

Installing Reforms in the Southeast Asian Region toward Sustainable Development of Aquaculture and Inland Fisheries: SEAFDEC perspective

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The Southeast Asian Fisheries Development Center (SEAFDEC) has been working incessantly for the sustainability of fisheries in the Southeast Asian region. Such efforts had been clearly manifested in the progress and development of fisheries in the region that prompted the ASEAN Member States (AMSs) to adopt the series of decennial ASEAN-SEAFDEC Resolutions and Plans of Action on Sustainable Fisheries for Food Security for the ASEAN Region in 2001, 2011, and 2020, which have served as policy frameworks and priority actions for the AMSs to support their efforts towards attaining sustainability in fisheries development and enhancing the contribution of fisheries to food security and socioeconomic advancement. As a result from such efforts, many Southeast Asian countries have become major exporters of fish and fishery products to the world's fish market. Nonetheless, it is feared that such feat might not be sustained in the long run considering the fate of marine capture fisheries, where its production had been dwindling due to the unhealthy condition of the marine fishery resources brought about by uncontrollable non-responsible fishing activities resulting in their over-exploitation and devastation. In order to address such concerns, it had become necessary to institute reforms within SEAFDEC as well as in the regional arena, which could include harnessing the potentials of aquaculture and inland fisheries towards sustainable development. Amidst such a

situation, SEAFDEC and the AMSs are not feeling desperate as these other fisheries sub-sectors could provide the gleam of hope because of their potentials that could be tapped to sustain the region's fishery production and eventually supply the rising demand for food fish by the increasing population. In view of the potentials that such sub-sectors could offer, SEAFDEC has always made sure that the sustainability of inland fisheries and aquaculture is embedded in its plans, programs and activities, as indicated in the 2001 and 2011 ASEAN-SEAFDEC Resolutions and Plans of Action on Sustainable Fisheries for Food Security for the ASEAN Region. Moreover, in the latest ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2030, Resolution Numbers 14 and 15, and Plan of Action Numbers 40-47 specifically focused on the sustainable development of inland fisheries, while Resolution Numbers 16-18 and Plan of Action Numbers 48-69 are devoted to sustainable development of aquaculture. By putting greater attention on the sustainable development of inland fisheries and aquaculture, the stakeholders from the region are ensured of food security in the years to come, while allowing the marine fishery resources to recover from their current state of decline and restore their capacity to rebuild and be able to provide again sufficient food fish for the people.

The Southeast Asian Fisheries Development Center (SEAFDEC) was established in 1967 to serve as a platform for the promotion of fisheries to improve the food situation in Southeast Asia (Silapajarn & Sulit, 2018). In order that SEAFDEC could fulfill such mission, the Marine Fisheries Training Department and Marine Fisheries Research Department (SEAFDEC/MFRD) were simultaneously established in 1967 in Thailand and Singapore, respectively, with the former which became more popularly known as the Training Department (SEAFDEC/TD) tasked to offer training on modern fishing technologies and the latter, which became operational in 1968, to conduct research on marine fishery resources evaluation and oceanographic surveys in the waters of Southeast Asia.

More than six years later, when it was deemed necessary to promote the sustainable development of fish culture in the region towards increased production to supplement the production from marine capture fisheries, the Aquaculture Department (SEAFDEC/AQD) was established in the Philippines in 1973. Almost during such time, a plan was conceived to transfer the marine research function of MFRD to the proposed Marine Fishery Resources Development and Management Department (SEAFDEC/MFRDMD) that was suggested to be established in Malaysia in 1990 but

became operational only in 2002. With such development, the function of MFRD shifted to undertaking research on fisheries post-harvest technology and processing, initially focusing on fish preservation and upgrading of the quality of the region's traditional fish products. After more than 10 years, and cognizant of the role that inland fisheries play for the socioeconomic development and food security of the people of Southeast Asia, and the need to tap the vast inland water resources available in the region, the SEAFDEC Council of Directors agreed to establish the Inland Fishery Resources Development and Management Department (SEAFDEC/IFRDMD) in 2014 in Indonesia.

