FISH for the PEOPLE

A Special Publication for the Promotion of Sustainable Fisheries for Food Security in the ASEAN Region
Volume 19 Number 3: 2021 Bangkok, Thailand, ISSN: 1685-6546

Conservation and Management of Aquatic Resources for Sustainability of Southeast Asian Small-scale Fisheries and Aquaculture

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Editor in Chief (Fish for the People)

SEAFDEC Secretariat
Kasetsart University Campus
P.O. Box 1046, Kasetsart Post Office,
Bangkok 10903, THAILAND
E-mail: fish@seafdec.org

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Editorial

In the Southeast Asian region, majority of the fishers are engaged in small-scale operations, be it in pre-harvest, harvest, or post-harvest arena, fundamental to the social and cultural structures in the fishing communities. Undertaken in "multi-use, multi-user" coastal and inland environments, such operations compete for the water resources with users from the other sectors, resulting in habitat degradation and resource depletion. Promotion of the Voluntary Guidelines for Securing Sustainable Small-scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines) by the Food and Agriculture Organization of the United Nations (FAO) could pave the way for better management of the region's small-scale fisheries and aquaculture, and facilitate equitable sharing of the water resources by the inland and coastal fishing communities. Based on the SSF Guidelines, strategies should be established and promoted to balance water resource utilization by the fisheries sector and non-fisheries sectors, *e.g.* agriculture, public utilities, power generation, and to address resources degradation.

In inland water environments, construction of infrastructures across rivers and other water bodies for economic development often results in depletion of economically-important inland fish populations as their migration routes are interrupted while they go about completing their life cycles. Construction of fish passage is therefore, being promoted to allow upstream waters of rivers to reconnect with the downstream waters, thus, maintaining river connectivity, and facilitating fish migration from downstream to upstream and vice-versa.

Production of this publication is supported by the Japanese Trust Fund.

There is also a need to balance the uses and users of marine waters, and the concept of marine spatial planning (MSP) could be adopted in formulating regulations, zoning, management, protection, and sustainability of the marine resources. Making use of the ecosystem approach, MSP could serve as means of better managing ocean spaces by balancing ecological, social and economic objectives. Considering that MSP concept addresses the multiple, cumulative and potentially conflicting uses of marine waters, it could also reduce the conflicting interactions between aquaculture and the environment. Meanwhile, efforts should also be sustained towards minimizing the impacts of fishing operations on the environment for the sustainability of fisheries.

Notwithstanding the efforts of the ASEAN Member States in promoting the sustainable management of fisheries and aquaculture operations during the COVID-19 pandemic, to date, the complex impacts of the pandemic on the fisheries and aquaculture sector in Southeast Asia has remained unpredictable and unstable. Nonetheless, strengthened cooperation among relevant stakeholders and organizations is crucial for the promotion and implementation of the strategies that support all efforts toward attaining an all-time sustainability of small-scale fisheries and aquaculture in the Southeast Asian region.

Call for Articles

FISH for the PEOPLE is a policy-oriented special publication of SEAFDEC. Now on its 19th year, the Publication is intended to promote the activities of SEAFDEC and other relevant fisheries concerns in the Member Countries. We are inviting contributors from the SEAFDEC Departments, Member Countries, and partner organizations to submit articles that could be included in the forthcoming issues of the special publication. The articles could cover fisheries management, marine fisheries, aquaculture, fisheries postharvest technology, fish trade, gender equity in fisheries, among others. Written in popular language and in layperson's terms for easy reading by our stakeholders, the articles are not intended to provide detailed technical and typical scientific information as it is not a forum for research findings. Please submit your articles to the Editorial Team of Fish for the People through the SEAFDEC Secretariat at fish@seafdec.org. The article should be written in Microsoft Word with a maximum of 10 (ten) pages using Times New Roman font 11 including tables, graphs, maps, and photographs.

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CONTENTS

FISH for the PEOPLE is a special publication produced by the Southeast Asian Fisheries Development Center (SEAFDEC) to promote sustainable fisheries for food security in the Southeast Asian region.

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Towards the Sustainable Development of Small-scale Fisheries and Aquaculture: the legacy of SEAFDEC

Malinee Smithrithee, *Koichi Honda*, *Nualanong Tongdee*, and *Virgilia T. Sulit*

In Southeast Asia, history has it in the past few decades or so that fishing operations were simple and conducted in near-shore areas using non-motorized or non-mechanized fishing vessels. Fish landings were barely enough for domestic consumption, but some countries dared to explore the export market with their fishery products that gave them in return, not only additional economic advantage but also the inspiration to enhance their fishing capabilities. Adapting the fishing technologies learned from more advanced countries, *e.g.* trawl fisheries, many Southeast Asian countries were able to increase their fish landings. Causing a domino effect, many fishing vessels were deployed to sea using a great variety of fishing gears, not minding their possible impacts on the fishery resources. Eventually, their catch started to get smaller not only in terms of quantity but also in size, prompting the governments to look for the ways and means of properly managing the fishery resources. In an effort to address the issues at hand, one of the major decisions made by the governments of the Southeast Asian countries was to agree on the establishment of the Southeast Asian Fisheries Development Center (SEAFDEC) in December 1967. With an initial task of promoting fisheries as means of improving the food situation in Southeast Asia, SEAFDEC has since then served as a catalyst for the transformation of the region's fisheries towards sustainability.

To enable SEAFDEC to carry out such gigantic tasks, the Southeast Asian governments also agreed to establish the SEAFDEC Training Department (TD) in 1968 in Samut Prakan, Thailand, with an initial task of training the officers and technical staff from the region to enhance their capabilities in directing and managing fishing activities. As the SEAFDEC responsibilities in the region progressed, TD in mid-1970s redirected its focus on the development of responsible fishing technologies and practices, and the promotion of marine and coastal fisheries management to ensure the stable supply of fish for food security of the region. Subsequently, the Marine Fisheries Research Department (MFRD) of SEAFDEC was established in Singapore in 1969 to conduct research on the actual conditions of the region's fishing grounds and improving the utilization of fishing grounds towards sustainability, a task that was taken over by TD before the end of the 1970s. By mid-1970s, as fish production of the region drastically increased necessitating the development of sustainable postharvest technologies, MFRD refocused its activities on the safety and quality of fish and fish products including the development of fish preservation protocols to upgrade the quality of the region's traditional fishery products, and on the proper utilization of trawl bycatch for the production of comminuted fishery products, *e.g.* surimi, and the development of surimi-based products. Meanwhile, as the adoption of culture technologies also flourished in the region, the Southeast Asian governments agreed to establish the SEAFDEC Aquaculture Department (AQD) in the Philippines in 1973 to make sure that the development and adoption of aquaculture technologies in the region, *i.e.* in coastal, brackishwater, and freshwater environments, are sustainable. Later, as the Southeast Asian countries needed assistance in the development and management of their marine fishery resources, the establishment of the SEAFDEC Marine Fishery Resources Development and Management Department (MFRDMD) in 1990 in Terengganu, Malaysia has addressed their concern. Furthermore, to also ensure the sustainable development and management of the region's inland fisheries, the SEAFDEC Inland Fishery Resources Development and Management Department (IFRDMD) was established in 2014 in Palembang, Indonesia.

Throughout its more than 50 years of existence as a regional center for R&D in sustainable development of fisheries and aquaculture of the Southeast Asian region, SEAFDEC unceasingly attained major advancements based on its mandates, *e.g.* in fisheries technologies, aquaculture, fisheries management, fishery resources conservation and enhancement, and fisheries post-harvest technologies, among others. With the SEAFDEC Departments spearheading such developments and improvements, the technologies have also been verified and disseminated to the Southeast Asian countries through human resource development programs as well as through dissemination of various information materials produced by SEAFDEC benefitting a wide-range of stakeholders. Based on such development, the countries were able to develop fisheries policy recommendations that had been used to improve and/or revise their respective countries' national policies, laws, and regulations relevant to the sustainability of their fisheries sector.

Through the more than 50 years, all efforts of SEAFDEC have always been catered to the small-scale fisheries and aquaculture niches of the Southeast Asian region, considering that most of fisheries operations in the region are small-scale. As a matter of fact, the majority of such fisheries operations and activities use relatively small production units with low inputs, and low capital investments. Notwithstanding such predicaments, small-scale fisheries contribute more than a quarter of world's catch, depicting the significance of this sector in food security and nutrition, poverty eradication, and sustainable resource utilization (FAO, 2005), especially in the Southeast Asian region, making it critical to develop and manage the region's small-scale fisheries in a sustainable manner for the benefit of the future generations.

Small-scale Fisheries in Southeast Asia: a situationer

The inadequate capacity of most fishers to venture in oceans and the high seas led to the concentration of fishing operations in coastal waters, but the increasing effort of fishers to harvest the fishery resources in coastal areas was feared to possibly result in over-exploitation. Thus, in mid-1990s, the Southeast Asian countries with technical support from SEAFDEC, exerted efforts to promote the sustainable development and management of small-scale fisheries in the region (SEAFDEC, 2006). Such efforts were not in vain as through the years, *e.g.* from 1970s to 2018, the total fisheries production of Southeast Asian had been increasing (**Table 1**) at an annual average increase of about 3.6 % although there were ups and downs along the way (**Table 2**).

According to FAO (2005; 2018), of the world's total fisheries production, about 50 % must have been generated by small-scale fisheries. Granting that the same trend also occurs in the Southeast Asian region, then the small-scale fisheries sector of Southeast Asia must have also contributed significantly to the region's total fisheries production as indicated in **Table 1**.

While the region's total population has also been increasing (**Table 3**), and considering that the average annual per capita consumption of fish by the Southeast Asian countries in 2018, for example, is 33.5 kg (Smithrithee *et al*., 2021; Chan *et al*., 2017), such requirements for food fish could be easily supplied by small-scale fisheries since the fisheries production from small-scale fisheries in 2018 is about 23,270 t. In order that the small-scale fisheries sector of the region could continue providing the necessary food fish for the region's populace, SEAFDEC therefore deems it necessary that this sector should

Table 1. Fisheries production of Southeast Asia by ten-year period* averages, in thousand tonnes (t)

	1970s–1980	1981–1990	1991–2000	2001–2010	2014	2015	2016	2017	2018
Marine capture fisheries	3,832	6,393	8,975	13,245	16,584	16,762	17,027	17,330	18,330
Inland capture fisheries	485	889	1,366	1,553	3,001	3,059	3.126	3,227	3,337
Aquaculture	310	872	3,622	5,834	22,530	24,177	25,183	24,940	24,872
TOTAL Production	**4,627**	**8,154**	**13,963**	**20,632**	**42,115**	**43,998**	**45,336**	**45,497**	**46,539**
Contribution of small-scale fisheries (FAO, 2005; 2018: about 50 %)	2,314	4,077	6,982	10,316	21,058	21,999	22,668	22,749	23,270

** until 2010*
Source: SEAFDEC (1976; 1980; 1990; 2000; 2012; 2020a)

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

	1970s–1980	1981–1990	1991–2000	2001–2010	2010–2014	2014–2015	2015–2016	2016–2017	2017–2018
Marine capture fisheries	7.0	4.0	2.9	3.2	2.0	1.1	1.5	1.8	5.5
Inland capture fisheries	9.3	4.5	3.5	1.3	4.8	1.9	2.1	3.1	3.3
Aquaculture	2.5	6.5	7.6	3.8	7.4	7.3	4.0	-1.0	-0.3
TOTAL Production	**7.9**	**4.3**	**4.2**	**3.2**	**5.1**	**3.8**	**3.0**	**0.4**	**2.2**

** until 2010*

Table 3. World's population in 1970-2030 (UN estimates in million), and Southeast Asia's per capita fish consumption*

	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
Ave. fish consumption (kg/person/year) of Southeast Asian countries	21.0	22.0	24.0	25.0	33.5	33.5	33.5	33.5

Source: Adapted from Laurenti (2007); Chan et al. *(2017); FAO (2020)*

be sustainably managed, by addressing the various issues and concerns that tend to impede its sustainable development and management.

In considering the role that the small-scale fisheries sector plays in stabilizing food security in the Southeast Asian region, Kato (2008a) had expected that small-scale fisheries would be given more attention by the global community and presumed that such initiative could be translated into the development of a global dedicated program on small-scale fisheries which could also provide the necessary momentum for its sustainable development. The promotion of the "Voluntary Guidelines for Securing Sustainable Small-scale Fisheries in the Context of Food Security and Poverty Eradication" (FAO, 2018) almost ten years later, is therefore a welcome development and answers the concern of Kato (2008a), and more specifically for the Southeast Asian region where small-scale fisheries is an important economic sector. Notwithstanding such development, SEAFDEC all the while, had exerted efforts to address the issues and concerns that impede the sustainable development and management of small-scale fisheries in Southeast Asia.

Harmonizing the divergent coverage and functions of small-scale fisheries

Early on, the FAO Glossary suggested that artisanal or small-scale fisheries refer to "traditional fisheries involving fishing households (as opposed to commercial companies), using relatively small amount of capital and energy, relatively small fishing vessels (if any), making short fishing trips close to shore, and produce fish mainly for local consumption." This is generally acceptable especially in Southeast Asia where capture fisheries are generally small-scale in nature, using varied types and sizes of vessels and fishing gears to capture the multispecies fishery resources. Nonetheless, in the absence of a concrete definition of small-scale fisheries that could be used in discussions and development of policy recommendations based on the Southeast Asian setting, Kato (2008) suggested that the cultural, social, and economic characteristics of the region's fisheries could be taken into consideration, *e.g.* the types and sizes of vessels, fishing gears and methods used, the species targeted which is generally multispecies, and postharvest technologies practiced, and that the value of the fisheries with respect to tourism and cultural heritage should also be considered. In short, he stressed that the role of small-scale fisheries should not be anchored only on its capability of producing fish and fishery products but also on the value of its existence and multi-function roles in the traditional ways of life in the coastal areas.

In the recent study by Smith and Basurto (2019) that reviewed the relevant literatures on small-scale fisheries in an attempt to find a definition of small-scale fisheries, the results indicated that about 25 % of the literatures did not mention any definition of small-scale fisheries. However, the nature and characteristics of the fisheries that include the vessels and fishing gears used had been referred to, and over time, technological dimensions have been mentioned like fishing vessels relative to socio-cultural characteristics of the fisheries operations.

SEAFDEC for its part, has not also attempted to develop a standardized definition of small-scale fisheries. Instead, a matrix showing the different perspectives of the respective small-scale fisheries operations in the Southeast Asian countries in certain fishing zones had been established (SEAFDEC, 2000; SEAFDEC, 2003). This was especially necessary when SEAFDEC carried out the "Regionalization of the Code of Conduct for Responsible Fisheries," and since then such matrix had been used extensively as reference material.

Valuating the true worth of small-scale fisheries through improved systems of collecting information

Compiling and analyzing data and information on small-scale fisheries, *e.g.* quantity and value of production, catch and effort, species produced, could provide the true value of small-scale fisheries but these had always been a gigantic task in the Southeast Asian region. Production from the region's small-scale fisheries is intended not only for local and domestic markets, but most often also for direct consumption within households. As a result, the total production is usually underreported in official statistical records.

The use of a wide range of simple fishing methods and gears, and small vessels also makes it difficult to compile any statistical data and information, especially on catch and effort. In inland waters, small-scale fishers are frequently shifting between different fishing methods and gears that suit the seasonality and availability of target species. Therefore, obtaining catch data at species or group levels necessary in understanding the status of the resources to support sustainable fisheries management remains a major concern. Absence of the necessary data has made it difficult for policy-makers to establish the value and true worth of small-scale fisheries

including its role in the socio-economic upliftment of the populace.

SEAFDEC has been improving the situation through capacity building of the region's concerned human resources, especially on the design, methods, and systems of collecting statistical data, as well as on the development of alternative methods of collecting and compiling information, especially for inland capture fisheries (Muthmainnah *et al*., 2020). These efforts are meant to provide real-time data on small-sale fisheries that could be used by policy-makers not only in formulating policies for the sustainable management of the fishery resources as well as on the conservation of the resources, but also for taking up measures to address such concerns as overcapacity and illegal fishing.

Generally, making available the necessary information and collection of data is typically inadequate because of the heterogeneity, diversity, and complexity of small-scale fishery activities. Frequently dispersed over large areas, the multiple landing points and direct informal markets make it difficult to record the production from the Southeast Asian region's small-scale fisheries operations, and especially because such production is meant mainly for household consumption. SEAFDEC has therefore strengthened collaborative and participatory approaches in data collection, while also continuing to explore alternative methods of quantifying the fishery resources and the contribution of small-scale fisheries to food security.

Alleviating poverty in small-scale fishing communities

In Southeast Asia, the majority of fishers and fishery workers are engaged in small-scale fisheries activities including pre-harvest, harvest, and post-harvest, fundamental to the social and cultural structures within and among fishing communities. Since small-scale fisheries communities are mostly located in remote areas where access to health, education, and other social services is limited, a large number of small-scale fishers remain impoverished and continue to be marginalized.

