronutrients and calcium requirements from small fishes. Furthermore, the possible impacts of freshwater aquaculture on the environment, e.g. restriction of access to inland water bodies, discharge of effluents that contaminates natural aquatic habitats, spread of diseases and pathogens, culture of few commercial species impacting biodiversity and genetic diversity in natural habitats, introduction and contamination of non-indigenous or invasive species, should also be considered.

2.2 Challenges and Future Direction

In mitigating the impacts caused by human activities (fisheries and non-fisheries sectors) on the sustainability of inland capture fisheries and assuring that the sub-sector would continue to provide significant contribution to food security and livelihood of people in the region, there are various approaches that should be taken into consideration.

2.2.1 Improvement of Data Collection and Dissemination

The inadequacy of reliable data and information on inland capture fisheries and its contribution to the well-being of the people in the region is one of the most important issues that should be addressed, as such a situation threatens the sustainability of the sub-sector. Lack of necessary data led to the low attention given by planners and policy makers on the need to conserve the aquatic habitats, and as a result, priorities are given to other sectors sharing the same water resources or to some extent, even converting aquatic habitats or diverting water resources to other development purposes. Recognizing that fishery statistics is important as basic information to support planning and policy making, valuation of inland capture fisheries and related aquatic ecosystems should be pursued taking into consideration either the direct or indirect benefits

that could be derived from the ecosystems. While it is also well-recognized that collection of relevant data and information is a prerequisite, the need to analyze, interpret, and disseminate such information is also equally crucial in order that the importance of inland capture fisheries is appropriately acknowledged, and trade-offs with other sectors could also be balanced to ensure the sustainability of inland capture fisheries in the future.

2.2.2 Habitat Conservation and Restoration

Inland waters contain large numbers of aquatic species that are adapted to the many different types of environment. In recent years, rapid increase of population and human activities in the Southeast Asian region has generated severe consequences on the conditions of inland waters, such as pollution, degradation of water quality, and so on. The negative effects of anthropogenic activities threaten the habitats of aquatic species and inland capture fisheries as a consequence (FAO and MSU, 2016). Several measures have been developed to conserve the environment although every conservation measure needs collaborative efforts among sub-sectors using the inland waters. Building the awareness not only of fishers but also of the other sub-sectors should be promoted so that measures to conserve the habitats of aquatic species are adapted by all concerned sub-sectors. At the same time, local knowledge, social structure, traditional culture, education, and other factors should be considered simultaneously.

2.2.3 Application of Fish Passage to Mitigate the Impacts of Cross-river Obstacles

Inland capture fisheries in the Southeast Asian region are increasingly threatened by riverine development projects including construction of cross-river obstacles that create barriers to fish migration. The effect of such migration barriers however could be mitigated by the establishment of fishways, which are channels around or through fish migration barriers that allow free passage of fishes during their migration. Although fishways have been set up in many riverine development projects worldwide and helped mitigate factors that hinder the sustainability of inland fisheries globally, it is important that fishway design criteria are established to cater to local aquatic species, and not just adapted from studies conducted elsewhere. Initiatives have therefore been undertaken by many countries in the Southeast Asian region to come up with fishway designs that are appropriate for the region.

Lao PDR is one of the countries where several projects had been implemented with respect to installations of fishways taking into consideration the emerging international concern over the country's national policy that supports hydropower generation as cost-effective source of energy. During the past decade, support from several agencies and

organizations, *e.g.* the Australian Center for International Agricultural Research (ACIAR) and Mekong River Commission (MRC), had been extended to the country for the sustainable development of its water infrastructures that include maintaining upstream and downstream fish passage, improving understanding of the technologies that facilitate fish migrations onto and from floodplains, and enhancing the country's capability to apply low-head fish passage technologies at various levels and improve biodiversity in the floodplains.

In other Southeast Asian countries, a number of cross-river obstacles have been constructed for several purposes, *e.g.* hydropower generation, irrigation, domestic water supply, flood control, among others. Although most of these obstacles have low-water head (*e.g.* less than 7 m) but the accumulated impacts of such construction particularly to the upstream-downstream migration of fish could also be enormous. During 2015-2017, SEAFDEC with support from ACIAR undertakes a project to design and construct experimental fishway facilities in an easily accessible site to facilitate on-station research where different parameters could be controlled and experimented, focusing on vertical-slot design and targeting at low-head weirs. In addition, public awareness and understanding have been enhanced through on-station demonstrations on the use of fishway to mitigate the impacts of cross-river construction on the inland fishery resources.

To encourage future application of fishways, investigation should be made to evaluate and enhance their effectiveness. Furthermore, methodologies for analyzing the cost-benefit analysis of fishways should also be developed considering the costs of construction, operation, and maintenance of the facilities; expected increased incomes from harvests of the fishery resources; benefits to human health; as well as other ecosystem services that could be rendered from the improved connectivity of habitats through the fishways.

2.2.4 Mitigating the Impacts of Freshwater Aquaculture

The rapidly increasing freshwater aquaculture activities could negatively affect the inland capture fisheries and freshwater environment. Freshwater aquaculture in the Southeast Asian region often uses floating cages in natural water bodies and seedstocks are fed intensively. In some areas, it is possible that introduced species escape from cages or culture ponds into the natural environment expelling the native species, including economically important species and endemic species. Seedstocks that are introduced from different water bodies could also bring with them unknown diseases that are passed into the natural environment. Excessive feeding of cultured fish results in the eutrophication of water bodies and degradation of water quality leading to degraded aquatic

resources as a consequence. Competition for the use of waters and areas could also happen between inland fishers and fish farmers (FAO and MSU, 2016). The development of freshwater aquaculture should therefore be promoted in accordance with the carrying capacity of inland water bodies and should take into consideration the possible effects of such aquaculture operations on the water bodies, environment, and existing inland capture fisheries.

3. MARINE SPECIES UNDER INTERNATIONAL CONCERN

3.1 Sharks and Rays

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) promotes the conservation and protection of endangered species of sharks, skates, and rays (elasmobranchs) to ensure that their international trade does not threaten the survival of the species in the wild. Meanwhile, FAO promoted the International Plan of Action for Conservation and Management of Sharks (IPOA-Sharks) which was adopted during the Meeting of the FAO Committee on Fisheries (COFI) in 1999. The IPOA-Sharks also intends to provide a framework for the development of national, sub-regional, and regional plans as well as assessments of sharks in the member countries' respective waters and also for transboundary species of sharks.

The Southeast Asian region has rich biodiversity of elasmobranch species. It has been recorded that at least 180 species of sharks, 30 species of skates, and 160 species of rays inhabit the Southeast Asian region from freshwater environments to the deep seas (SEAFDEC, 2016g). The AMSs developed and implemented their respective National Plans of Action for Sharks (NPOA-Sharks) subsequent to that of the IPOA-Sharks published in 1998, by updating the status of the resources, biodiversity, socio-economic aspects as well as information related to trade. Records also show that in the Southeast Asian region, almost all parts of sharks and rays including their meat, skin, liver as well as cartilages, are fully utilized.

In Southeast Asia, sharks and other elasmobranchs are by-catch of hook-and-line, gillnet, trawl net, purse seine net, and other fishing gears. Even though the Southeast Asian waters have one of the richest elasmobranch diversity of the world, the status of production and utilization of sharks and other elasmobranchs is still largely underdetermined due to insufficient data including information on catch and landings at identified species level. Moreover, information on trade as well as on the biological parameters of many shark species are also difficult to establish due to the limited capacity in collecting fishery data of most countries in Southeast Asia. Nevertheless, SEAFDEC reported that the total landing of sharks and rays of the AMSs in