It should be recalled that in the history of Southeast Asian fisheries development, fishing activities in the region before the 1980s were confined in near-shore areas and in territorial seas that lay only 12 nautical miles from the shore, and fishers made use of simple implements and non-motorized or non-mechanized fishing vessels. Most of their landings were intended mainly for domestic consumption with few countries producing fishery products bound for the export market. Nonetheless, some national planners at that time had the view that the fishery resources could be inexhaustible so that big national plans were made with such perception in mind. Embracing the latest fishing technologies coming from the

modern world, many Southeast Asian countries were able to enhance their fishing capabilities, and started investing heavily on fishing vessels and fishing gear. These had proved them right as the returns of investments were huge and increases in landings from marine capture fisheries had ensued.

Nevertheless, overfishing became prominent that eventually led to declines in landings that were felt more by the fishers rather than by the policy-makers. When the United Nations Convention on the Law of the Sea (UNCLOS) was signed into force in December 1982 signaling the expansion of the exclusive economic zone (EEZ) to 200 nautical miles from the shore, many coastal countries, including those in Southeast Asia welcomed such development as it could mean stretching their control over the expanded fishing areas. Many countries therefore intensified their fishing activities by deploying more fishing vessels to sea, only to find out later that this was detrimental to the fate of the fishery resources, as fewer fish had been caught later.

Way back in 1997, FAO (1997) confirmed that while the population of Southeast Asia has been rapidly growing, the countries in the region would need to increase their domestic protein supply from fish by tapping the potentials of aquaculture and inland fisheries considering that marine fishery resources have been generally fully exploited. FAO added that in the early 2000s, some of the Southeast Asian countries had been among the top ten fisheries producers from aquaculture (*i.e.* Indonesia, Thailand, Philippines, Viet Nam), and in inland capture fisheries, *e.g.* Indonesia, Cambodia, Myanmar (FAO, 2000; FAO, 2002).

In the Southeast Asian scenario, the fishery statistics indicated that although after 1976–1980, the annual production in terms of number appeared to have been increasing but the annual increases had been very minimal (**Table 1** and **Table 2**). Meanwhile, the United Nations had estimated that the world's population by 2030 would be about 8,501 million and that Southeast Asia's population would be about 717 million (**Table 3**). Considering that the average annual consumption of fish in the AMSs is 33.4 kg/capita, this means that in 2018, the amount of fish available for consumption in the AMSs should be 21,877,000 t, and about 22,177,00 t in 2020. By 2030, the amount of fish available for consumption of the people in the AMSs should be about 23,957,800 t. It is therefore necessary that the fisheries sector of Southeast Asian should be sustainably developed and be able to fulfill the gigantic task of producing sufficient quantity of fish to supply the demand of the region for food fish.

Such circumstances had led to a general situation which necessitated reforms in the fisheries sector, especially in terms of developing the ways and means of promoting sustainable management of the fishery resources. Thus, SEAFDEC instituted reforms within the organization by establishing and advocating measures directed towards the sustainable development and management of fisheries in the Southeast Asian region. Under such reforms, the marine fishery resources had been allowed to recover by developing and instituting measures for their sustainable development and management, *e.g.* countermeasures to eliminate illegal, unreported and unregulated (IUU) fishing (Smithrithee *et al.*, 2020). Meanwhile, the sustainable development of

Table 1. Fisheries production of Southeast Asia by five-year period* in thousand t

	1976a	1980a	1986a	1990a	1996a	2000a	2006a	2010b	2016b	2018b
Marine capture fisheries	3,832	5,894	6,893	8,083	9,868	12,550	13,939	14,874	17,247	18,330
Inland capture fisheries	485	904	874	1,015	1,717	996	2,107	2,377	3,126	3,337
Aquaculture	310	815	928	1,564	2,679	3,320	8,348	14,187	25,183	24,872
Total	4,627	7,613	8,695	10,662	14,264	16,866	24,394	31,438	45,536	46,539