Moreover, the region's small-scale fishers and fish workers are generally self-employed, and their fishing activities are conducted full-time, part-time, or seasonally in combination with other agriculture activities such as farming of crops and rearing of livestock. In the case of small-scale aquaculture, where minimal investment is also involved and family labor is largely engaged, this sub-sector has been an important contributor to sustainable rural development as well as to the generation of livelihoods and the steady supply of fish and fishery products for the local populace. SEAFDEC through its Aquaculture Department has been promoting the sustainability of small-scale aquaculture for rural development (SEAFDEC Aquaculture Department, 2013). Meanwhile, traditional fish processing methods of fish preservation (*e.g.* smoking, sun-drying, salt-drying, among others) to extend shelf-life or to preserve the large amount of catch during peak season, are the usual practice adopted by the region's fishers and fish workers despite insufficient means and infrastructures. SEAFDEC through its MFRD has improved such traditional methods in terms of safety and quality, and in the technical aspects to make sure that processing could be easily managed under local conditions requiring minimal inputs (Pongsri *et al*., 2015). SEAFDEC also encourages small-scale fish workers to be engaged in other ancillary fishery-related income opportunities, especially in coastal and inland fishing communities, *e.g.* net making, boat building, vessel engine repair and maintenance, local handicrafts production. Through the development and

promotion of policy recommendations, SEAFDEC also makes sure that such ancillary activities are sustainable.

Taking into consideration the prevalent poverty situation in small-scale fishing communities in Southeast Asia and while supporting the Southeast Asian countries towards sustainable development of small-scale fisheries for food security, SEAFDEC initiated the promotion of "One Village, One Fisheries Product (FOVOP)" System with the main objective of improving the livelihood opportunities of the fisheries communities in the region (Kato, 2008b). With funding support from the Japan-ASEAN Solidarity Fund, such a system was patterned after the Japanese One Village One Product (OVOP).

Under the FOVOP System, local producers identify and promote unique and differentiated traditional fishery products and related services from particular fisheries communities (Kato, 2006; Wongsanga & Sulit, 2010). It should also be noted that in the promotion of FOVOP System, the role of women are properly recognized as they are the potential stakeholders in the rural economic activities, and the level of their involvement in the fisheries-related activities is clearly identified.

SEAFDEC has sustained its efforts in alleviating poverty in fisheries communities by enhancing human capacity development on-site at the community level. With funding support from donors and partners, regional fisheries and aquaculture expertise has been mobilized for such efforts while participation of relevant stakeholders maximized. As a result, SEAFDEC has been able to reach out to far-flung fisheries communities and promote sustainable fisheries development for poverty alleviation in those Southeast Asian communities.

Balancing utilization and conservation of small-scale fishery resources

Small-scale fishery activities are undertaken in "multi-use, multi-user" environment where both coastal and inland fishing communities compete for the resources with other users, resulting in habitat degradation. Ecologically sound measures such as the installation of artificial reefs, mangrove reforestation, coral plantation, fish passage construction, good aquaculture practices, stock enhancement, combating IUU fishing, and others are being undertaken by SEAFDEC in the Southeast Asian region to conserve the aquatic habitats and ensure the sustainability of the fishery resources.

The small-scale inland capture fishing activities of Southeast Asia are influenced by seasonal movements of fish between connected habitats, such as rivers, floodplains, rice fields, irrigation systems, and other inland bodies of water. Although inland capture fishing operations are conducted all year round, the highest abundance of fish captured could be achieved during rainy season when fishes migrate and are caught in their migratory path as well as during dry season when fishes take refuge in smaller pools and become easier to catch. SEAFDEC through its IFRDMD has been developing measures to ensure the sustainability of small-scale inland capture fisheries (Muthmainnah *et al*., 2017).

Meanwhile, the continued practice of overfishing prevents the recovery of fish stocks that eventually degrade the fishery resources. In addressing such concern, the Southeast Asian countries have been trying to control overfishing through the enforcement of relevant regulations, while SEAFDEC has been mitigating the impacts of overfishing by implementing enhancement programs and activities to safeguard the fish stocks. These programs have two-pronged objectives: improvement of the critical habitats and nursery grounds of the fishery resources; and direct enhancement of the fishery resources through artificial propagation techniques.

Nevertheless, the increasing demand for fish driven by rapid growth of human population and coupled with the deteriorating situation of the fishery resources has forced many fishers to practice illegal fishing activities not only in Southeast Asia but also outside the region. In fact, some fishers have been found to be poaching in seas beyond their national maritime borders. Such a situation had prompted SEAFDEC to establish a general direction to combat illegal, unreported and unregulated (IUU) fishing through the JTF-funded Project "Promotion of Sustainable Fisheries and IUU Fishing-related Countermeasures in Southeast Asia" (Smithrithee *et al*., 2020). With the collaboration of the ASEAN Member States (AMSs), SEAFDEC was able to initiate the development of several approaches to address those IUU fishing issues and concerns, *e.g.* the ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain, Regional Fishing Vessels Record (RFVR) and RFVR Database, Regional Plan of Action for the Management of Fishing Capacity (RPOA-Capacity), the ASEAN Catch Documentation Scheme (ACDS) and its electronic version eACDS.

As the looming emerging issues continue to impede the efforts of the AMSs in attaining sustainable fisheries, and while the importing countries impose stringent measures on export of fish and fishery products by making sure that these are not sourced from IUU fishing activities, SEAFDEC spearheaded the establishment of the "Joint ASEAN-SEAFDEC Declaration" that was signed by the Senior Officials of the ASEAN-SEAFDEC countries, to signify the countries' commitment to work towards addressing the issues caused by the practice of non-responsible fisheries operations, especially IUU fishing activities.

Staging management approaches to small-scale fisheries

The approach to small-scale fisheries management being promoted by SEAFDEC in Southeast Asia is ecosystem-based, integrated, holistic, and participatory. For sustainability of the fishery resources, the capacity of small-scale fishing communities in designing, planning, and implementing management measures is enhanced with special attention to equitable participation of women and men as well as the vulnerable and marginalized groups. Similarly, ecosystem-based would also be adopted for small-scale aquaculture development, considering the need to develop aquaculture sustainably in order that it could continue to provide food fish for the people.

The concept of ecosystem approach to fisheries management (EAFM) has been advanced by SEAFDEC in the Southeast Asian region through capacity building of the relevant stakeholders. With some selected countries serving as pilot sites, the experience that would be gained from the pilot sites would be used as inputs for the development of the Guidelines on EAFM for Extension Officers of the Southeast Asian region (Weerawat & Worranut, 2019).

Recognizing that developing the capacity of local human resources would lead to empowerment of the local people in community development and enabling them to manage the fishery resources toward sustainability, SEAFDEC continued to promote human capacity building in the Southeast Asian countries. Moreover, considering that resource-use conflicts are reduced and resources are efficiently managed when fishers and other stakeholders share the responsibility of looking after the fishery resources through their participation in the planning and implementation of fisheries management plans, SEAFDEC has been promoting the concepts of community-based fisheries management and co-management, especially in inland fisheries, to pave the way for fishers to have equal rights and access to the fishery resources as well as to the market of their fish and fishery products.

Typically, in the Southeast Asian scenario, men are engaged in fishery activities and women in fish processing and marketing as well as in near shore or coastal harvesting and culture activities, although men are also known to engage in fish marketing and distribution. Therefore, in formulating enhanced fisheries policies, SEAFDEC makes sure that gender equality and equity are being fostered by highlighting the roles and well-being of women and men in the region's small-scale fisheries and aquaculture.

Recognizing the importance of small-scale fisheries and assuring their sustainability

After the adoption of the global Code of Conduct for Responsible Fisheries (CCRF) in 1995, SEAFDEC with funding support from the Japanese Trust Fund (JTF) initiated the program "Regionalization of the CCRF (RCCRF)" starting in 1998. RCCRF was meant to make the global CCRF understandable and adaptable in the Southeast Asian region, by taking into consideration the region's specific fisheries context that encompasses the region's culture, fisheries structure, and the region's ecosystems. RCCRF therefore accommodated the specific regional fisheries concerns that the global CCRF might have failed to consider, especially the very nature and characteristics of the region's small-scale

fisheries which are multi-species and multi-gear. Moreover and under the framework of the CCRF, the issues of particular importance to the region were explained, clarified, and elaborated on in the series of Regional Guidelines produced through the RCCRF (SEAFDEC, 2000; SEAFDEC, 2003; SEAFDEC, 2005a; SEAFDEC, 2005b; SEAFDEC, 2006). These Regional Guidelines had been disseminated to the Southeast Asian countries and had been used as basis for the development and/or revision of their respective national laws and regulations with respect to the sustainable development of their fisheries sector.

Nonetheless, in order that the Southeast Asian countries would be able to adopt the Regional Guidelines, SEAFDEC with support from the SEAFDEC-Sweden Project, provided the platform for capacity building of the region's human and institutional resources. This has led to the development and promotion of the most practical national systems on the various facets of fisheries, especially small-scale fisheries that are meant to improve fisheries management though responsible approaches.

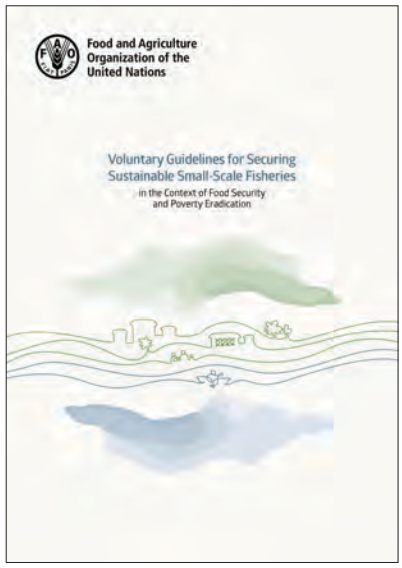
Concerned that the unsustainable fisheries practices could negatively impact on the future fish supply risking food security and socioeconomic stability of peoples in the Southeast Asian region, the ASEAN and SEAFDEC spearheaded the formulation and adoption of the Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region in 2001 (RES&POA-2001) (SEAFDEC, 2001). With the CCRF serving as the guiding principle, RES&POA-2001 (SEAFDEC, 2001) has served as guide in the development and implementation of programs and activities carried out by SEAFDEC in the Southeast Asian region that aim towards sustainable fisheries for food security. The subsequent ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020 (RES&POA-2020) (SEAFDEC, 2011), a revitalized version of the RES&POA-2001 to address the emerging issues and adapt to the changing environment, had been instrumental in the development and promotion of various actions undertaken by the AMSs leading to significant achievements that were attained during the periods from 2001 to 2020, specifically with respect to the ASEAN-SEAFDEC policy documents that have been developed during such period (Smithrithee *et al*., 2020a). In 2020, SEAFDEC and the AMSs reviewed the RES&POA-2020 and assessed the emerging issues and challenges that seem to impede the development of the region's fisheries sector taking into consideration the paradigm changes in the fisheries sector of the region. Results of such review had been used as inputs to the ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2030 (RES&POA-2030) (SEAFDEC, 2020b). While the RES&POA-2030 reiterates the regional cooperation to combat

IUU fishing and enhance the competitiveness of the ASEAN fish and fishery products, it also includes major additional aspects that deal with emerging issues.

Way Forward

For the past 53 years, SEAFDEC through its Departments had been implementing programs and activities that led to the development of national policies serving as guidelines for the Southeast Asian countries in the sustainable development and management of their respective fisheries sector. SEAFDEC therefore remains committed to continue attaining fisheries technical advancements and disseminating the developed technologies to the AMSs while also looking beyond the horizon to explore new frontiers and new resources for expanding and enhancing its efforts towards the sustainability of the region's fisheries and aquaculture endeavors. The series of RES&POAs have paved the way for the future works of SEAFDEC, however, SEAFDEC would also heed to the call for continued setting up of its future activities towards food security and socioeconomic stability, and could specifically include: 1) The sustainable development and management of small-scale fisheries in the Member Countries of SEAFDEC with in-depth consideration of coastal area management and the use of an ecosystem approach in the management of fishery resources; 2) Issues relevant to the transboundary fish stocks or shared stocks on the Sunda Shelf, with a view to launching cooperative study programs and formulating appropriate management measures to effect their sustainable production, with special reference to Article 63 of the Law of the Sea of the United Nations; 3) Establishment on a permanent basis of a centralized and efficient regional database for fisheries information and reliable fishery statistics for use in the planning and implementation of programs and projects for the sustainable development and rational utilization of fishery resources of the AMSs; and 4) Strengthening of the human resource capacity of the AMSs to enable them to achieve the long-term goal of good governance and sustainable fisheries development (Menasveta, 2017).

The promotion of the FAO Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication is indeed timely as it serves as reference for the AMSs and also for SEAFDEC to boost the sustainable development of small-scale fisheries. The Guidelines could also provide the guiding principles for the AMSs and SEAFDEC to continue setting its future activities towards food security and socio-economic stability, and be able to carry out the abovementioned recommended future activities.



FAO Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication

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About the Authors

Ms. Malinee Smithrithee is the Secretary-General of SEAFDEC, based at SEAFDEC Secretariat Office in Bangkok, Thailand, and is also the Chief of SEAFDEC Training Department, Samut Prakan, Thailand.

Mr. Koichi Honda is the Deputy Secretary-General of SEAFDEC, based at SEAFDEC Secretariat Office in Bangkok, Thailand, and is also the Deputy Chief of SEAFDEC Training Department, Samut Prakan, Thailand.

Ms. Nualanong Tongdee is the Information Program Coordinator of SEAFDEC based at SEAFDEC Secretariat Office in Bangkok, Thailand.

Ms. Virgilia T. Sulit is the Managing Editor of Fish for the People based at SEAFDEC Secretariat Office in Bangkok, Thailand.

The Development of Traceability Systems for Capture Fisheries in Southeast Asia: the eACDS in focus

Kongpathai Saraphaivanich, Yanida Suthipol, and *Namfon Imsamrarn*

Traceability system is one of the most recent trade requirements being put into force in response to the pressing needs expressed by the markets to ensure that fish and fishery products in the supply chain are not derived from IUU fishing activities. It is also being used to facilitate the tracking of the flow of products through the production processes or the supply chain to ensure that these are safe for human consumption. In the Codex Alimentarius Commission, traceability is defined as "the ability to follow the movement of a food through specified stage(s) of production, processing and distribution." Traceability has therefore been used to compile information regarding the identity, history, and source of a product or of the materials contained within a product, as well as on its destination, or any ingredient contained within it, making traceability system an information management tool. In the fisheries sector, information on traceability is used to ensure food safety which means that the products and materials from which they are made should come from origins that meet food safety conditions. Traceability is also applied for determining the tariffs and quota tariffs, making sure that appropriate rates of duty are applied, and finally, traceability is also meant to warranty that the fish is derived from sustainable sources, *e.g.* from fishing operations and vessels that follow conservation rules.

In the early 2000s, consumers from the European Union (EU) had become concerned with the trade of fish and fishery products produced through illegal, unreported and unregulated (IUU) fishing operations as these constitute one of the most serious threats to the sustainable exploitation of living aquatic resources and jeopardize the very foundation of the common fisheries policy and international efforts to promote better ocean governance. For this reason, the EU adopted the Regulation (EC) No. 1005/2008 establishing a community system to prevent, deter and eliminate IUU fishing, also known as the EU IUU Regulation, which comes with the respective implementing regulations and other legislative tools. The EU IUU Regulation includes a provision on the need for importing countries to develop their respective catch documentation schemes (CDSs) building upon the primary responsibility of the flag States to prevent, deter and eliminate IUU fishing, and constituting a valuable supplement to port State and other measures.

The EU therefore, introduced on 1 January 2010, the Catch Certification Scheme (CCS), whereby fisheries products must be accompanied by Catch Certificate (CC) declaring that the catch had been produced in accordance with applicable laws, regulations, and international conservation and management measures. While the CDS should be designed to address the concerns on IUU fishing, especially as an important tool to combat IUU fishing, and should be developed from the point of view of Monitoring, Control and Surveillance (MCS) or from trade documentation perspective.

Meanwhile, the EU IUU Regulation is being applied to all trade of marine fishery products, processed or not, originating from third country fishing vessels and exported to the EU by any means of transportation, and also to any catch originating from EU fishing vessels to be exported to third countries, as well as to transshipments and processing operations. Legally, the CCS is meant to record the origin of all marine products arriving the EU market. This implies that EU importers must ensure that all consignments to be imported have validated certificates provided by exporters prior to the importation to the EU. Normally, the Fisheries Authority of the flag country of the vessel is responsible for the issuance of the Catch Certificate.

In 2017, FAO developed the Voluntary Guidelines for Catch Documentation Schemes (VGCDS) which includes the Catch Documentation Schemes (CDSs) for wild capture fish caught for commercial purposes in marine or inland areas, whether processed or not. The Guidelines had been developed recognizing the relevant international laws and other international instruments, *e.g.* the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU).The VGCDS therefore aims to provide assistance to States, regional fisheries management organizations, regional economic integration

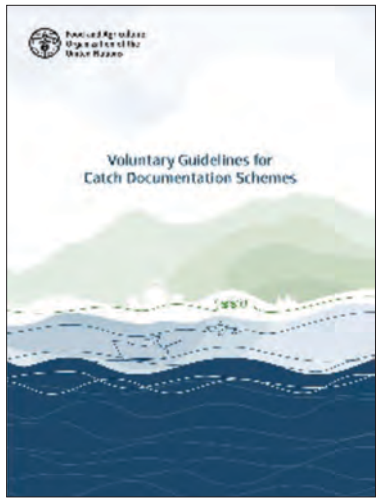

Figure 1. FAO Voluntary Guidelines for Catch Documentation Schemes

organizations, and other intergovernmental organizations, in their efforts towards developing and implementing new CDS or harmonizing or reviewing their existing CDSs.