*Except for 2016–2018

Source a: SEAFDEC (1976, 1980, 1986, 1990, 1996, 2000, 2006a)

Source b: SEAFDEC (2010, 2016, 2018)

Table 2. Average annual rate (%) of increase in fisheries production of Southeast Asia: by five-year period*

	1976–1980	1981–1985	1986–1990	1991–1995	1996–2000	2001–2005	2006–2010	2011–2015	2016–2018
Marine capture fisheries	7.00	2.90	2.94	3.62	4.28	2.00	1.26	2.76	1.97
Inland capture fisheries	9.28	-0.69	2.78	8.18	-14.48	10.55	2.27	5.80	2.11
Aquaculture	2.48	2.49	8.13	8.32	3.86	12.05	8.23	8.83	-0.42
Total	7.85	2.35	3.69	5.05	3.09	6.17	4.48	6.33	0.86

*Except for 2016–2018

Table 3. Total population of the world and Southeast Asia in 1990–2030 in million (UN estimates)

	1970	1980	1990	2000	2010	2018	2020	2030
World's population	3,683	4,433	5,327	6,143	6,957	7,714	7,795	8,501
Population of Southeast Asia	285	359	445	524	594	655	664	717

aquaculture and inland capture fisheries had been given more focus in the plans and programs of SEAFDEC (Pongsri *et al.*, 2011; Pongsri *et al.*, 2015a; Pongsri *et al.*, 2015b; Platon *et al.*, 2007; Ayson *et al.*, 2015; Prisantoso & Sulit, 2014; Wibowo *et al.*, 2018).

Institutional Reforms

First and foremost in the 1990s, SEAFDEC enhanced its collaboration with the Association of Southeast Asian Nations (ASEAN) to be able to intensify the promotion of sustainable fisheries development in the whole Southeast Asian region. This also called for the expansion of the membership in SEAFDEC which originally included Japan, Malaysia, Thailand, Singapore, and Philippines, by inviting all the other ASEAN Member States (AMSs) to become members of SEAFDEC in order that all the AMSs would benefit from the technologies developed and promoted by SEAFDEC. So, by 2003, all the AMSs and Japan comprise the members of SEAFDEC, *i.e.* Brunei Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam.

Meanwhile, the worldwide concern about the sustainability of natural renewable resources led to the adoption in 1992 of Agenda 21 of the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil. UNCED reflected a global consensus for more ecosystem-based sustainable development across all sectors of human activity, as means of improving the human welfare of present generations without sacrificing that of the future. UNCED also called for a substantial shift in governance, improved scientific support to decision-making, and a substantial increase in strategic information (FAO, 1992).

On the part of SEAFDEC, various reforms were carried out for the sustainable development and management of fisheries, which were instituted in collaboration with the AMSs and with major technical and financial support provided by the Government of Japan through the JTF (Tsubata, 2008; SEAFDEC, 2008; Ishii *et al.*, 2017; SEAFDEC, 2020a). As shown in the **Box**, such reforms include progress and development in the region's fisheries that also dovetail to propelling inland fisheries and aquaculture of the Southeast Asian region towards sustainability.