Benefits of Traceability

A traceability system requires that fisheries companies should record the source, volume, form, and certificate numbers of all products received under a CDS. The same type of records must be kept by operators for all products leaving a company, whether these are meant for international export or as business-to-business transfer/sale of products within the national supply chain. Therefore, a trace is created that indicates the complete information of a batch of products flowing through the supply chain, which could be accessed by authorities for inspection purposes, if necessary. Specifically, the benefits of traceability systems could be seen from three main aspects, *i.e.* ensuring food safety, promoting better process controls, and securing better market niches (**Box 1**). In this connection, it has also become necessary to develop a Catch Documentation and Traceability System (CDT) not only to trace the fish and fishery products in the value chain but also to certify their origin and quality with respect to food safety and sustainability.

Catch Documentation and Traceability Systems in Southeast Asia

The fisheries sector in Southeast Asia is critically important considering its significant role in boosting the people's social, economic, and livelihood conditions. During the past decades and until now, several ASEAN Member States (AMSs) have been the top ten seafood producing countries exporting to the world seafood market, notwithstanding the challenges in addressing the international fish trade-related issues, *e.g.* IUU fishing issues, that have significantly impacted the seafood export of the region until the present.

Efforts had therefore been made by SEAFDEC in collaboration with the AMSs, to establish and promote a CDT under the Japanese Trust Fund (JTF)-funded Project "Combating IUU Fishing in the Southeast Asian Region through Application of Catch Certification for Trading of Fish and Fishery Products." Implemented by SEAFDEC/MFRDMD since 2013, the Project had come up with the "ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain" and supported as one of the Project activities, the promotion and implementation of the "ASEAN Catch Documentation Scheme" in the Southeast Asian region.

The development of the ASEAN Catch Documentation Scheme (ACDS) was in response to the request of the AMSs for SEAFDEC to enhance the traceability of fish and fishery products in the Southeast Asian region. SEAFDEC therefore, through technical consultations with its Member Countries, drafted the ACDS concept, which was later on endorsed by

Stakeholders use their mobile devices to scan the QR Codes on fish/fishery products as they check the traceability details of the products throughout the value chain

Box 1. Benefits of applying traceability systems

- **Securing food safety**

Damages from the impact of food safety failure in terms of illness or death could be minimized if not eliminated, when the distribution of the affected fish and fishery products is curtailed because the trace provides the relevant information. So that when the source of the contamination and the precise affected batch could not be identified, then the food business operator is obliged to withdraw and destroy all batches which could be potentially contaminated. There are numerous cases where food safety failures were discovered in only part of a consignment but the affected part could not be identified, because traceability batch codes were not applied, while testing every unit in a batch is also not feasible. Thus, if the affected products could not be identified and separated, an inspector is obliged to consider any detectable food safety non-compliance as grounds for the batch to be condemned.

- **Promoting better process controls**

Once correctly implemented, traceability can improve stocks control and reduce out-of-date product losses by allowing efficient operation of first-in-first-out systems, lower inventory levels, quicken the identification of processes and supplier difficulties, and raise the effectiveness of logistics and distribution operations. In addition, operators can collect quantitative data on yields associated with specific batch codes. Over time, by relating yields to independent variables concerning the process conditions, operators can often gain a better understanding of the critical process variables and thus improve the efficiency of their production processes. Improved process control to manage yields can provide significant financial benefit to the operators.

- **Securing better market niches**

In the longer term, the better food safety management resulting from improved traceability, provides greater guarantees in terms of sustained market access and buyer confidence. Improved customer confidence also helps with branding and improved brand equity. In fact, traceability can be employed as a marketing tool, by providing customers with unique information about the product they are buying and its origins.

the ASEAN during the 25th Meeting of the ASWGFi in 2017, and subsequently adopted by the SOM-AMAF Meeting, also in 2017.

The ACDS concept constituted one of the most significant regional initiatives pursued by SEAFDEC with the collaboration of the AMSs for improving the traceability of marine capture fisheries to ensure that the entry of fish and fishery products from IUU fishing activities, into the supply chain is prevented. Based on the ACDS initiative, national CDTs had been developed by the respective AMSs for their fish and fishery products, especially those that are bound for the export market.

Development of the electronic ASEAN Catch Documentation Scheme

In an effort to support and enhance the traceability system for fish and fishery products in the Southeast Asian region, the electronic ASEAN Catch Documentation Scheme (eACDS) was developed by SEAFDEC (Siriraksophon *et al*., 2017; Saraphaivanich *et al*., 2019), as an application that links all information and data in the supply chain from point of catch to plates/consumers (**Figure 2**), taking into consideration the instruction of the SEAFDEC Council of Directors that the ACDS should not create unnecessary burdens, costs, or lengthy processes for the supply chain, especially to the importers and exporters. The eACDS consists of two applications: web-based and mobile applications (**Figure 3**). First is the **"**web-based application" which had been designed for: (a) port-out permission and issuance of initial Catch Declaration (CD) to fishing masters, (b) port-in permission including catch weight and species verification and issuance of the CD to fishing masters, (c) issuance of Movement Document (MD), (d) issuance of Statement of Catch (SC), and (e) requirement of Catch Certification (CC) and issuance of CC. The second is the **"**mobile application" which is for catch reporting at sea and purchasing fish. The eACDS requires several inputs of basic data and information called "Key Data Elements" (KDEs) that include information on: 1) Point of Catch, 2) Buyers/Receivers and Sellers (Broker/ Wholesaler), 3) Processors, 4) Exporters and International Shippers, 5) Importers, and 6) End Consumers.

In June 2017, the eACDS was pilot tested in Brunei

Figure 2. Work Flow of the eACDS from point of catch to plates/consumers

Darussalam and a series of consultations and on-site trainings on the use of eACDS ensued with the involvement of relevant stakeholders in collaboration with the Department of Fisheries of Brunei Darussalam to apply, test and improve the applications of the eACDS, especially making the application more user-friendly. This led to the development of the web-based and mobile applications of the improved eACDS, for offline reporting of the catch at sea.

The first version of the electronic system of the ACDS (eACDS-VER.1) was developed by SEAFDEC/TD in collaboration with Brunei Darussalam as the pilot country in 2017. The prototype eACDS covers the management of the Catch Declaration (CD), Movement Document (MD), and issuance of Catch Certification (CC). However, catch reporting at sea became a fundamental problem when mobile devices operated offshore do not have internet signal. As a result, there was no monitoring system on how raw fish materials were used in the processing plants and no vessel tracking functions.

For these reasons, SEAFDEC/TD has improved the eACDS applications in collaboration with the Directorate of Fisheries (D-Fish) of Viet Nam in 2019, based on the existing paper-type Viet Nam Catch Certification for the EU market, and was pilot-tested in Binh Thuan Province, Viet Nam. The eACDS-VER.2 includes the traceability of fish in the value chain and supports the users with its new features added, including mobile apps in both online and offline modes for catch reporting at sea, which is part of the Catch Declaration process.

Figure 3. eACDS applications consist of web-based application and mobile application to cover all relevant stakeholders

The new features in eACDS-VER.2 include: 1) Request for port-out/port-in by vessel owner/fishing master via an online webpage (**Figure 4**); 2) Bilingual function (English - local language) for both eACDS web-based and eACDS mobile applications (**Figure 5**); 3) eACDS-catch report application showing the date, start, and end positions of fishing vessels (**Figure 6**); 4) eACDS-catch report application for transshipment at sea (**Figure 7**); 5) Dashboard to summarize reports ofmanagers (**Figure 8**); 6) Mapping of status of a vessel:nline and offline (**Figure 9**); 7) Information

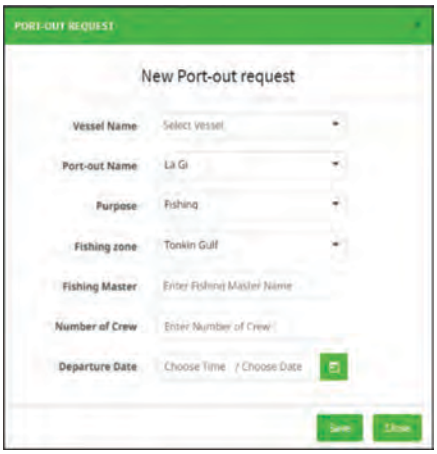

Figure 4. eACDS webpage for requesting port-out

Figure 5. Changing language in eACDS web-based application

Figure 6. Inputting catch data into eACDS-catch report application

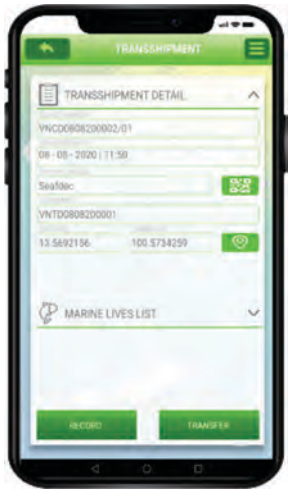

Figure 7. Inputting trans-shipment data into eACDS-catch report application

Figure 8. Dashboard to summarize reports of all certificate including CD, MD, SC and CC

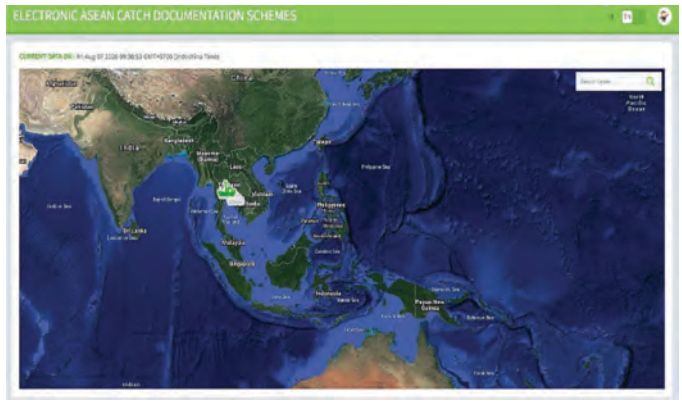

Figure 9. Status of a vessel on map (online and offline)

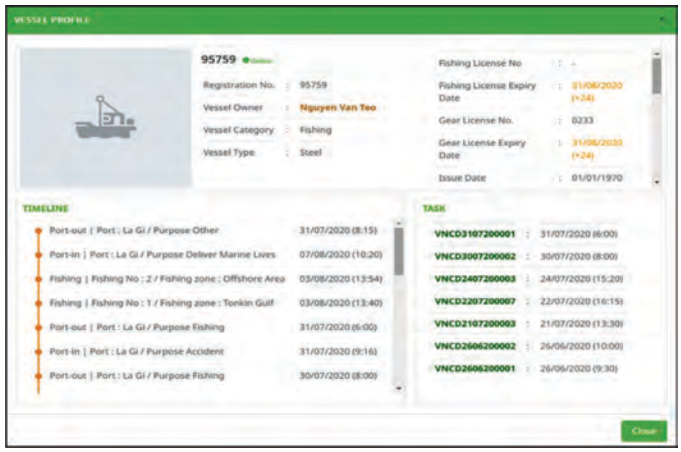

Figure 10. Vessel information and timeline of fishing vessel activities

and timeline of fishing vessel activities (**Figure 10**); 8) Vessel tracking system on eACDS (**Figure 11**); and 9) New application on mobile known as the eACDS-Market Application (**Figure 12**). Also added in the ACDS-VER.2 are other critical functions on traceability, such as the Statement of Catch (SC) for monitoring the use of raw-fish materials in processing plants.

During the succeeding years, the eACDS has also been pilot tested in Myanmar and Malaysia. The promotion and implementation of eACDS in participating AMSs, namely: Brunei Darussalam, Viet Nam, Myanmar, and Malaysia have been carried out in response to the respective countries' requests during the SEAFDEC high level meetings. The progress of implementation of the eACDS in the participating countries as of 2021 is shown in **Box 2**.

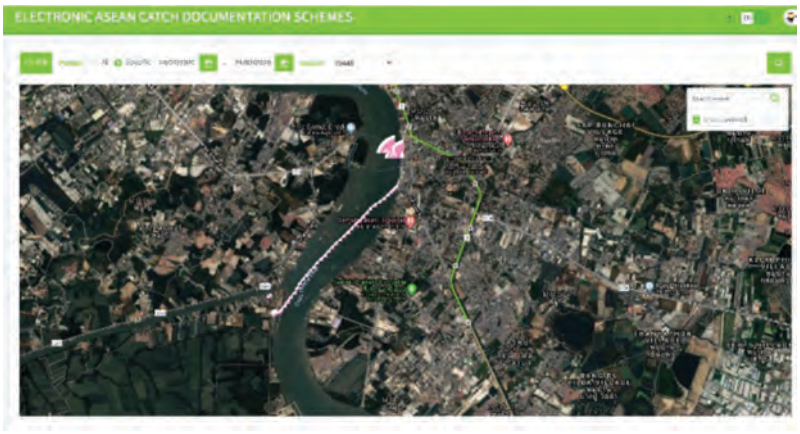

Figure 11. Vessel tracking system on eACDS application

Figure 12. List of sellers shown on eACDS-Market Application

Box 2. Progress of implementation of the eACDS in participating countries (as of 2021)

Brunei Darussalam

Choosing Brunei Darussalam as the first country to pilot test the eACDS in 2016, had an advantage because Brunei Darussalam has only one fishing port, the Muara Fishing Port which is near the offices of the Department of Fisheries, besides, not many fishing vessels had been in operation. The sea areas and fishing grounds are also clearly divided into zones so that vessels can be easily controlled and monitored. With only 3-4 processing companies in the country that purchase the raw materials from their own vessels, the challenge of Brunei Darussalam is to encourage stakeholders to use the eACDS application to issue Catch Certification, and use it for their export of fish and fisheries products even if their export may not be in large quantities. After pilot testing the eACDS in Brunei Darussalam starting in June 2017, series of consultations and on-site trainings on the use of eACDS application for all relevant stakeholders were conducted in collaboration with the Department of Fisheries (DOF) of Brunei Darussalam.

Viet Nam

In responding to the request made by Viet Nam during the 40th Meeting of SEAFDEC Program Committee in November 2017, the eACDS was introduced to relevant stakeholders in Binh Thuan Province, as the first pilot site in Viet Nam. Four sites in Viet Nam have been considered to pilot test the eACDS, namely: Phan Thiet Fishing Port, La Gi Fishing Port, Phu Hai Fishing Port, and Phan Ri Cua Fishing Port. Participated by 50 fishing vessels, the pilot test carried out several activities including discussions on the development and verification of the eACDS application, training on the use of the eACDS application through trials conducted in Binh Thuan Province as the pilot site, in collaboration with the Sub D-Fish.

Myanmar

The Council Director for Myanmar reiterated during the 50th Meeting of the SEAFDEC Council in March 2018 that Myanmar is ready to cooperate with SEAFDEC in strengthening regional cooperation to combat IUU fishing by supporting the implementation of the eACDS at the national level. To follow up on such proposition, the eACDS system was introduced to relevant stakeholders and the Department of Fisheries (DOF) of Myanmar through a discussion on the initial planning and cooperation with DOF of Myanmar for the eACDS implementation. The DOF proposed Yangon as its pilot site with the participation of two private jetties, namely: Ei Phyo Yadanar Jetty, and New Pinle Jetty, and the involvement of more than 50 fishing vessels. Training was conducted on the collection of KDEs, verification of the application to develop the eACDS database, and use of the version of eACDS application.

Malaysia

In 2019, the eACDS system was introduced for all relevant stakeholders and the Department of Fisheries Malaysia, as requested by Malaysia during the 41st Meeting of SEAFDEC Program Committee in November 2018. Two pilot sites in Kelantan and Kuantan were selected as proposed by DOF Malaysia. Initial discussion on planning and cooperation with DOF Malaysia agreed that a baseline survey would be conducted, and training would be organized for the analysis of the data as well as for the collection and verification of KDEs for the eACDS database development, and also on the use of the eACDS application.

Figure 13. eACDS Project Sites in Brunei Darussalam, Malaysia, Myanmar, and Viet Nam

Development of Other Initiatives on Catch Documentation and Traceability Systems in Southeast Asia

In addition to the eACDS being promoted by SEAFDEC (**Figure 13**), other initiatives on CDTs have also been promoted in the Southeast Asian region, including the development of an electronic Catch Documentation and Traceability (eCDT) system by the USAID Oceans Project (a five-year collaborative project between SEAFDEC and USAID (2015–2020)). This was carried out through the establishment of a wide range of partnerships in both the public and private sector, including productive partnerships with government ministries, global seafood companies,

Box 3. Development of eCDTs and other technologies in Southeast Asia

Indonesia: had been supporting the development of national systems (*i.e.* e-logbook and Stellina) and three private sector technologies, such as:

- **The Pointrek** two-way communication Vessel Monitoring System (VMS) which was developed for large and medium-scale capture fisheries, is a web-based application at sea that can connect with Inmarsat's satellite networks to monitor the movement of vessels, including data such as: speed, heading, distance, weather information and two-way communications. Pointrek VMS provides real-time VMS and electronic catch data via a mobile tablet, installed onboard fishing vessels (**Figure14**). The system offers person-to-person communication from ship to shore by offering onboard Wi-Fi to connected mobile devices via text message, email, and the conventional SMS technology.
- **Trafiz** was developed as a mobile catch documentation application for small-scale fish suppliers and buyers that provide first data entry point for seafood products originating from small-scale fishers. Trafiz enables data collection at the landing site, allowing users to enter and submit catch data via a mobile device and cellular connectivity. Trafiz also includes value-added user functions that support loan and payment management and other tools that add user value. Trafiz therefore, supports catch reporting, as well as business functionalities that help small-scale fishers manage their business (**Figure 15**).
- **TraceTales** was developed to enable the processing companies to capture data throughout the processing stage (**Figure 16**). With the system, processors can quickly and easily compile the information that are essential to comply with the various national and international traceability requirements, thereby ensuring the company's access to valuable export markets, as well as bring paper-based record keeping online for improved business and resource management.

Philippines: the USAID Oceans Project supported the Philippine Bureau of Fisheries and Aquatic Resources national eCDT system and one private sector to develop a technology known as the "Futuristic Aviation and Maritime Enterprises, INC. (FAME)" for small-scale vessel trackers and monitors that also serves as communication devices, enabling small-scale fishers to participate in the eCDT system and establishing increased communication and safety at sea.

- **FAME** makes use of radio frequency to send and receive information, and its gateways receive the information from transponders and sends to the cloud. Telemetry data can be sent up to 50 km offshore and can be extended farther via mesh technology between the transponders. Even if a vessel/device is out of range, but within range of another vessel equipped with a FAME transponder, the data can still be sent to a gateway. Personal communication, together with telemetry data can also be sent through the FAME transponders. FAME also provides a dashboard through a web and mobile browser-based application, allowing users to see the details of each transponder and other related data in near real-time, anywhere. The dashboard allows users to draw geofencing areas for remote areas or areas to prioritize, as well as generate custom reports with integrated graphs. FAME users can receive notifications (alerts) both to fishers at-sea and users on-shore. Fishers can use their mobile phones with USB On-The-Go (OTG) or Bluetooth to send and receive messages without mobile phone tower connectivity (**Figure 17**). Their platform is fully customizable and has been modified to incorporate the required Key Data Elements (KDEs).

Figure 14. Pointrek/ Inmarsat Two-Way Communication Vessel Monitoring System (VMS)

Figure 16. TraceTales System

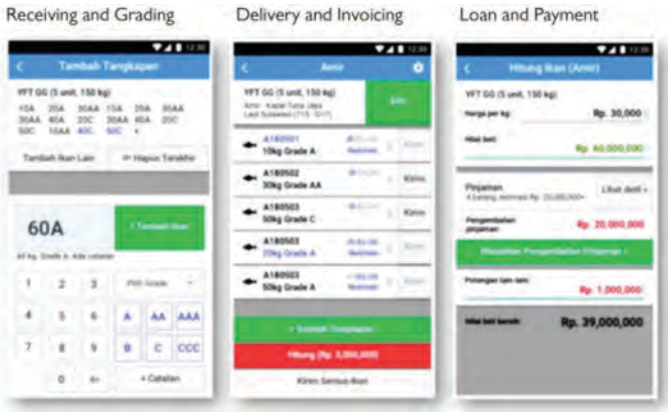

Figure 15. Trafiz (Mobile Application)

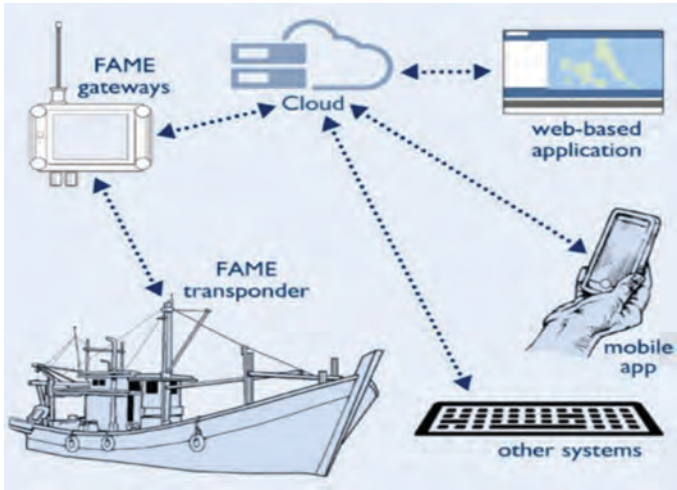

Figure 17. Futuristic Aviation and Maritime Enterprises, Inc. (FAME) Vessel Transponders Work Flow

processors, suppliers, sector associations, non-governmental organizations (NGOs), and academic institutions.

The development of such eCDTs had added to the regional momentum for action on seafood traceability where the industry (suppliers, processors, buyers) had been encouraged to invest in eCDT systems to improve the efficiency of their operations and regulatory compliance. More specifically, the USAID Oceans Project supported the development of national eCDTs and complementary private sector technologies in Southeast Asia, mainly in Indonesia and the Philippines (**Box 3**).

Issues and Concerns on Southeast Asian Catch Documentation and Traceability Systems

The adoption of catch documentation and traceability systems (CDTs) is a relatively new initiative in fisheries in the Southeast Asian region, and lessons on their implementation could be learned. During the 2019 Workshop on the Technical Guidance on the Design and Implementation of Electronic Catch Documentation and Traceability Systems in Southeast Asia, issues and concerns were identified by the AMSs that could possibly hinder in their efforts to effectively adopt such CDTs (**Box 4**). The issues and concerns could be summarized into: inadequate capacity building not only of the human resources but also institutional, especially in IT as the traceability systems require sufficient knowledge in IT to be able to use the applications; limited mainstreaming of the concepts of eACDS or eCDTs in national policies, laws, and regulations; laws and regulations do not generally address the concerns on the need to promote traceability of fish and fishery products at national level; weak cooperation and collaboration among agencies concerned with traceability as well as with the private sector, among others. Efforts should therefore be exerted to address such issues and concerns in order that the benefits of traceability with respect to the sustainable management of the fishery resources could be realized.

Box 4. Issues and concerns on the adoption of the Southeast Asian catch documentation and traceability systems

Brunei Darussalam
• Large volume of capture fisheries production is contributed by small-scale fishers (70 %) • Limited human resources and assets for MCS activities • Selectivity of jobs by local youth
Cambodia
• Limited market access due to inability to keep up with production and marketing systems of neighboring countries • Insufficient cross-border collaboration among key players • Inadequate cross-border trade regulations and means of implementing the regulations • Limited incentives for the private sector to enter into development of commercial post-harvest facilities • Insufficiency of appropriate financial resources • Absence of port-in port-out system to meet the ASEAN Catch Documentation Scheme (ACDS) requirements • Fisheries Administration being challenged by traders selling fish at sea without transmission of catch records to authorities • High numbers of small-scale fishers
Indonesia
• Absence of integrating data from downstream and upstream in a single national data system, to support decision making for fisheries management • Identification of responsible unit to monitor compliance • Accountability towards verification and validation processes
Lao PDR
• Absence of any catch documentation or traceability system • Recording of information includes only the amount of sale at landing sites • Fishing ports consist mainly of small local landing sites along the Mekong River, reservoirs and lakes • Fisheries sector is characterized by 95 % small-scale fishing activities • Inadequacy of necessary resources • Inadequate capacity building programs for staff
Malaysia
• Only 6 states implement Catch Certificate – Penang, Perak, Selangor, Johor, Pahang, and Sabah • Need for additional resources (manpower, financial) necessary for monitoring, auditing, and verification • Need for training of new officers and conduct of refresher courses for existing officers • Key Data Elements are collected more than once through different forms managed by different agencies with very limited scope for data sharing, resulting in lack of proper consolidation and organization of these KDEs under one eCDTS platform • Current approach to CDT is very compartmentalized within government and should be streamlined • CDT is not yet officially mandated or streamlined under any policy, across fisheries in Malaysia
Myanmar
• Fisheries sector is characterized by predominantly vessel type(s) for offshore fisheries (trawlers) • Catch documentation and traceability system is largely paper-based • Low interest of policy makers and decision makers in the fisheries sector • Insufficient technical capacity and financial resources • Inadequate post-harvest facilities

Box 4. Issues and concerns on the adoption of the Southeast Asian catch documentation and traceability systems *(Cont'd)*
Philippines
• Lack of appreciation of CDT as a mechanism for sustainable fisheries development • Need to harmonize CDT systems of trading partners in the development of IT system for CDT in the Philippines • Catch documentation is mainly paper-based and primarily for business dealing purposes • Non-uniform methodology for data capture, storage, and sharing; differences in terminology used by different players along the chain; and differences in the types of data captured and transmitted by different players along the chain • Restrictive policies and unsupportive governance • Subscription or adherence to several standards dictated by international markets and other international and non-regulatory standards which have their own lists of certification requirements • Compliance with regulations and certification requirements are considered labor and resource intensive • Inactions on the part of the government agencies tasked with regulating food systems hamper the maturation of technologies and standards necessary for achieving whole-chain traceability • Lack of buy-in and commitment to implement an electronic CDT system by both small- and large-scale sector stakeholders • Limited awareness of the CDT system brought about by the diversity of nature and technology (*e.g.*, computers, smartphones) and multiplicity of fishing gear and target species of the small-scale fisheries sector • Limited capacity to pay for increased CDT, particularly in the case of small-scale fishers • Inadequacy of needed skills and human capacity • Absence of trust among companies to participate in the implementation of CDT system which they believed could result to data breach
Singapore
• Limited domestic fishing grounds • Extensive species and sources of seafood imports • No commercial fishing
Thailand
• Ability and willingness to adopt technology that is not compulsory, depend on the personalities and progressiveness of boat captains and owners • Fisheries regulations of Thailand including VMS requirements have been changing frequently in recent years causing mistrust in the government • Insufficient technical capacity and interest of fishers on the technology (as suggested by the following findings during the pilot testing of the Hi-Chat application and e-logbook technology), *e.g.* the use of e-logbook technology, for some older captains who are resistant to change and end up designating the filling of the e-logbook to a crewmember, although most boat captains use the Hi-Chat application, so that the problem is more on users' interest rather than technical capability • Companies are wary of authorities getting data for the eCDT, implying the need for bridging over through incentives, demonstrating the benefits, and so on • Need improvements in terms of the number of KDEs collected by the e-logbook system, as additional data points are necessary for the system to be compatible with the CDT system in use by the Department of Fisheries of Thailand, and with other international standards—including USAID Oceans' recommended point of production KDEs • Needs value proposition analysis based on the evaluation of efficiencies and benefits • Unclear cost-sharing structure
Viet Nam
• Fisheries sector is characterized by small-scale fishing (71 % small vessels) • Low awareness of fishers on IT • Limited application of IT for the CDT • Country's catch documentation system is mainly paper-based up to the point of the processors • Low awareness of the need for CDT on the part of fishers and limited application of IT for CDT

Way Forward

Among the major benefits of traceability include the prevention of damages to human health due to food safety concerns, in terms of illness or death, as the distribution of the contaminated products is avoided. Furthermore, if the source of the problem and the precise batches of contaminated products could not be identified, then the food business operator concerned will be obliged to withdraw and destroy all batches which could have been potentially affected. Promotion of traceability which provides the tool to address the aforesaid issues, should therefore be enhanced.

Moreover, traceability can improve stock control and reduce out-of-date product losses, lower inventory levels, quicken the identification of process and supplier difficulties, and raise the effectiveness of logistics and distribution operations. In the longer term, better food safety management resulting from improved traceability, provides greater guarantee in terms of sustained market access and buyer confidence. Improved customer confidence also helps with branding and improved brand equity. In this regard, traceability should be promoted as a marketing tool, by providing customers with unique information about the products they are buying and their origin. This also implies the need for the AMSs to consider the development and improvement of their traceability systems that could complement those of the importing

countries not only in commercial/large-scale fisheries but also by exploring appropriate approaches for the small-scale fisheries in coastal and inland waters through the use of new technologies that support traceability processes and systems. This would enhance the intra- and inter- regional trading of fish and fishery products. More specifically at the regional level, AMSs should harmonize the catch documentation scheme importer's requirements (paper-based and electronic), including IT Catch.

Furthermore, the AMSs should move toward ensuring compatibility and linking of data in the future for the traceability processes and systems. This would necessitate the development of new projects or additional activities for the existing relevant projects being implemented in the Southeast Asian region.

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About the Authors

Mr. Kongpathai Saraphaivanich is the Head of Training and Information Section in SEAFDEC/TD. He is a team member of the project "Strengthening Regional Cooperation and Enhancing National Capacities to Eliminate IUU Fishing in Southeast Asia" implemented by SEAFDEC/TD.

Ms. Yanida Suthipol is the Information and Technology Officer at the Training and Information Section of SEAFDEC/TD. She is a team member of the project "Strengthening Regional Cooperation and Enhancing National Capacities to Eliminate IUU Fishing in Southeast Asia."

Ms. Namfon Imsamrarn is the Information and Technology Officer at the Training and Information Section in SEAFDEC/TD. She is a team member of the project "Strengthening Regional Cooperation and Enhancing National Capacities to Eliminate IUU Fishing in Southeast Asia."

Minimizing the Impacts of Fishing on the Environment through Innovations in Technologies and Operations

Suthipong Thanasarnsakorn and *Thaweesak Thimkrap*

Fishing operations could create certain impacts on the environment, especially on the fishery resources and their habitats, where the impacts on the fishery resources could be from fishing practices without appropriate fisheries management to control fishing capacity as well as from IUU fishing. Fishing activities could also result in changes of the environment due to carbon emissions, and one of the major concerns is related to the impacts of fishing vessels and fishing gears on fish and non-fish species, incidental catch/bycatch of very small fishes, juveniles, or even the endangered species. Modifications of such fishing vessels and gear, and improvement of the associated fishing operations and practices could reduce the impacts of fishing on the environment. Concerned about the impacts of fishing on the environment, the ASEAN Member States (AMSs) had always been of the consensus on the need to obtain understanding and mitigate the impacts of fishing on the fishery resources and the environment. Given such a backdrop, SEAFDEC and the ASEAN made sure that the Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2030 adopted by SEAFDEC and the ASEAN, include provisions on the need to "*Support the efforts to promote low carbon development technologies by minimizing the contribution of the fisheries sector to greenhouse gas emissions, with emphasis on promoting the use of energy-efficient equipment and alternative energy sources*" (Resolution No. 9); "*Enhance the efficient use of energy by adapting appropriate technologies for fishing gear and fishing vessel design, and fishing operations; and promote the use of alternative energy sources" (Plan of Action No. 18); "Improve the capability of fishing crew and workers in fishing industry, and conduct educational and skills development program for new crew members and workers entering the industry; while also adopt appropriate technologies to optimize number of crew onboard fishing vessels*" (Plan of Action No. 19).

Over the decades, SEAFDEC in collaboration with the AMSs has been carrying out activities that address the issues and concerns on the impacts of fishing operations on the environment through responsible fishing operations. Specifically, SEAFDEC/TD with support from the Japanese Trust Fund (JTF) has been implementing the Project "Responsible Fishing Technologies and Practices" that includes activities related to marine engineering technologies (*i.e.*, fuel efficiency, and greenhouse gas reduction, and safety of fishing operations at sea); and on the development of fish handling techniques onboard fishing vessels. Moreover, R&D on the development of appropriate technologies to reduce carbon emissions to the environment in response to the issues of global crisis by climate change, and reduce labor onboard by applying appropriate hauling devices to improve the national economies and fishers' well-being onboard fishing vessels, have also been enhanced.

During the Online Meeting on Reducing Negative Impact to Ecosystem, Optimizing Energy and Fuel Consumption, and Enhancing Safety in Fishing Practices in Southeast Asia, convened by SEAFDEC in September 2020, some technical measures had been suggested to mitigate the impacts of fishing on the environment. These included: closing the most sensitive areas for certain fishing (*e.g.* coral reefs, seagrass beds, nursery grounds); fishing where the fish is (*i.e.* increase fishing efficiency and reduce fishing time); modifying fishing vessels and their operating methods; replacing intrusive fishing gears with the more habitat-friendly gears.

Energy efficiency and fuel-saving options for fishing vessels

All movements of a fishing vessel in the water create resistance force, as the vessel is subjected to dynamic force and resistance of its surroundings to maintain its moving speed. In propulsion systems, the thrust force produced must be equal to the resistance force in order to move forward, and to minimize drag, the vessel's propulsion system should be improved (**Figure 1**). Minimizing the shaft angle could result in reduced thrust variation on the propeller (cavitation) and significantly increased the life span of the propeller.

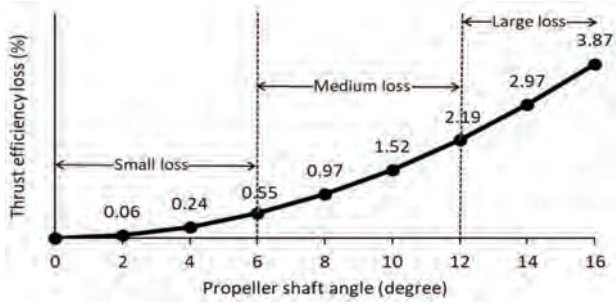


Figure 1. Thrust efficiency loss (%) in relation to propeller shaft angle (degree)

Reducing the propeller shaft angle also minimizes power loss in the transmission system as the upper blade is receding from the onrushing water as it rotates up. When the lower blade is moving forward into the slipstream as it rotates down, it could cause uneven blade loading that creates vibration and/or cavitation.

Vessel design, size of the propeller, propeller clearance, and the water flow's path to the propeller blade should be taken into consideration when constructing and/or renovating fishing

vessels to improve the performance and energy use of the vessels. If the hull shape of the vessel is obtuse, it will increase the water resistance of the hull to the flow. In case the propeller clearance is small, a propeller with small diameter should be used, although it might not be able to absorb all the thrust efficiently, resulting in inappropriate force that facilitates the vessel to move forward in both speed and thrust especially for trawlers and purse seiners.