Box. Major reforms instituted by SEAFDEC and the AMSs for the sustainable development of fisheries in the Southeast Asian region
<p>General institutional reforms</p> <p>Promotion of the Strategy and Action Plan of the Resolution on SEAFDEC Strategic Plans Cognizant of the way forward of SEAFDEC towards intensifying the promotion of sustainable fisheries development in the Southeast Asian region, the SEAFDEC Council of Directors during their Thirtieth Meeting in 1998 adopted the Strategy and the Action Plan of the Resolution on SEAFDEC Strategic Plans, to serve as guides in realizing the goal set by the SEAFDEC mandate, and in enhancing the collaboration of SEAFDEC with the ASEAN. Against the backdrop of such enhanced collaboration, SEAFDEC has been working with the AMSs in generating policy guidelines and recommendations for the sustainable development of fisheries taking into consideration the provisions stipulated in the Strategy and the Action Plan.</p>
<p>Establishment of the ASEAN-SEAFDEC Fisheries Consultative Group The aforesaid enhanced collaboration facilitated the establishment in 1998 of the ASEAN-SEAFDEC Fisheries Consultative Group (FCG) as a mechanism for the implementation of joint ASEAN-SEAFDEC plans, programs and activities for the sustainable development and management of fisheries in the Southeast Asian region. The implementation of the relevant plans, programs and activities has been financially supported from the Government of Japan through the Japanese Trust Fund (JTF).</p>
<p>Regionalization of the Code of Conduct for Responsible Fisheries At the international arena, FAO had been promoting the implementation of the global Code of Conduct for Responsible Fisheries (CCRF) which was adopted by the FAO member states in 1995. In order that the CCRF could be adopted in the Southeast Asian region considering its specific context, <i>e.g.</i> culture, fisheries structures, ecosystems, SEAFDEC embarked on the Project Regionalization of the Code of Conduct for Responsible Fisheries (RCCRF) in 1998. With support from the JTF, the RCCRF Project came up with the Regional Guidelines for Responsible Fisheries in Southeast Asia: Responsible Fishing Operations (SEAFDEC, 2000a); Responsible Fisheries Management (SEAFDEC, 2003); Responsible Aquaculture (SEAFDEC/AQD, 2001; SEAFDEC, 2005a); and Responsible Post-Harvest Practices and Trade (SEAFDEC, 2005b). Moreover, to elucidate on the management of inland fisheries, the Project RCCRF also developed the Supplementary Guidelines on Co-management using Group User Rights, Fisheries Statistics, Indicators, and Fisheries <i>Refugia</i> (SEAFDEC, 2006b). To ensure that the AMSs would be able to adopt the regionalized CCRF, SEAFDEC provided capacity building of the human and institutional resources of the AMSs with financial support from the Government of Sweden through the Swedish National Board of Fisheries (Wanchana, 2007).</p>
<p>Promotion of the ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security in the New Millennium In an effort to address the issues on unsustainable fisheries practices in the region that could negatively impact on the availability of sufficient fish supply for food security and socioeconomic well-being of peoples in the Southeast Asian region, the ASEAN and SEAFDEC adopted the Resolution and Plan of Action (RES&POA-2001) on Sustainable Fisheries for Food Security in the New Millennium (SEAFDEC, 2001) during the ASEAN-SEAFDEC Millennium Conference "Fish for the People" in November 2001. The RES&POA-2001 had served as guidelines in formulating programs and activities, <i>e.g.</i> Special Five-year Program on the Contribution of Sustainable Fisheries for Food Security for the ASEAN Region in the AMSs leading to the revision of fisheries regulations of the respective AMSs towards sustainability. The RES&POA-2001 also included provisions on the sustainable development and management of aquaculture and inland fisheries in the AMSs</p>
<p>Establishment of the ASEAN-SEAFDEC Strategic Partnership As means of strengthening the ASEAN and SEAFDEC cooperation and collaboration for the promotion of sustainable fisheries development under the ASEAN-SEAFDEC FCG, the ASEAN-SEAFDEC Strategic Partnership (ASSP) was established upon the signing of the Letter of Understanding (LOU) in 2007 that provided the formal complementary framework for the ASEAN and SEAFDEC to work together and support the ASEAN in fulfilling its vision of "becoming a leader in sustainable tropical fisheries for the people" and in the economic integration of the fisheries sector. Signed by the Secretary-Generals of the ASEAN and SEAFDEC, the LOU stipulates the agreed principle to continue using the existing FCG mechanism to consult, deliberate and agree on the ASEAN-SEAFDEC fisheries programs, activities and policies.</p>

Box. Major reforms instituted by SEAFDEC and the AMSs for the sustainable development of fisheries in the Southeast Asian region (Cont'd)