Installing new propeller shaft aligned with the purpose of attaining improved propulsion efficiency and efficient utilization of fishing vessel fuel, would result in reduced total fuel consumption after vessel renovations. To provide high-efficiency thrust, the flow platform should be improved to ensure that the propeller axis is aligned with the flow pattern of the ship hull for a smooth and efficient flow of water supply to the propeller. In practice, it is difficult to install such propeller, but it is most important to have propeller clearance to the hull structure and keel (aperture size) adequate for the propeller size requirements and there must be enough space for the engine and gearbox inside the engine room.

The angle of the propeller shaft should be as small as possible compared to the keel (**Figure 2**). Thus, the design of the engine base and the transmission system should be adjusted to match the angle to support the driving force and reduce vibration. Most fishing vessel owners and skippers have misunderstood the importance of propeller clearance to avoid the enclosed distance between the propeller and the hull structure. Consequently, many fishing vessels have been set with the angle of the propeller shaft made steeper to avoid such close ranges, missing the hydrodynamics performance and the direction of the force.

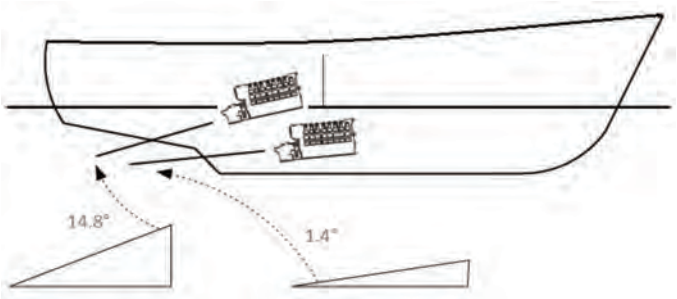


Figure 2. Adjustment in the propeller shaft alignment

To enhance the understanding and awareness of the fishing vessel owners on the aforementioned concepts, SEAFDEC/TD embarked on a six-year Japanese Trust Fund-funded Project "Optimizing Energy Use and Improving Safety at Sea in Fishing Activities" in 2013, which included the "R&D on the implementation of fishing operations with optimizing energy use." Specifically aimed at improving fishing vessel design appropriate for local fisheries in the Southeast Asian region, the R&D activity focused on the SEAFDEC/TD innovation which includes not only in upgrading the purse seine fishing vessels but also the improvement of the propulsion system and of the length of waterline, which has then pilot-tested in Pattani Province in southern Thailand, in collaboration with the Department of Fisheries of Thailand, the Fisheries Association of Pattani Province, and the owner-operator of the pilot purse seine fishing vessel (Thanasansakorn *et al*., 2019).

Renovation of the engine bed and transmission gears

The engine foundation (engine bed) should be adjusted to a lesser angle so that the propulsion engine and reduction gear are placed at the same angle of the vessel as it moves straight forward, and mounted close to the keel of the vessel (**Figure 3**). Thus, the propeller shaft angle has been changed from 14.8 ° to 1.4 °.

Figure 3. Installation of engine in the engine room

Refinement of the stern tube

After the previous propeller shaft exit had been firmly sealed *(above left)*, the new propeller shaft angle *(above right)* is installed, and a new exit is drilled at the sternpost for the stern tube installation *(below)*, as shown in **Figure 4**.

Figure 4. Refinement of the stern tube

Reinstallation of propeller blade

The angle of the propeller blade should be adjusted to higher degrees to optimize the thrust/propulsion efficiency of the fishing vessel during traveling/fishing operations.

Results of the innovation

Improvement in engine speed

Engine speed (rpm)	Vessel speed (kt)	
	Pretest	Posttest
1,850	8.0–8.5	11.0–12.0
1,500	5.0–6.0	8.0–9.0
1,200	4.0–5.0	7.0–8.0
1,000	3.0–4.0	6.5–7.0

Cost of Improvement	
Item	**Amount (USD)**
Materials (engine bed and mounting materials)	2,320
Labor	1,000
Docking and services	1,680
Total cost of renovation	**5,000**

The benefits gained from the innovation include:

- Increased vessel speed
- Efficient fuel consumption and reduced greenhouse gas emission by 36 %
- Reduced vibration and noise at the stern
- Smaller waves or turbulence (vortex) at the stern which means that there is less resistance

Improving the length of waterline

Fishing vessels operate at certain speed for a particular fishing gear. As the vessel speed accelerates, the wave resistance also increases, leading to efficiency loss and high fuel consumption. Reducing fuel consumption allows greater savings for the cost of fishing operations. In general, a vessel cruising at low speed consumes lesser fuel than at high speed, but such relationship is non-linear. It is therefore important to consider the optimum speed, also called the "operating speed" or "service speed," which is used to set up the speed range of vessels in operation. Such operating speed is an important factor that should be considered in improving and/or renovating the vessel design in order to increase the vessel speed capacity and reduce vessel operation costs (*e.g.* fuel cost, working days at sea, etc.).

To achieve the optimum speed, the vessel should have an appropriate L/B ratio, where L or LwL is the length of the vessel at waterline from bow to stern, when it sits on the water

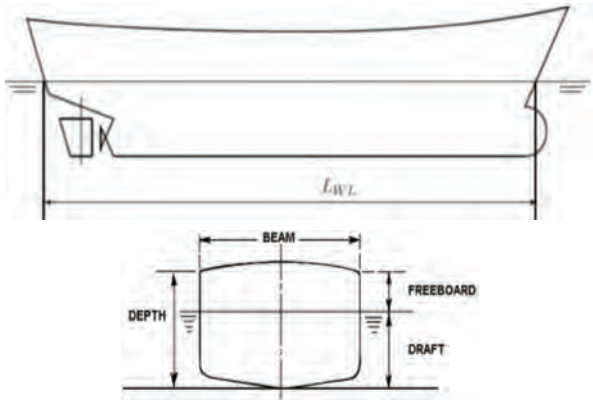


Figure 5. Vessel length at waterline *(above)* and beam or width of the vessel *(below)*

surface, and B is the beam or width of the vessel measured between the most outboard points of the vessel (**Figure 5**). The larger L/B ratio indicates slimmer hull shape and less wave-making resistance, resulting in more efficient high-speed performance of the vessel, optimized its energy used, and increased its load-carrying capacity.

In the pilot project in Pattani Province in southern Thailand, a pelagic purse seiner was improved by increasing the vessel length from 13 m to 18 m.

Renovation

Cutting of the hull structure (A); making two sections of hull structure (B); and increasing the hull structure (C) by 5 meters in length (m).

Results

	Before	After
Propulsion engine capacity	375 hp	375 hp
Breadth	4.4 m	4.4 m
L_{wl}	13 m	18 m
L/B ratio	2.95	4.09
Maximum speed (nautical mile/h)	8.601	9.944
Fuel consumption (litter/hour (l/h))	27.348 l/h	27.348 l/h
Fuel consumption (litter/nautical mile (l/nmi))	3.179 l/nmi	2.750 l/nmi
Greenhouse gas emission per hour	72.198 kg of CO_2	
Fuel consumed/equivalent to produce carbon emission/100 miles	317.963 liters equivalent to 839.422 kg of CO_2 emission	275.020 liters equivalent to 726.052 kg of CO_2 emission
Fuel saved/h or reduced carbon emission/h	4.269 l/h or equivalent to 11.270 kg of CO_2/h emission	

Cost and benefit

Item	Amount (USD)
Materials	2,350
Labor	6,300
Docking and services	3,350
Total cost of renovation	**12,000**

The benefits obtained from the renovation include:

- Bigger space is available for handling the catch onboard, more comfortable living space is created for fish workers onboard, and better ship stability
- Efficient fuel consumption
- Fresh catch arrives the markets faster and thus, commands good price

Pilot testing of the improved technology would be continued to address the issues and concerns encountered during the refinement and verification trials on optimizing energy use in fishing operations, and find the best options that could lead to further improvement of the innovations, which also include not only improving and/or renovating the operations of the physical structure of the vessels but also on the possible reduction of manpower onboard and on proper handling of catch onboard.

Specifically, this would require among others, standardizing the rate of fuel consumption per kilogram of catch, comparing the quality of fish catch and post-harvest losses per fishing trip, determining the average rate of greenhouse gases emitted by the vessels per kilogram of fish catch, and identifying the factors that lead to improved working conditions and safety at sea of fishers onboard. After refining and verifying the improved technology at the pilot sites in Thailand and other selected AMSs, this would be promoted to the rest of the Southeast Asian countries to contribute to the enhancement of sustainable fisheries development in the region.

Reduction of carbon emission from fishing operations

A privately-owned purse seiner in southern Thailand, the "NOR LARPRASERT 8 " has been commissioned by SEAFDEC/TD through a collaborative arrangement since 6 July 2018 for a pilot project on labor reduction onboard fishing vessels during the fishing operations, as well as enhancement of the working practices and living conditions onboard the vessels following proper hygiene and adopting the low-impact and fuel efficient (LIFE) fishing concepts to catch fish, and preserving the freshness of the catch at sea for the benefit of the consumers. The initial activity using this pilot purse seine fishing vessel was launched through a joint fishing operation between the local fishers and SEAFDEC staff from 8 to 12 February 2019, and continued thereafter. During the trial period, the pilot project has shown improved efficiency of the fishing gears (net plan), fishery machinery, and fish handling tools.

After more than three years of research on fuel saving/energy efficiency using this pilot vessel by adopting the appropriate technology on improving energy efficiency, SEAFDEC has contributed to the improvement of fishing practices and working conditions onboard fishing vessels, and reduction

Table 1. Summary of the data on the operation of the pilot purse seine fishing vessel (from 2019 to date)

Total fishing operation (day)	Total fishing voyage (trip)	Total fish catch (kg)	Total fuel consumption (l)	Engine operation (hr)
219	20	260,500	54,035	4,919
(l)	Ave fuel consumption per voyage or trip (l)	Ave fishing per voyage (day)	Ave catch per fishing voyage (kg)	Catch per 1.0-liter fuel consumption (kg)
10.98	2,701.75	11	13,583	4.82
Ave fuel consumption per day (l/day)	Ave selling price of catch per kg (THB)	CPUE/day (kg/day)	CO_2 emission per day ($kgCO_2$)	CO_2 emission per 1.0 kg of catch ($kgCO_2$)
246.73	30	1,189.49	651.36	0.5475

Table 2. New carbon emission recorded about the pilot purse seine fishing vessel

Ice consumption/trip reduced by	Compared to emission $KgCO_2$	New total emission/trip $KgCO_2$	New emission per 1.0 kg of catch ($KgCO_2$)
150 box = 36 t	972	6,160	0.453

Table 3. Improvements made before and after the implementation of the project using the pilot purse seine fishing vessel (2019-2021)

Aspects to be improved	Before project implementation	After project implementation
Manpower onboard (MO)	more than 30 fishers	17 fishers
Average hauling time	About 1.5 hr	30 min
Living space (LS)	72 m^2 (2 levels: 3m x 6m each) shared by 29 fishers (skipper uses different area), each fisher occupies 2.50 m^2 of workspace	72 m^2 (2 levels: 3m x 6m each) shared by 17 fishers (skipper uses different area), each fisher occupies 4.23 m^2 of workspace
Total catch (TC) recorded on logbook	260,500 kg	
Ave catch per voyage	13,583 kg	
Total gross income (at 30 THB/kg)	USD 260,500	
Fishing trip (FT): Thailand regulations indicate that fishing vessel more than 30 GT is permitted to go fishing for not over 240 days/year		219 days (11 days/trip)
GHG emission	0.5475 $KgCO_2$ to catch 1.0 kg of fish	0.4530 $KgCO_2$/kg of fish (to catch 1.0 kg)

of the manpower onboard purse seine fishing vessels. The summary of such efforts made by SEAFDEC/TD, is shown in **Table 1**.

After implementing the project, the new carbon emission record is shown in **Table 2**, while the changes and improvements comparing before and after the implementation of the project using the pilot purse seine fishing vessel, is shown in **Table 3**.

Greenhouse Gas Emission (GHG Emission) refers to the carbon emission or the release of carbon dioxide gas from burned fossil fuel into the atmosphere. Included in **Table 3** are some facts about greenhouse gas emissions from the fisheries sector considered as one of the sources of carbon emission that fuels climate change.

Fuel Consumption (FC): the rate at which an engine uses fuel, expressed in units such as voyage per liter, liters per working hour, or liters per kilogram of the catch. The pilot purse seine fishing vessel makes use of Cummins Engine brand model K-500. Since the first fishing operation until now and referring to the data record for fuel consumption, the average fuel consumption, working-hours of engine operation, and the CO_2 emitted, had been recorded in detail as shown below. For the sake of showing an example, consider 1.0 liter of diesel that weighs 835 g. Diesel consists of 86.2 % carbon or 720 grams of carbon per liter of diesel. To burn this carbon to CO_2, 1920 g of oxygen is needed. The sum is then 720 + 1920 = 2640 g of CO_2/liter of diesel. It should be noted that in the U.S.A., the electricity generated by the electric power industry results in the emission of carbon dioxide (CO_2) which is equal to about 0.99 lb of CO_2 emitted per kWh.

As shown in **Table 3**, 0.5475 $KgCO_2$ is emitted to the atmosphere while catching 1.0 kg of fish before the project implementation. After the project implementation, 0.4530 $KgCO_2$ is emitted per kilogram of fish caught.

GHG emission (before project implementation)
= 0.5475 $KgCO_2$ to catch 1.0 kg of fish
GHG emission (after project implementation)
= 0.4530 $KgCO_2$/kg of fish

Moreover, the fuel consumption of propulsion engine is 246.73 liters/day, then correspondingly the gas emitted from fuel consumption is: 246.73 x 2.64 $KgCO_2$ = 651.36 $KgCO_2$/ liter.

Catch per unit Effort (CPUE): also called the catch rate, is frequently the single most useful index for long-term monitoring of a fishery. Declines in CPUE imply that the fish population cannot support the level of harvesting. Increases in CPUE could mean that a fish stock is recovering, and more fishing effort can be applied. CPUE can therefore be used as an index of stock abundance, where some relationship is assumed between that index and the stock size. The simple calculation of CPUE is the total catch divided by the total amount of effort used to harvest the catch.

$$\text{CPUE} = \frac{\text{Total catch (kg)}}{\text{Total amount of effort used to harvest the catch}}$$

$$\text{CPUE of pilot purse seine fishing vessel} = \frac{260{,}500 \text{ kg}}{219 \text{ days}}$$

CPUE = 1,189.49 kg/day
= 4.82 kg of catch/liter of fuel consumption
Or equivalent to = 1 kg of catch/0.2074 liter of fuel consumption

Reduction of labor in purse seine fishing operations

Due to the kinds of equipment being used for fishing and set up onboard many fishing vessels, *e.g.* purse seiners and trawlers, a large number of workers is required in fishing vessels, especially in the case of Thailand. For example, purse seiners require as many as 30–40 fishers onboard while trawlers require up to 22 fishers onboard. In the case of purse seiners in Thailand, heavy demand for labor comes from the enormous weight of the catch, while the nets are largely pulled aboard by hand. In view therefore of such a scenario, the Department of Fisheries (DOF) of Thailand had approached SEAFDEC/TD and with the collaboration of the Pattani Fishery Association in southern Thailand, to design a more labor-efficient purse seiner. In 2018–2019, experts from SEAFDEC/TD worked with the vessel owner on the project that aimed to design and reconfigure a 91-GT purse seiner (NOR LARPRASERT 8) based in Pattani Province, and used as the pilot fishing vessel for this project.

The design and reconfiguration of the fishing vessel included the installation of a multi-purpose crane, hydraulic system, power block, and central cooling with refrigeration system, on the purse seiner. The crane and power systems facilitate the hauling of nets that was done before by fishers, and the refrigeration system prolongs the preservation of the catch, thereby increasing its value in the market. The costs of the reconfiguration had been shared, with SEAFDEC paying for the equipment and the vessel owner paying for the installation as well as acquisition of new nets. The installation of the new equipment in 2018 took two months because of the extensive optional renovations, although SEAFDEC estimated that installation of similar equipment installation on other fishing vessels would take less than one month to complete. SEAFDEC also reported that the technology and equipment are promptly available in Thailand, and spread the information to all major stakeholders and important fishing ports of Thailand to also undertake the appropriate vessel improvement.

Cost-Benefit Analysis (before and after reconfiguration)

Before the equipment installation, the vessel required around 30 fishers for each seven-to-ten-day fishing trip, yielding a catch that was worth about USD 15,833, based on the vessel owner's price estimates and cross-checked with SEAFDEC experts. Such manning level also meant that the fishers' living space of 72 m^2 (4 levels of 3 m × 6 m space) was shared among 29 fishers (the skipper sleeps in a different area), and implied that each fisher occupied an average of 2.5 m^2 of space onboard, before the reconfiguration.

Since the installation of the new equipment in early 2019, the purse seiner has seen an approximate reduction of 37 percent in terms of labor required. The power block, crane, and hydraulic systems enable net hauling to be done more efficiently by fewer fishers. In this case, the fishers needed onboard have gone down from 27 to 17, while the average time for hauling the fishing nets is less than an hour and 30 minutes, down from more than two hours before the reconfiguration. With more adjustments, SEAFDEC forecasts that eventually, the manning will come down to 14 or 15 men, about half of the original fishing crew. The total costs of labor per year will be reduced as well, from USD 137,237 per year to USD 108,100 in the second year after reconfiguration, even with an increase of monthly wages for fishers to USD 400 per month, which is at par with past policy proposals made by Thai vessel owners and workers' organizations. The costs of workers' permit will also be reduced along with the overall cost of workforce by 45 percent (*i.e.* to approximately USD 2,633) in two years. Even accounting for the increases in base pay of the fishers, supervisors, and skippers, the savings from the total labor cost are significant at approximately 21 percent.

The central cooling and refrigeration systems have proven to reduce the quantity of low-quality fish, especially the fish caught on the first few days at sea which loses its value as the

quality deteriorate from 34 percent down to around 10 percent. This means that with the current renovations, 90 percent of the catch can be sold at full market price (up from 70–80 percent of the quantity before the installation), increasing revenues by roughly 10 percent from USD 15,833 to USD 17,416 on the average per trip.

The work area onboard for fishers has also seen significant change. After the boat reconfiguration, the 72-m^2 living area is now shared by only 17 fishers (excluding the skipper), hence each fisher now has 4.23 m^2 of workspace versus the 2.48 m^2 before. This means that the fishers no longer work in such a crowded space, which has been notoriously dangerous in the fishing industry, this means safer work conditions.

Fuel costs are largely unchanged after the reconfiguration. The vessel owner however noted that any increases in fuel usage due to the installation of the crane are offset by the reduction in the number of fishers onboard. SEAFDEC has planned to change the configuration of the refrigeration system starting in late-2019 as the engineering team believes that such changes could lead to reduced energy costs. With regards to engines used in the fishing industry, certain more efficient fuel-injection engines have been in use elsewhere but these are not available in Thailand and are three times more costly than the traditional engines. As a result, most vessel owners in Thailand have reportedly shown little interest in the lower-carbon types of engines. Meanwhile, the owner of the pilot fishing vessel and SEAFDEC had estimated that the resale value of the vessel after the reconfiguration is about USD 330,000 an increase of about two-thirds of its USD 200,000–230,000 value before the changes.

Improvements in their working conditions had led to reduced turnover rate of fishers from 30 percent to effectively zero in the months after the reconfiguration. This demonstrates that the installation of basic power-hauling equipment on purse seiners can help alleviate labor shortages and improve the conditions of those working and living onboard the vessels. The total cost of the comprehensive reconfiguration carried out on the pilot fishing vessel (excluding the cost of acquiring new nets) is USD 58,330. This includes the central cooling system, refrigeration system, other installations, and the core reconfiguration: crane, power block, and hydraulic system. The investment cost for the vessel's reconfiguration is relatively high as far as the owners of even the smallest commercial fishing companies that own one or two fishing vessels are concerned. However, SEAFDEC is of the view that the investment costs could be reduced if only the core equipment are changed, *i.e.* crane, power block, and hydraulic system. The central cooling system, the refrigeration system, and the purchase of new purse seine nets are not necessary for the core reconfiguration, as vessel owners can make such additional improvements over time. Assuming that a ten percent increase in revenue per trip due to the enhanced cooling and refrigeration systems, from an average of USD

15,833 per trip to USD 17,416 per trip, at 30 trips per year, the increase in annual revenue during the second year after the reconfiguration is estimated at USD 47,500. Adding the savings from labor cost of USD 29,138 per year, the total amount could easily cover the investment cost for the reconfiguration and installations in less than one year. The summary of the cost of the vessel reconfiguration and benefits gained, is shown in **Table 4**.

Table 4. Summary of reconfiguration cost and benefits

Comprehensive Reconfiguration Cost (excluding new nets)	USD 58,333
Estimated increase in revenue per year after reconfiguration	USD 47,500
Savings from labor cost per year after reconfiguration	USD 29,000
Return on investment (estimated period)	Less than 1 year

Catch per unit of fishing effort and greenhouse gas emission of a purse seine fishing vessel are among the most important factors that determine the impacts of the increasing contribution of Southeast Asian fisheries to global seafood production. Purse seine fishing is one of the activities that significantly contribute to the region's seafood production, but requires considerations in terms of the energy use (man and machine), and in mitigating the negative impacts of fishing activities and vessel operations on the environment.

Improvement of catch preservation technology onboard fishing vessels

SEAFDEC/TD has been developing a design and also initiating the construction of onboard refrigeration system to be used for fishing vessels by adopting a hybrid technology that can make use of multi-mode operation sources, *e.g.* from the propulsion engine or diesel generator or electricity from the shoreline. In addition, the design also utilizes various types of preservation tools onboard that are more suitable for the fishing gear and target species, such as the refrigeration seawater (RSW) and airblast freezing system. The possibility of using both RSW and airblast freezing system in unison is also being explored as means of prolonging the freshness of the catch at their premium quality onboard, taking into account the optimum utilization of energy.

Refrigeration seawater

Refrigeration seawater (RSW) is a system used onboard fishing vessels to preserve the freshness of the catch. The advantage of using the RSW system is its cost-saving capacity and its ability to preserve the catch at premium quality until it is unloaded ashore or for further processing. Its cooling efficiency is improved, cooling down the catch close to freezing point much faster than using ordinary ice or limited ice, thus, ensuring the freshness and fresh quality of the catch while being transported onboard. It should be noted that the approximate electricity consumption per tonnes of ice (box) produced for the icemaker and refrigeration plant for temperate and tropical areas, is approximately 60 kWh/tonne. This does not include requirements for handling, crushing, or storage.

Airblast freezing system

The use of air flow to improve heat transfer from the product being cooled through the refrigeration system is probably the most common method used in commercial fishing vessels. However, the natural convection of the air alone would not give a good heat transfer efficiently, therefore, forced convection using fans has been introduced. To enable the product to reach the freezing point within a reasonable time, the air flow rate should be fairly high (2–6 m/s). Also, to obtain uniform cooling rates throughout the freezer, the air should flow over each fish in every fish container.

Power take-off

Power take-off (PTO) is any of several methods used for taking power from a power source, such as the main engine, and transmitting it to an application such as a water pump, hydraulic pump, and/or compressor for the refrigeration system. Usually, the refrigeration system whether in an industrial establishment or on a fishing vessel, uses an energy source which is either from the electric motor or engine, to keep the compressor of the refrigeration system going. It is designed to be capable of using more than one type of energy source which consists of the main engine and the electric motor.

Split shaft power take-offs

In a fishing vessel, the propulsion engine or diesel generator has greater capacity in delivering a relatively steady amount of torque at both high and low running speeds. Consequently, the propulsion engine or diesel generator can drive the compressor of the refrigeration system by providing enough power take-off, which is a mechanism to bring power from its operating speed that properly matches with the requirements of the refrigeration unit that utilizes the power source. Split shaft power take-offs have many advantages, making it an excellent option to capitalize on the full potential of the fishing vessels. The split shaft power take-offs are equipment like a gearbox or power take-off application that allow single or multiple pumps to be driven from a single prime mover. This multiple/split type power take-off is a combination of different propulsion technologies. In the hybrid transmission system, an electric motor performs the function in place of the engine, such as exerting force to the transmission shaft.

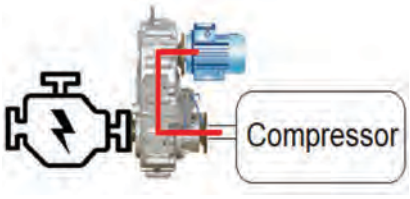
The use of split shaft power take-offs is advantageous because of their properties that include:

- Multiple outputs

- Various styles and sizes
- Standard PTO is driven by a pulley for versatility
- A shiftable compressor can drive both the electric motor and main engine
- Fuel is utilized efficiently and cost is beneficially optimized
- Waste from fish preservation onboard is reduced

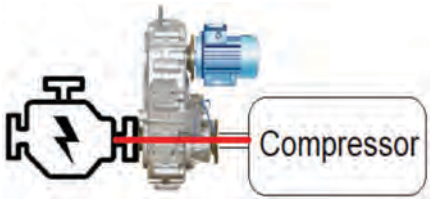
The refrigeration system could use either the electric motor or the engine, as energy source to keep its compressor going. The functions of such energy sources are summarized below:

Hybrid refrigeration system driven by electric motor



In general, the compressor of the refrigeration system is driven by an electric motor, the size of which depends on the cooling capacity or cooling efficiency of the compressor. This means that a lot of electricity is needed from the diesel generator. Since the electricity demand is defined as fuel consumption, even when a fishing vessel moored at the fishing port/jetty, it will still be able to operate the refrigeration system through the electric motor. This is because fishing vessels must continue to run either through its diesel generator ordinarily or by utilizing the shoreline power source when the main engine stops. But whenever the fishing vessel leaves the pier/port and the main engine is in use, the refrigeration system can change the mode of operation to engine mode so that the compressor would continue to function.

Hybrid refrigeration system driven by propulsion engine



The merit of the refrigeration system is driven by the propulsion engine. Whenever the fishing vessel leaves from the fishing port to the fishing ground for certain fishing period, it will take time to operate the engine. Therefore, using the engine drive mode will result in energy utilization without using the electric sourced from the diesel generator.

Way Forward

Fishing vessel owners in southern Thailand have already applied the innovation on improved fishery machinery for purse seine fishing vessels aimed at enhancing working practices and optimizing the energy utilization of their fishing vessels' operations, *e.g.* in this case where it has become necessary to make the vessel more thrust efficient, as well as improve the length of the waterline to increase the vessel speed capacity and reduce vessel operation cost. The lessons learned from the adoption of the innovations in Thailand could be shared to the other AMSs. Moreover, the R&D on the development of appropriate technologies to reduce carbon emissions to the environment at a low level in response to the issues of global crisis by climate change, and reduce labor onboard by applying appropriate hauling devices to contribute to improving the national economies and fishers' well-being onboard fishing vessels, would be enhanced and continued. The results of such activities would be shared by SEAFDEC/TD with the AMSs through the production of information and training materials/models that would be introduced through the training courses of SEAFDEC/TD on the improvement of appropriate fishing vessel technology in terms of marine engineering, and also through the SEAFDEC website. Capacity building programs through online workshops and demonstrations, as well as hands-on practical sessions could also be organized. Results of such innovations in technologies and operations could be used for the compilation of the Southeast Asian regional reference for minimizing the impacts of fishing on the environment.

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About the Authors

Mr. Suthipong Thanasansakorn is Head of Training and Research Supporting Division of SEAFDEC Training Department in Samut Prakan, Thailand.

Mr. Thaweesak Thimkrap is an Engineer assigned at the Fishery and Postharvest Engineering Section of the Training and Research Supporting Division of SEAFDEC Training Department in Samut Prakan, Thailand.

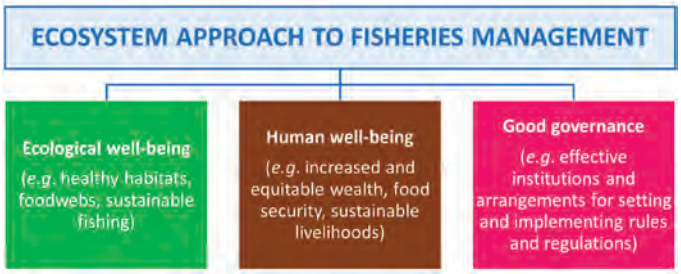
Continued Promotion of the EAFM Concept in Southeast Asia: Case in Myanmar

Supin Wongbusarakum, Myat Khine Mar, and *Panitnard Weerawat*

The FAO Code of Conduct for Responsible Fisheries (CCRF) indicates that "*the purpose of the ecosystem approach to fisheries is to plan, develop, and manage fisheries in a manner that addresses the multiple needs and desires of societies without jeopardizing the options for future generations to benefit from the full range of goods and services provided by marine ecosystems*." The CCRF sets the principles and international standards of behavior and practices to ensure effective conservation, management, and development of living aquatic resources, with due respect for the ecosystem and biodiversity. These include the ecosystem approach to fisheries management (EAFM) that focuses on the relationship between fishing activities and the ecosystem as a whole, including the socioeconomic implications as well as management requirements. EAFM encompasses the management of target species as well as non-target species, endangered species, aquatic waste and pollution, biodiversity, and welfare of coastal communities, small-scale fisheries, and subsistence fishers.

SEAFDEC has been promoting the EAFM concept in the Southeast Asian region in line with the priority actions stipulated in the ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020. More particularly, with support from the Japanese Trust Fund (JTF), the SEAFDEC Training Department (SEAFDEC/TD) implemented the project "Human Resource Development for Sustainable Fisheries" in 2013–2019, under which the concept of an EAFM has been promoted in pilot sites in the ASEAN Member States (AMSs), namely: Cambodia, Lao PDR, Myanmar, and Thailand. In this article, the lessons learned from the pilot site in Myanmar are summarized including the impacts of the adoption of the EAFM concept in the country.

The EAFM concept strives to balance diverse societal objectives, by considering the knowledge and uncertainties about biotic and human components of ecosystems and their interactions, and applying an integrated approach to fisheries within meaningful boundaries (FAO, 1995). It is a practical, participatory way to manage fisheries by continually striving to achieve a balance between ecological well-being and human well-being through good governance.



EAFM is a platform that promotes the concept of planning, developing, and managing fisheries in a manner that addresses the multiple needs and desires of diverse stakeholders and the broader societies, without jeopardizing the options for future generations to benefit from the full range of goods and services provided by the marine ecosystems (Garcia *et al*., 2003; FAO, 2003; FAO, 2012; Heenan *et al*., 2015).

SEAFDEC EAFM Pilot Sites in Southeast Asia

Under the JTF-funded project "Human Resource Development for Sustainable Fisheries" (2013–2019), the EAFM concept had been piloted in selected sites in Cambodia, Lao PDR, Myanmar, and Thailand. The lessons learned from the pilot site in Thailand (Weerawat & Worranut, 2019) as well as those in Cambodia (Panitnard *et al*., 2020) had been compiled and analyzed to serve as input for the activity at the pilot site in Myanmar.

The EAFM pilot site of SEAFDEC in Myanmar was at the Aung Kan Thar Village in Thahton Township, Mon State (**Figure 1**). The results of the survey conducted in 2017 showed that there were 168 households or 1,032 villagers, all of whom were small-scale fishers and some run a grocery shop at home for daily income. Moreover, the people in the village also produced fish and shrimp paste. The estimated monthly income of the fishers in the Aung Kan Thar village was approximately USD 100.

Figure 1. EAFM pilot site in Myanmar: Aung Kan Thar Village, Thahton Township, Mon State

The common fishing gears used for fishing to catch the target species, *i.e.* flathead grey mullet (*Mugil cephalus*), barramundi or Asian sea bass (*Lates calcarifer*), brushtooth lizardfish (*Saurida undosquamis*), river catfish (*Mystus cavasius*), croaker (*Otolithes* sp.), Indian threadfin (*Polynemus indicus*), and mangrove crab (*Scylla serrata*), include hook and line, small cast nets, eel traps, surrounding nets, gill nets, drift nets, and crab traps. The village has nine traders who provide loans to fishers at a high-interest rate of 20 %, including three who trade mangrove crabs and six who trade fish and other marine harvests.

The pilot site was chosen considering the several issues and concerns, especially in terms of the ecological aspect, as the fishery resources had been declining due to overfishing. Moreover, in the human well-being aspect, the fishers earn low income not only because of the decreasing fish catch, but also due to the low market price, while the technical know-how of the fishers when it comes to adding value to fish and fishery products, was found to be limited. In the governance aspect, enforcement of fisheries regulations was seen as weak and ineffective, especially that the awareness among fishers of the fisheries regulations has been insufficient, and there was also weak collaboration among the fisheries stakeholders.

Promotion of the EAFM Concept

In order to address the aforementioned issues and concerns, the EAFM concept was introduced to the pilot site through the conduct of a training course on EAFM organized by SEAFDEC/TD in 2015. This led to the establishment of the EAFM core team to facilitate the development of the Fisheries Management Plan. Specifically, the major activities on the promotion of the EAFM concept in Myanmar are shown in the **Box**.