Promotion of the ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020

Although significant progress had been attained by the AMSs in promoting sustainable fisheries and in improving the people's livelihoods for food security, ten years after the adoption of the RES&POA-2001, the continued deterioration of the ecosystem and the environment brought about by climate change, and social and economic factors, necessitated the AMSs to keep abreast of the changing environment to be able to address the emerging challenges in fisheries development, and enhance the competitiveness of the region's fish and fishery products in the world market. Thus, the AMSs and SEAFDEC adopted the ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020 (RES&POA-2020) during the ASEAN-SEAFDEC Conference "Fish for the People 2020: Adaptation to a Changing Environment" in June 2011 (SEAFDEC, 2011). The RES&POA-2020 has since then served as policy guidelines during the following decade, and as priority actions towards ensuring fisheries sustainability for food security and improving the livelihoods of the peoples in the region. The RES&POA-2020 has stipulated sufficient provisions on the sustainable development of aquaculture and inland fisheries.

Fostering joint commitment to combat IUU fishing in Southeast Asia

Considering the stringent measures imposed by importing countries on the export of fish and fishery products by checking on their source to make sure that such products do not come from IUU fishing activities, the ASEAN and SEAFDEC convened a consultation in 2016 where expression of support and commitment of the AMSs was conveyed through the signing the Joint ASEAN-SEAFDEC Declaration on Combating IUU Fishing and Enhancing the Competitiveness of ASEAN Fish and Fishery Products (SEAFDEC, 2016). The signed Joint Declaration is a testimony of the commitment of the AMSs to work together in addressing the emerging issues spawned by the practice of irresponsible fishing, especially IUU fishing activities.

Promotion of the ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2030

After the ten-year implementation of RES&POA-2020, and upon considering the results of a review carried out by the AMSs with support from SEAFDEC and JTF, the AMSs and SEAFDEC came up with the ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2030 (RES&POA-2030) that accommodated the emerging issues and challenges in the fisheries sector of Southeast Asia (SEAFDEC, 2020b). The adopted RES&POA-2030 is being used as a regional framework for the sustainable development of fisheries and enhancing the contribution of fisheries to food security and livelihoods of peoples in the Southeast Asian region in the next decade.

Major reforms in marine capture fisheries

Promotion of the concept of Ecosystem Approach to Fisheries Management

The concept of Ecosystem Approach to Fisheries Management (EAFM) had been advanced by SEAFDEC in the Southeast Asian region with support from the JTF, initially focusing on the management of marine fishery resources, through capacity building by enhancing the understanding of the region's fisheries management officers on the appropriate fisheries management approaches for the sustainability of the fishery resources (SEAFDEC, 2017a). The concept has been extended by SEAFDEC to cover the inland fishery resources, as well as aquaculture through the concept of what is known as the Ecosystem Approach to Aquaculture Management.

Establishment of regional approaches and tools to combat IUU fishing in the Southeast Asian region

Recognizing that the increasing demand for fish driven by rapid human population growth and coupled with the deteriorating state of the marine fishery resources, had contributed to the continued practice of illegal fishing by many fishers in the Southeast Asian region, SEAFDEC established the general direction for combating IUU fishing in the region in collaboration with the AMSs and with support from JTF. Various approaches had been developed to address such concern (Smithrithee *et al.*, 2020), starting with the promotion of the ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain (Ali *et al.*, 2015) developed by MFRDMD in collaboration with the AMSs. Then, TD also embarked on the establishment of the Regional Fishing Vessels Record (RFVR) and RFVR database for fishing vessels 24 m in length and over, the promotion of the adoption of the Regional Plan of Action on Fishing Capacity to manage fishing capacity in Southeast Asia (SEAFDEC, 2017b), strengthening of the monitoring, control and surveillance (MCS) and regional MCS networks, intensifying the promotion of port State measures, and promoting catch documentation and traceability of fish and fishery products among others. While efforts are now being made by TD to link the RFVR with the FAO Global Record of Fishing Vessels, Refrigerated Transport Vessels and Supply Vessels (Global Record) to avoid duplication of efforts and information, discussion is also underway among the AMSs and SEAFDEC for the possibility of expanding the RFVR to cover fishing vessels less than 24 meters in length.