Accomplishments

Establishment of the fisheries management area

The fisheries management area was established to: 1) ensure food security, food safety, and sustainable development of the fisheries sector by conserving the fishery resources following the fisheries laws; 2) increase the level of compliance with fisheries laws, and at the same time amend the rules and regulations to align with international provisions; and 3) support the establishment of an accurate operational framework for systematically improving and implementing fisheries co-management and ecosystem approaches to

Figure 2. Key stakeholders workshop in April 2017

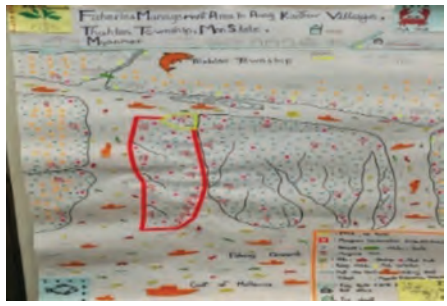


Figure 3. Map of fisheries management area established by key stakeholders

Box. Major activities on promoting the EAFM concept in Myanmar
December 2015: E-EAFM training was conducted in Yangon, Myanmar to introduce the EAFM concept, from which the participants had acquired the skills and knowledge to develop, implement, and monitor an EAFM Plan
June–July 2016: National EAFM Training of Trainers (ToT) was conducted in Nay Pyi Taw, Myanmar to build a pool of EAFM trainers in Myanmar
December 2016: Inception meeting was organized in Myanmar to strengthen the knowledge and skills of key national officers in all aspects of sustainable fisheries development with a focus on human well-being (*i.e.* improving income through value-adding of catch adopting applicable and suitable methods)
April 2017: Workshop "Key Stakeholders' Engagement and Investigation of the Current Situation which Leads to Low Income of the Fishers" was conducted to identify the issues that impede the improvement of fishers' income by adding value to their catch (Figure 2), and subsequently, Aung Kan Thar Village was selected as the pilot site of the Project (**Figure 3**)
July 2017: Survey was conducted in Aung Kan Thar Village (**Figure 4**) to identify the appropriate activities that could increase the income of the fishing community and enhance the habitats, after which it was decided that the activities should focus on mangrove crabs and plantation of mangroves
November 2017: Workshop was conducted to develop the EAFM plan focusing on increasing the income of the fishing community (**Figure 5**), followed by a study visit to observe the relevant activities in Surat Thani, Thailand, especially those related to mangrove crab fisheries, *e.g.* using responsible traps, fattening, fish and seafood processing and production, packaging and marketing, among others
May 2017: Workshop was held to revisit the existing fisheries management plan, which was finalized by the Department of Fisheries (DOF), Myanmar, while mangrove plantation was started at the pilot site
September 2017: Follow-up activities were carried out to support the finalized fisheries management plan at the pilot site including the field survey at the mangrove crab conservation zone in the mangrove plantation area of the pilot site

Figure 4. Field survey of the mangrove crab conservation zone and mangrove plantation area

Figure 5. Workshop in November 2017 to develop the EAFM Plan

fisheries management. When the EAFM concept was promoted in the pilot site, mangrove plantation was initiated by the fishers with support from SEAFDEC. Mangrove conservation has been considered an important tool to enhance fishery resources and support both the fishers and ecosystems.

Mangrove forest is critical for sustainable and enriched fishery resources in Aung Kan Thar Village. For successful mangrove restoration, sea level, salinity, and suitable mangrove species were considered. Approximately 50 acres of the 500-acre mangrove forest area was designated by the DOF Myanmar for mangrove forest and crab conservation. The DOF staff, members of the Fisheries Community Group, and villagers planted 1,200 mangrove seedlings per acre. The planted mangrove species include *Avicennia alba*, *A. officinalis*, and *Rhizophora mucronata*. The mangrove trees of the replantation activity, had 90 % survival rate of the seedlings.

Mangrove farm at Aung Kan Thar Village supported by SEAFDEC and mangrove planting activity spearheaded by the Prime Minister of Mon State

Engagement of women in building supplementary livelihoods

The EAFM concept has contributed to improving gender equality and building the capacity of women in the pilot site. In 2018, the women's group was established as means of promoting supplementary livelihoods in the area (**Figure 6**). With 71 members, seven of whom were core women leaders, the women had undergone skills training for value-added products, especially producing fish crackers and dried fish from mullets and brushtooth lizardfish. The women also learned to process and package chili paste, dried shrimp, tamarind paste, and tomato paste with quality ingredients. SEAFDEC supported the installation of fish drying racks (**Figure 7**) and trained the women on fish processing including high-quality value-added products and hygienic packaging that would be attractive to consumers.

Moreover, the technical assistance from the DOF of Myanmar had led the Project to become successful in supporting sustainable fisheries development and livelihood opportunities. Since then, the incomes of fishers have improved and fishers have become more aware of responsible fisheries management concepts.

Improved governance

The EAFM Core Team in Myanmar was strengthened to enable them to apply the EAFM concept in the pilot site. Also, the Fisheries Community Group was established at Aung Kan Thar Village with 120 members including the core members of four women and 48 men. The Mon State Fisheries Committee, which is composed of the DOF fishery officers, government staff, Fisheries Community Group leaders, and officers from relevant departments, had set the fisheries rules and regulations.

The fisheries rules and regulations include the prohibition of fishing gear with a mesh size smaller than 2.54 cm and restriction of the use of surrounding nets. As a result, IUU fishing incidents dropped to three cases in 2017 and became rare in 2018. Furthermore, awareness has been raised among the members of the Fisheries Community Group as well as traders, villagers, fishers, and other relevant stakeholders about the importance of sustainable resources, and the local people have become better informed about fisheries regulations. The DOF Myanmar and officers from relevant ministries started to cooperate with the fisheries committee to monitor and control illegal fishing, and it was agreed that monitoring would take place once a month by official inspection boat and 20 times a month by local fishers. Meanwhile, the EAFM Handbook was

Figure 6. Women's group at Aung Kan Thar Village

translated into the Myanmar language and disseminated to all stakeholders for increased understanding of the stakeholders of the EAFM concept.

Way Forward

Myanmar had adopted the new version of Essential EAFM (E-EAFM) course materials for the Southeast Asian region. These materials would be useful for both fisheries managers and extension officers in their continued efforts of conducting EAFM activities in the coastal areas of the country. After the implementation of the Project at the pilot site in Myanmar, SEAFDEC had sustained the conduct of EAFM training courses throughout the country until 2019.

The five-year project "Small-scale Fisheries Management for Better Livelihood and Fisheries Resources" of SEAFDEC/TD which commenced in 2020 and supported by JTF, includes an expansion of the EAFM concept to other areas through building and strengthening human resources and further promoting the EAFM concept among the fisheries officers of SEAFDEC Member Countries. This Project has therefore been used to support another EAFM pilot site in Kawthaung, Tanintharyi Region, Myanmar where the EAFM plan would be developed considering the apparent issues that also occur in the area.

Figure 7. Fish drying rack constructed in Aung Kan Thar Village with support from SEAFDEC

EAFM Core Team in Myanmar

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About the Authors

Dr. Supin Wongbusarakum is International Community Fisheries Officer at the FAO Complementary Support to the Cambodia Programme for Sustainable and Inclusive Growth in the Fisheries Sector: Capture component (CAPFISH Capture), Phnom Penh, Cambodia, and Affiliate Faculty at the University of Hawaii Sea Grant College Program, Honolulu, Hawaii, USA (Email: supinw@gmail.com).

Ms. Myat Khine Mar is Assistant Director at Department of Fisheries, Ministry of Agriculture, Livestock and Irrigation in Yangon, Myanmar (Email: mar268354@gmail.com).

Ms. Panitnard Weerawat is Senior Instructor at SEAFDEC/TD in Samut Prakan, Thailand (Email: panitnard@seafdec.org).

Sustaining the Philippine Marine Reserves: issues and concerns

Leilani Chavez

The Philippines pioneered a community-based approach to marine protected area (MPA) management in 1974, aimed at achieving a balanced conservation and community livelihood. This became the blueprint of the more than 1,500 marine reserves in the country today. While the government depends on its MPA system in protecting its seascapes and meeting its international commitments, research results suggest that only a third of the country's MPAs are well-managed and only around 1 % of the country's coral reefs is protected. With management and resource challenges, these MPAs are threatened by overfishing and illegal fishing practices as well as the worsening impacts of climate change. Experts therefore say that strengthening the country's larger MPA systems, synchronizing conservation with fisheries management policies, adapting newer models, and creating a network of MPAs may help the country buffer the impacts of climate change on its rich marine resources.

In the town of Pilar, part of the Camotes Islands, Cebu Province in central Philippines (**Figure 1**), a community of 11,308 residents looks after one of the most successful marine protected areas in the country (Bianchessi, 2010), the Pilar Municipal Marine Park (PMMP). Established in 2005, the 179-hectare park stands out among the thousands of MPAs in the Philippines, which experts say are only protected on paper. At the heart of the PMMP is a 29-hectare no-take zone, an area where fishing and all other marine activities are banned. Like in all MPAs, these no-take zones are spawning grounds for fish. To balance the livelihood needs of the community, the remaining 150 ha of the PMMP have been allotted as a marine reserve open to limited fishing activities using non-destructive, basic fishing gear.

Figure 1. Map of the Philippines showing Cebu Province that includes the Camotes Islands, one of which is Pilar, where Pilar Town, the host of PMMP is located (★)

A resident of Pilar, *Ms. Susan Cataylo* once said that the MPA was a lifesaver when Typhoon Haiyan struck central Philippines in 2013 and cut off the island of Pilar from the rest of the province of Cebu. She also said that "Camotes Islands is far from Cebu City, which was also devastated by Typhoon Haiyan, and if we waited for aid from the government, we would have gone hungry. But the spillover fish from the MPA kept us alive." The foremost expert on MPAs in the Philippines, *Dr. Rene Abesamis* also said that marine reserves are known as such since they function as "piggy banks" — a stop-gap resource to alleviate community needs during drastic events.

Governments and communities have recognized the importance of MPAs in boosting fish stocks, generating local income through tourism, and cushioning climate change impacts, which in the Philippines manifest as a string of late-season super typhoons from the Pacific Ocean. The Philippine Government has always put its MPA system at the forefront of its conservation strategy. In 2020, the country reported protecting 9.7 % of its seascapes, narrowly missing its commitment under the Convention on Biological Diversity's Aichi Biodiversity Targets to protect 10 % of coastal and marine areas by 2020. Yet the country's accomplishments in sustaining its more than 1,500 MPAs have been beset with challenges. Experts say that it is possible that only a third of the country's MPAs are well-managed, and the collective coverage of no-take zones barely protects the country's corals and coral reefs.

While some MPAs are reported to possess high fish abundance, overfishing in the areas surrounding these MPAs and the intrusion by fishing vessels due to weak monitoring and enforcement structures, have doomed these reserves to the extent that experts call them "dummy parks" — protected on paper but not on the ground. Experts point to various "moving parts," factors that contribute to the effectiveness of marine protected areas and their promised bounty. At the top, laws and policies collide and overlap. On the ground, changing political will and community engagement exacerbated by resource limitations weaken the effectiveness of MPAs both as a conservation and fisheries management model.

The underwater rainforest of Verde Island Passage (between Batangas and Mindoro in the Philippines), the richest part of the Coral Triangle
(Image by Jeff Britnell/Coral Reef Image Bank)

The Issues and Concerns

Varying levels of protection

Policies in the 1970s and 1980s focused on increasing fish yields, and the string of seas threading through the central Philippines became a playground for fishers using destructive gear. Fishing with cyanide-loaded explosives was the norm, so was the use of trawling techniques, known as the *muro-ami* or the *baling-baling* and *hulbot-hulbot* in the Visayan (central Philippine) tongue. Despite the ban on these methods, recent studies show that some are still in use today.

The country is considered the "center of marine biodiversity in the world" by the Global Marine Species Assessment of the World Conservation Union, a designation that highlights its importance in the Pacific Coral Triangle. The country's waters contain the third most extensive reef system in the world, spanning about 22,000 km^2. Threatened by coastal development, pollution, overfishing, and destructive fishing practices, how the Philippines manages its seascapes impacts global marine conservation (Selgrath *et al*., 2018).

In the last decade, the Philippines lost one-third of its coral cover, and nearly 75 % of the country's fishing grounds are overfished — figures based on assessments done a decade ago, which means the situation may have worsened today, says Oceana Philippines, a marine NGO. Coral protection was the focus of the MPA movement in the 1970s, and

Figure 2. Sites of first MPAs in the Philippines (in Sumilon Island and Apo Island)
Source: Alcala (2004)

Apo Island of Apo Reef Natural Park, one of the first MPAs in the Philippines

(Image by macoy.mejia via Wikimedia Commons (CC BY-SA 4.0))

marine protected areas back then were adapted to allow corals to regenerate and to improve decreasing fish stocks. The initiatives started in two areas, *i.e.* off Sumilon Island, established in 1974; and Apo Island in 1984 (**Figure 2**). Both located in central Philippines, these MPAs became the blueprint for the more than 1,500 MPAs that now dot the country's waters, some are small, averaging just 15 ha; close to shore; and, most importantly, co-managed by the local government and the coastal community.

Studies of Alcala and Russ (1990) and Russ and Alcala (1999) indicated that MPAs can contribute directly to fish biomass and diversity. An MPA with limited to no fishing activities can see a rebound in fish stocks, as was the case in Apo Island. By contrast, Sumilon Island failed to meet its purpose of replenishing fish stocks and coral rehabilitation when it was opened for fishing for 10 years. Both case studies highlight the importance of protecting the most ecologically important part of the seascape, the "core zone," which is usually the spawning ground for fish.

"But to sustain a community-managed reserve requires social preparations," says *Dr. Abesamis*. "You cannot just tell fisherfolk to stop fishing in an area that is important to their livelihood," he says. "There is a psychological impact in creating an MPA and there are lots of social preparations necessary to establish one." In Sumilon and Apo Islands, the locals' livelihoods were a major consideration, if not the main driving force. *Dr. Alcala* added that the coral reef areas around the islands were zoned into two parts, *i.e.* 15–25 % of the area of these reefs was within no-take zones, and the remainder was opened to "fishermen using only non-destructive fishing methods."

While the country's MPAs started small, *Dr. Alcala* pushed for a bigger system when he was appointed as the Secretary of the Philippine Department of Environment and Natural Resources (DENR) in 1992. He influenced the creation of expansive, government-managed MPAs through the National Integrated Protected Area Systems (NIPAS) Act, which provided legal protection to three marine seascapes in 1992. It would take 26 years, however, before the Philippines issued a follow-up: In 2018, the government enacted the Expanded National Integrated Protected Area Systems (E-NIPAS), supporting 32 marine protected areas with legislations, and included Apo Island under this protection scheme. Currently, the Visayas Region holds the greatest number of NIPAS sites with seven MPAs covering 548,157 ha.

The slow road to legislating government-managed MPAs, prompted local governments and communities to establish smaller ones in the 1990s through the Local Government Code (LGU Code), which gave them power to enact ordinances. This saw the mushrooming of 564 MPAs in the thousands of scattered islands in the Visayas Region, making it the region that holds a third of the country's MPAs today. While NIPAS and E-NIPAS sites receive steady funding from the national treasury, community-managed MPAs depend on a budget allocated by local government units, which are most often sourced from tourism receipts. As such, these sites have different levels of protection, and their fates mainly relying on political priorities.

More, but less

The waters around Pilar Island used to teem with reef fish species like the Napoleon wrasse (*Cheilinus undulatus*) and the bumphead parrotfish (*Bolbometopon muricatum*), *Ms. Cataylo* said. But during the 1990s, the parrotfish speared by fishers were getting smaller in size, and by the 2000s, the seas were "empty" — devoid of fish, large or small. This forced fishers to go farther out to sea, up to 20 km, spend more hours fishing and more money on motorized boats and expensive gear.

After the PMMP was established as a protected area, the community devised a rigorous enforcement scheme that saw volunteers working in shifts to keep illegal fishers and poachers at bay. The results were immediate, so that in four years, the fish returned. Biophysical assessments done there, however, show the corals remain in poor condition. Despite this, the PMMP received the DENR Award "Para el MAR" in 2009, a recognition given to well-managed MPAs in the country.

The Mayor of Pilar Municipality said in 2009 that it was political will that led to the success of the PMMP, but for community members like *Ms. Cataylo*, it was the enforcement. "When Typhoon Haiyan struck, our watch house was washed away, but even then, we have volunteers watching over the marine protected area," she added. Other MPAs, however, are failing. In a study on community-managed marine protected areas in the Visayas Region in 2008, Alcala (2004) found that only about 34 % of the 564 MPAs there were "working" in improving fish biomass. The lack of consistent

The century-old mangroves of Camotes Island, Cebu, Philippines

(Image by Oggie Ramos/Rare Philippines)

monitoring and enforcement, compounded by meager community engagement, had created "dummy parks." Under the Philippine Fisheries Code of 1998, municipalities are encouraged to establish fish reserves or sanctuaries to cover 15 % of their waters. Today, barely 1 % of municipal waters fall under the MPA scheme. *Dr. Alcala* says only 0.5 % of municipal waters had been designated as no-take MPA zones, and these areas only protect 2.7–3.4 % of the country's total coral reef area.

Nonetheless, *Dr. Abesamis* takes it further saying that "If he were to adapt the 2008 study of Dr. Alcala to assess the status of the MPAs in the Philippines, it is possible that only about 1 % of the country's corals are protected, he says, since two-thirds of the MPAs are not efficiently managed to begin with. The current MPA count still fails to protect our country's marine and coastal biodiversity." He then suggested that "the real counting should be closer to the ecological effect of these marine protected areas; otherwise, it is meaningless — we will continue to face effectiveness problems."

Beyond corals

Experts point to a series of possible solutions, *i.e.* strengthening the larger MPA systems in the Philippines, synchronizing conservation with fisheries management policies, adapting newer models, and creating a network of MPAs. "Larger MPAs, like Australia's Great Barrier Reef, cover bigger areas so it is protecting a larger ecosystem," *Dr. Abesamis* said. "But when it comes to MPAs, the Philippines never moved beyond the small, nearshore level."

Marine scientists are banking on marine protected networks — a series of interconnected MPAs, particularly no-take zones — to ease the protection gap. While efficient MPAs boost fish abundance, studies show that the waters surrounding isolated MPAs are burdened by heavy fishing activities and, in the worst cases, intrusion by commercial vessels capable of catching 800,000 kg of fish in a single trip.

Interconnected MPAs, though, require a shift from a coral-centric mindset to one that treats all coastal areas as important to marine species. "Mangroves, sea grass beds, coral reefs — even the soft sandy bottoms," *Dr. Abesamis* said. "These areas are part of a larger ecosystem that are well-connected physically and biochemically through the life cycle of certain fish and invertebrates. Ideally, a system of MPAs should be trying to protect all of these components, whether these are found in one MPA or in many different MPAs."