Major reforms in fisheries post-harvest and processing

Promotion of guidelines on food safety measures to ensure the quality and safety of fishery products for food security in Southeast Asia

While before, traditional fishery products of the AMSs had been generally produced by backyard processing industries and consumed domestically, the increasing demand for fishery products necessitated the improvement of these traditional fishery products to comply with the safety and quality standards, and requirements for fish and fishery products traded in the world market. In this regard, MFRD developed and promoted the appropriate guidelines on food safety measures, e.g. good manufacturing practices (GMP), standard sanitation operating procedures (SSOP), and with support from JTF, MFRD assisted the AMSs in implementing such measures by incorporating the Hazard Analysis Critical Control Point (HACCP) plans in their GMP programs (Yeap & Chow, 2011). This has enabled the processing industries of the AMSs to meet the safety and quality assurance requirements for their traditional fishery products. The processing industries had also developed fishery products using freshwater fishes from inland fisheries as raw materials to fill the gap caused by the dwindling supply of raw materials from marine capture fisheries.

Promotion of the regional system of monitoring and analysis of contaminants in seafood

In order to enhance the understanding of stakeholders in the AMSs of the levels of chemical contaminants in fish and fishery products in Southeast Asia, and to transfer the developed testing technologies and methodologies to the region through capacity building of their human and institutional resources, MFRD in collaboration with the AMSs and with support from JTF, conducted series of surveys to monitor and analyze the presence of chemical contaminants and drug residues in fish and fishery products of the region (Ong, 2020). Moreover, surveys on biotoxins were also carried out to monitor the incidence of biotoxins contamination of the region's fish and fishery products. This resulted in the publication of the series of Technical Compilations of Biotoxins Monitoring in the ASEAN region that also include monitoring of the toxic harmful algal blooms (HABs), e.g. red tide. The Technical Compilations (Tan & Saw, 2008; Neo *et al.*, 2012; Ong & Chai, 2019) had served as reference and learning tool for concerned stakeholders especially the policy-makers in the region on the occurrences and incidences of biotoxins and on HABs. Meanwhile, the regional capability of the national testing laboratories of the AMSs had been improved making them capable of monitoring and analyzing contaminants in seafood.

Box. Major reforms instituted by SEAFDEC and the AMSs for the sustainable development of fisheries in the Southeast Asian region (Cont'd)

Major reforms in aquaculture

Getting out of the fish meal trap

While the aquaculture industry in Southeast Asia continues to expand and aim for increased production, aquaculture operations had been viewed as a threat to marine capture fisheries because of the rampant use of fish by-catch in aquaculture feeds. By using the fish catch meant for human direct consumption for aquaculture feeds, this resulted in over-exploitation and eventual degradation of the marine fishery resources. With support from JTF, AQD had enhanced its R&D activities since early 2010s to find fishmeal substitutes in aquafeed formulations by using locally-available plant and other non-fish based protein sources in order to minimize the pressure on the marine fishery resources (Mamaug, 2016; Aya, 2017). Assessing the sustainability and cost-effectiveness of the various alternative protein sources and ingredients for aquafeeds is also being pursued by AQD.

Promotion of prompt and effective aquatic animal health management

In early 2010s, several new transboundary aquatic animal diseases (e.g. EMS/AHPND) have emerged resulting in widespread devastation of the aquaculture industry, especially the shrimp industry of Southeast Asia (Tendencia & Estilo, 2017). As means of addressing this concern, SEAFDEC with support from JTF, enhanced regional cooperation for the adoption of recommendations on policy issues that include harmonization of legislations and regulations related to aquatic animal health management, e.g. legislation on transboundary movement of live aquatic animals, compliance with good aquaculture practices, strengthening cooperation and collaboration arrangements with various international and regional organizations and agencies concerned with aquatic animal health management. The series of international and regional consultations came up with the Regional Technical Guidelines on Early Warning System for Aquatic Animal Health Emergencies (SEAFDEC, 2020c), which is being promoted in the AMSs for the prompt and effective aquatic animal health management. AQD would strengthen the adoption of the Guidelines in the AMSs through its planned Regional Technical Consultation on Aquatic Animal Health Emergencies to be organized in 2022.

Promotion of the Regional Guidelines to support development of traceability system for aquaculture products

Considering the significant volume of cultured fish and fishery products exported by the AMSs annually to regional and international markets, the traceability of such products should be ensured to enhance the competitiveness of such products and facilitate trade with major importing countries. As traceability has also become a requirement for exporting these products to global fish market, the international community had called for the establishment of a reliable traceability system that would ensure the safety and quality of the products. This led to the development by MFRD in collaboration with the AMSs and with support from JTF, of the Regional Guidelines on Traceability System for Aquaculture Products in the ASEAN Region (SEAFDEC, 2017c) to serve as common reference for the AMSs in the implementation of traceability systems for aquaculture products as well as for the development of national programs on traceability of aquaculture products.

Major reforms in inland fisheries

Establishment of a regional center for inland fisheries

Recognizing that the sustainable development of inland fisheries in Southeast Asia is crucial for food security and for improving the well-being of the peoples of the AMSs, and considering the crucial role that inland fisheries could play for the region's socioeconomic development of the vast inland resources, the SEAFDEC Council of Directors agreed to establish a regional center for inland fisheries in September 2014 under the umbrella of SEAFDEC (Pongsri *et al.*, 2015; Wibowo *et al.*, 2018). Known as the Inland Fishery Resources Development and Management Department (IFRDMD) of SEAFDEC, it is tasked to provide the platform for the proper development and management of the inland fishery resources of the Southeast Asian region.

Promotion of the sustainable development of inland fisheries in Southeast Asia

Confirming that inland fisheries could play a significant role in enhancing the region's socioeconomic development for the region's food security by sustainably utilizing the vast inland resources that are available for sustainable development and also tapping the numerous species of indigenous fishes that inhabit the region's inland waters (Isa *et al.*, 2011), IFRDMD with support from JTF, has currently undertaken the colossal task of developing the guidelines and tools relevant to the sustainable development of fisheries. These include among others, basic data collection system for routine monitoring of different types of inland habitats, assessment and management of inland fishery resources, monitoring the state and levels of exploitation of inland fishery resources, and scientific basis for the proper development and management of inland fishery resources (Wibowo *et al.*, 2018).

Promotion of an efficient system of data collection on inland fisheries

The development of inland fisheries is crucial for sustaining the socioeconomic conditions of many countries in Southeast Asia. However, information on the actual contribution of inland fisheries to food security is not readily available, making it difficult to assess the importance and value of inland fisheries, and constitutes a big challenge for its development. Even if data are available, these are not sufficient enough for any analysis (Muthmainnah *et al.*, 2020). Considering that the importance of catch statistics from inland capture fisheries had not been given much attention before, IFRDMD has been exploring all the possible ways for developing an effective and efficient system of collecting data from inland capture fisheries. Such effort had resulted in the development and promotion of a novel application-based system on android mobile phones for collecting data from inland capture fisheries. Although initially promoted in Indonesia at the moment, this system would be introduced to other AMSs, especially in Lao PDR, Cambodia, Myanmar, and Viet Nam where the amount of catch from inland capture fisheries could be significant.

Way Forward

While the marine fishery resources of the Southeast Asian region is allowed to recover from degradation and restore their potentials for future utilization, SEAFDEC would continue to exert efforts in developing the strategies for the sustainable development of aquaculture and inland capture fisheries, considering that these two sub-sectors have the

potentials that could be tapped to increase fish production. Such development is expected to lead to increased fisheries production, stabilizing the supply-demand gap in food fish brought about by the dwindling production from marine capture fisheries.

Through the plans and programs of AQD, promotion of responsible aquaculture would be enhanced as this has always

been the long-term strategy for the economic development in the region. However, there is a need to continue efforts in addressing the major concerns and knowledge gaps in the sustainability of aquaculture. These concerns could include, among others: the availability of good quality seeds for culture; maintaining environmental integrity through responsible aquaculture; sustaining healthy and wholesome aquaculture; adapting to the impacts of climate change; and meeting social and economic challenges (Ayson *et al.*, 2015). In other words, as Platon *et al.* (2007) aptly explained in their discourse, AQD should continue to make sure that aquaculture remains sustainable, technically feasible and economically-viable, as well as environment-friendly and socially equitable. Moreover, Ishii *et al.* (2017) also added that, such future actions would also include addressing the major concerns in the occurrence and spread of aquatic diseases through the promotion of proper aquatic health management to make sure that the region would continue to generate healthy and wholesome fish and fishery products from aquaculture.

This also confirms that SEAFDEC would continue to promote the adherence of the AMSs to the Regional Technical Guidelines on Early Warning System for Aquatic Animal Health Emergencies (SEAFDEC, 2020c) to prevent the rapid spread of aquatic diseases that could impact on the sustainable development of the region's aquaculture sub-sector. By adhering to the wholesomeness of aquaculture, the region's aquaculture production could be increased while the competitiveness of the region's fish and fishery products from aquaculture is enhanced.

Furthermore, it has also become crucial for aquaculture operations to reduce their dependence on fishmeal for aquafeeds production to allow the fishery resources to rebuild and rehabilitate their potentials. This strategy calls for the replacement of fishmeal in the production of aquafeeds using less expensive alternative protein sources, *e.g.* plant-derived materials, agricultural wastes, food processing byproducts (Mamaug, 2016; Aya, 2017). Therefore, AQD would continue its R&D efforts toward producing cost-effective aquafeeds as well as developing affordable processing techniques for converting these alternative feed ingredients into effective raw materials for aquafeed production (Ishii *et al.*, 2017).

In the current scenario of the inland capture fisheries of Southeast Asia, where its sustainability is being confronted with various concerns, the plans and programs of IFRDMD aimed at the sustainable development and management of inland fishery resources would be pursued vigorously. Muthmainnah & Makmur (2017) surmised that there is a need to effectively address such concerns in order that considerable quantity of quality freshwater fish could be generated from inland fisheries. Considering that the most crucial concern is the dearth of realistic data and information on the benefits that could be gained from responsible utilization of aquatic habitats

and water resources to sustain food security and livelihoods of peoples, it has become imperative that the development of practical methodologies for the valuation of the aquatic ecosystem services, and intensification of the awareness building on such aspects should be sustained in the AMSs. There is also a need to adopt the most efficient and effective fisheries management measures applicable for inland fisheries, *e.g.* co-management, community-based fisheries management, rights-based management. Nonetheless, adoption of the concept of the ecosystem approach to fisheries management (EAFM) could encompass all those previously suggested management measures, as the EAFM gives due consideration to the socioeconomic aspects of fisheries management (SEAFDEC, 2017a). As for the other challenges that could also impede the sustainable development of inland fisheries, *e.g.* insufficient data and information, especially on the actual production from the fisheries; environmental degradation due to pollution caused by land-based activities; overexploitation of inland fishery resources by fishers unmindful of the need for food fish by future generation; rapidly increasing population leading to severe conflict on the use of water and resources, IFRDMD would continue to work towards developing the most appropriate approaches to address such concerns and ensure the sustainability of the inland fishery resources (Muthmainnah *et al.*, 2017).

With regard to the severe competition on the use of water resources among the various economic and development sectors coupled by the massive water infrastructure development programs of many governments that include construction of dams and weirs to fulfill their urbanization and industrialization plans, IFRDMD would continue to promote the significance of constructing fish ways, also known as fish passes or fish passages on dams and weirs, and enhance the awareness of stakeholders on the important role that such fish ways play in improving water connectivity to sustain the inland fishery resources (Pongsri *et al.*, 2016; Ditya *et al.*, 2021). Without having these fish ways would create depletion or even population collapse of many freshwater fishes as their migration patterns could be disrupted.

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