"Community acceptance of creating an MPA varies. Basic problems persist on the ground, including a knowledge gap about the marine resources, among others, and an aversion to closing 15 % of municipal waters due to the perceived livelihood impact," *Dr. Abesamis* added. As such, the Philippine Government has instead implemented closed fishing seasons in major fishing grounds to allow the fish population to rebound, with varying results (Sarmiento, 2021).

In the Visayas Region, however, the communities like in Pilar Municipality are receptive to MPAs due to the anticipated spillover of larval and adult fish driven by ocean currents moving northwest from the Pacific Ocean. "In the case of Apo Island, for example, we have evidence that fish larvae have spilled over to several areas in southwestern Negros Oriental province due to the prevailing ocean currents," *Dr. Alcala* said.

For most governments, MPAs are attractive for their potential as tourism sites, as has been shown by successful ecotourism cases in Palawan (Fabro, 2020). On the island of Panglao, another protected area in the Visayas, the municipality earned at least PHP 11 million (USD 230,000) from collecting environmental user fees from its more than five diving sites (Chavez, 2018) after the better-known Boracay Island closed down for rehabilitation in 2018 (Aguirre, 2020) and divers looked for alternative sites. *Dr. Alcala* suggested that it is necessary to repeat the surveys to determine the current state

An ecotourism site in Palawan, Philippines

(Image by Guy Goddard via Pixabay)

of the country's MPAs and adopt newer methods. Current methods of administering these protected areas may be "too difficult" for MPA managers, resulting in irregular monitoring.

"One of the major challenges in the management of MPAs is the adoption of newer methods and techniques in determining live coral cover and the fish biomass inside and outside of no-take zones," *Dr. Alcala* advised. "Our present techniques should give way to the newer technologies to make it easier for people to monitor their MPAs for coral cover and fish biomass." Establishing these networks, however, faces the same bottleneck in sustaining single MPAs: Politics.

'Area feud'

Marine protected areas in the Philippines are small for political reasons. Their borders end where the neighboring municipality's border begins. The seas flow unimpeded, but administratively they are delineated by invisible lines, cut apart as if each were a thriving ecosystem on its own.

On the ground, experts say that the prevailing framework for managing these MPAs is beset by overlapping policies between local governments and national agencies, as well as party politics at the local level. Jurisdiction over marine areas is governed by complex, and at times overlapping, policies. More than 90 % of the Philippine MPAs fall within municipal waters, which are under the jurisdiction of the local government units. But once an MPA is included in the NIPAS or E-NIPAS system, its management becomes the responsibility of the Protected Area Management Board of DENR.

This raises questions among local mayors, says *Mr. Dennis Calvan* of Rare Philippines, a non-profit organization advocating marine biodiversity. "Overlapping policies is one of the primary challenges being faced by our partner communities," he said, and added that "We are often asked: 'How do we define municipal waters that are within protected areas?'" The same concern has been raised in Tañon Strait, a 518,221-hectare marine protected area in central Philippines (between Cebu and Negros Islands) shared by 35 municipalities and 7 cities under 3 provinces. It is one of the country's busiest sea lanes, but it has no fisheries management plan.

Three spinner dolphins found in Tañon Strait
(Image by Teri Aquino)

Coastal management includes not just conservation but enforcement schemes. Crucially, it also encompasses streamlining conservation initiatives with fisheries plans, *Mr. Calvan* said. "In some MPA areas under NIPAS, there are no fisheries management plans, and yet, these areas are also among the country's prime fishing grounds," he added. "How to marry the conservation objectives of NIPAS and E-NIPAS with the production goals of the Philippine Fisheries Code is a persistent challenge — and it is a big issue that needs to be addressed."

"While concessions have been made, in part due to the local governments exerting their rights over MPAs, it is unclear whether community-managed MPAs under the NIPAS and E-NIPAS structures receive budget allocations from the DENR. In the same vein, smaller MPAs that are sourcing funds from local government units may need a steadier flow of financing, especially during the pandemic," *Dr. Abesamis* stressed. There have been efforts to create a network, both of MPAs and their managers. In northern Palawan, 18 municipalities created a network to link the 15 MPAs spanning 1,378 ha in Coron, Culion, Calauit and Linacapan. Under this network, communities share expenses to cover monitoring and enforcement. The Chair of the Network, *Mr. Jose Mazo* explained that joining forces has allowed them to cushion the impacts of the pandemic, which forced them to shut their marine parks and cut off their revenue streams. "Putting that system in place, however, took a decade," *Mr. Mazo* said. "At the onset, mayors tend to be hot and cold on the MPA network — one mayor likes it but when that mayor gets defeated by his opponent in the elections, the next mayor is averse to the network," *Mr. Mazo* added. "We need to persuade them to support the MPA system again. It is an area feud, you see. Sometimes, mayors from different political parties do not want to talk to each other so the meetings stall."

Conservation-fishing nexus

Another major problem besetting the MPAs in the Philippines is the encroachment of commercial vessels into municipal waters. While considered illegal under the Philippine Fisheries Law, these intrusions persist and may have gotten worse during the pandemic. Figures from Oceana Philippines culled from the VIIRS vessel-tracking technology show that 40,204 commercial vessels entered Philippine municipal waters in 2020. Around 1,412 were detected in 15 larger MPAs, mostly in the Ticao Burias Pass Protected Seascape in Masbate, in the Turtle Islands Marine Sanctuary on the border with Malaysia, and in the Malampaya Sound Protected Seascape and Landscape in Palawan.

These vessels claimed that "they are harboring there from inclement weather but the occurrence is too frequent to be ignored," according to *Ms. Gloria Estenzo Ramos*, Vice President of Oceana Philippines, an international ocean conservation organization. "The presence of commercial vessels in municipal waters is particularly dangerous for communities and MPAs," *Ms. Ramos* stated. An artisanal fisherman catches an average of 5 kg of fish after a five-hour trip, but a commercial vessel could catch 800,000 kg — a disparity that impacts the sustainability of fish stocks within community waters and of MPAs.

While the government has invested in campaigning against illegal fishing, a recent report released by the USAID and the Bureau of Fisheries and Aquatic Resources (BFAR) calculated that 27–40 % of fish caught in 2019 — valued at approximately PHP 62 billion (USD 1.3 billion) — are caught illegally. At least 30,000 municipal fishing vessels are unregistered, and commercial fishers fail to report up to 422,000 t of fish catch each year. For local fishers, the presence of commercial fishing vessels within their waters — and within MPAs they manage and protect — can be disheartening. "We take turns watching over our MPA because if you volunteer to watch over it, you cannot go fishing," said *Mr. Ernesto Gabrino*, a fisher from Leyte, a province in the country's eastern border region. "But those commercial vessels sneak in, take all the fish and in just one trip for them, our effort and sacrifices are wasted," he exclaimed.

The declining status of the Philippines' seascape and the gravity of illegal, underreported and unregistered fishing prompted BFAR to craft the fisheries management areas (FMA) framework, which was implemented in 2019. Among its grander goals was to curb illegal fishing by streamlining public and private initiatives on the ground. Under the revised Fisheries Code of the Philippines, the government has implemented a vessel monitoring system (VMS) to keep tabs on boats encroaching within community waters. But this has been challenged by the commercial fisheries sector through a bill in Congress that would legalize their entry into municipal waters. "We see this bill as retaliation from the industry," *Ms. Ramos* stressed. "If you look at the timeline, this bill was filed in the same month that BFAR issued an order for the full implementation of the VMS."

A Philippine commercial fishing vessel

(Image via PxHere (CC0 1.0))

Bigger factors at play

MPA Experts, *Dr. Abesamis* and *Mr. Calvan* have been working on the ground for decades. *Dr. Abesamis* as a marine scientist has been tasked by local governments and civil society groups to assess the Philippine marine resources. *Mr. Calvan* on the other hand, is a fisheries specialist who focused on shifting illegal fishing behaviors. They work in different communities in the Philippines. Separately, they had been raising similar points that should be taken seriously, *i.e.* science- and evidence-based policies are important; establishing MPAs and changing fishing behavior need major social preparations; there is a need to harmonize conservation and fisheries policies; and there is a need to stabilize funding for MPAs, which directly impacts enforcement. They also pointed out a very important element, which is time.

"Corals grow at decadal rates," *Dr. Abesamis* said, adding that "natural populations of reef fishes also take time to rebound." *Mr. Calvan* added that a decade is also the minimum period to change fishing behaviors, since implementing such programs require various consultations with communities. But time is a luxury, considering that sea-level rise, ocean acidification, warming waters, and other related impacts of climate change have been threatening to decimate shallow coral ecosystems in the Philippines. "Climate change is expected to impact negatively on our marine resources," said *Dr. Alcala*. "High temperatures could wipe out our shallow coral ecosystems, and we may have to extend the concept of MPAs to deeper reef systems beyond 40–50 m where marine water temperatures are expected to remain cool and thus could help save the reefs and their fish populations."

The Philippine model of MPA management is deeply rooted in communities. But with figures showing that this mechanism has not been providing the level of protection necessary to sustain the marine ecosystems, experts say working across local governments and establishing alliances to improve management may be the best way forward. "In theory, a well-maintained MPA connected to a network should be able to buffer some of the impacts of climate change," *Dr. Abesamis* explained. "But looking at the figures now … would it be enough? Right now, it is hard to be optimistic, but we do what we can."

While possible solutions would take years, or even decades, both *Dr. Abesamis* and *Mr. Calvan* agree on the need to engage with non-politicized players on the ground and secure the tenure of the *Bantay Dagat,* the sea wardens hired by mayors to enforce fisheries measures, and sometimes, to watch over MPAs. "There is a lot of governance structures that need to be present for MPAs to be sustained, and at the same time, a lot of these actions are also trying to catch up," *Dr. Abesamis* said. "But as long as there is support from the barangays or local communities, MPAs would survive and can be sustained. You need good governance too — you cannot get around that. The day-by-day management will be done by people living on the coasts and they must be supported by the local government units, even by the national government."

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About the Author

Ms. Leilani Chavez is writer, reporter, and author of news articles and features for Mongabay, a U.S.-based non-profit conservation and environmental science news platform. Mongabay.com is a web site that publishes news on environmental science, energy, and green design, and features extensive information on tropical rainforests, including pictures and deforestation statistics for countries of the world. Mongabay.com is the primary distribution platform for content produced under Mongabay.org.

Impacts of Closed Season on Philippine Sardines Industry: a tale of two seas

Bong S. Sarmiento

Since 2011, the Philippine Government has imposed a closed fishing season on various major fishing grounds during the sardine spawning season. Implemented during the tail end of the year until March the following year, the closed fishing season has been both a boon and bane for communities. In the sardines capital of the Zamboanga Peninsula in southern Philippines, the ban has boosted catch sizes for artisanal fishers, while in the Visayan Sea in central Philippines, catches have dwindled. Experts point to different implementations of the fishing ban in the two regions and highlight the need to assess the economic implications of the measures, particularly to marginalized fishers.

In 2016, villagers in the town of Labason in the southern Philippines' Zamboanga Peninsula woke up to a spectacle that they never thought could happen in these modern times, which is the sight of tons of wriggling sardines washed ashore. Ecstatic residents, young and old alike, rushed to the shoreline with all kinds of containers and filled them with these sardines (*Sardinella lemuru*) locally called *tamban* that they scooped up with their bare hands. The extraordinary event of the heyday fish harvest was caught on video that went viral on social media. For most Filipinos, sardines are a cheap source of protein. A can of sardines, which costs about PHP 20 (USD 0.40) at mom-and-pop stores, is a must-have pantry item in poor Philippine households.

The President of the Coalition of Municipal Fisherfolk Association in Zamboanga Sibugay (COMFAZS), *Mr. Robert "Dodoy" Ballon* once said that the "sardine galore" event occurred not just in Labason but also in nearby Pagadian City and Tukuran Municipality. *Mr. Ballon,* a two-time national winner of the *Gawad Saka ng Pangulo* Award (Presidential Excellence Award for Agriculture), attributed the unusual beaching of *tamban* to an annual, three-month-long ban on commercial sardine fishing.

Small-scale fishermen resume fishing operations after the closed fishing season in the Zamboanga Peninsula was lifted in 2017

(Image courtesy of the Provincial Information Center – Zamboanga del Norte)

The fishing ban extends from 1 December to 1 March, the peak of the sardine spawning season, and covers commercial operators in a conservation area spanning 22,260 km^2 in portions of the East Sulu Sea, Basilan Strait and Zamboanga Sibugay Province. Under Philippine law, violators of the fishing ban can face imprisonment of six months to six years, as well as fines ranging from PHP 40,000 to PHP 1 million (USD 830–USD 20,700), confiscation of their catch and gear, and loss of fishing licenses. The closure was introduced in 2011 by the Bureau of Fisheries and Aquatic Resources (BFAR) after studies conducted in the Zamboanga Peninsula, the heart of the country's sardine production, concluded that the sardine catch was dwindling and individual sardines were getting smaller, apparently due to overfishing.

In addition to commercial fishing and canning, the species has spawned a cottage industry in southern Philippines involving the production of bottled Spanish-style sardines. The combined value of all of these ventures is around PHP 20 billion (USD 413 million), according to data from the Mindanao Development Authority (MinDA).

Industry support

The ban was supported by major players in the sardine industry of Zamboanga Peninsula (**Figure 1)** and has also gained support from small-scale fishers. The big stakeholders, including the canned sardine manufacturers and commercial fishing operators, feared that without conservation measures, the species would dwindle to a point where catches would no longer be feasible for commercial operations, which would result in industry-wide shutdowns that would displace tens of thousands of workers. The municipal fishers also welcomed the conservation initiative, which imposes no additional restrictions on small-scale operators. The fishing ban does not apply to fishing in the zone designated for marginal fishers, called municipal waters, which extend up to 15 km from the shoreline.

Figure 1. Zamboanga Peninsula, an administrative region in the Philippines designated as Region IX, consists of three provinces (Zamboanga del Norte, Zamboanga Sibugay and Zamboanga del Sur) including four cities (Dapitan, Dipolog, Isabela, Pagadian), and the highly urbanized Zamboanga City

Moreover, since commercial fishing operations further offshore are restricted during the closed season, high-value fish such as tuna can stray into municipal waters, to the benefit of the small-scale fishers. "With fewer efforts, municipal fishers catch more sardines and other fish species during the closed fishing season because commercial operations are not allowed. It's a blessing to the marginal fisherfolk," *Mr. Ballon* exclaimed.

The fisheries sector in the Philippines employs at least two million people, with more than half coming from the local communities. While major businesses engage in canning, locals are into fish drying as is the case of a community in Olingan, a town in Dipolog City, Zamboanga del Norte.

During the fishing ban, Mr. Ballon said that a municipal fisher can catch 50–100 kg of sardines even without venturing far from the shoreline, because schools of the fish swarm close to shore to feed on plankton. Records from BFAR show a steady rise in the volume of sardines landed by both commercial and municipal fishers. From 141,658 t in 2015, the catch rose to 208,000 t in 2019.

Fish drying as a community activity in Olingan, Dipolog City, Zamboanga del Norte

(Image by WorldFish via Flickr (CC BY-NC-ND 2.0))

The studies by experts from 2016 to 2018 (Rola *et al*., 2017; Rola *et al*., 2018) recommended the continuation of the closed fishing season, noting that the results of the ban showed not only an increase in sardine catches but also a rise in the landed catch of high-value non-sardine species such as tuna. "There was a positive impact to society overall," the authors said. Nevertheless, the workers in the sardine canning plants and commercial fishing companies were displaced during the closed fishing season in the Zamboanga Peninsula, which produces 70 % of sardines in the Philippines. There are at least 26 commercial fishing companies and 11 canning firms operating in the Peninsula, providing jobs for 50,000 people, industry data show.

During the closed fishing season, many displaced sardine cannery workers look for other work to sustain themselves and their families, such as working in the rubber plantations that thrive in the region, or engaging in oyster (*talaba*) harvesting. Others find work in the bottled sardine industry. The Philippine Government, through the Department of Agriculture, also offers easy access to small loans for workers affected by the closed season. The sardine canneries and commercial fishing companies, meanwhile, use the downtime to conduct repair and maintenance operations on their facilities and vessels.

Meanwhile, the *Hon. Emmanuel Piñol*, the Secretary of MinDA and former Secretary of the Department of Agriculture, said that his agency strongly supports the closed sardine fishing season and will continue to engage coastal communities in working for clean and healthy seas. He cited the positive impacts not just for the environment but also in the war to eradicate poverty. "The reinvigorated fishing industry in Zamboanga Peninsula has resulted in the reduction of poverty incidence among fisherfolk families from over 40 % to 34 %," *Mr. Piñol* said.

An Executive Officer of BFAR tasked to oversee the Zamboanga Peninsula, *Mr. Isidro Velayo, Jr.* said that allowing sardine stocks to replenish is crucial for a sustainable industry, and also has benefits that extend far beyond. To enforce the fishing ban, BFAR deploys three patrol boats to the conservation area and works to improve its cooperation with municipal fishers and other stakeholders. "Protecting certain species has far-reaching benefits to the ecosystem as a whole," *Mr. Velayo* said. "We need to ensure the abundance of our fishery resources for future use," he added.

Differing Impacts

While the closed fishing season in Zamboanga Peninsula has become a boon to the region's sardine industry, the results of similar conservation measures were not as rosy in the Visayan Sea in central Philippines (**Figure 2**), another major fishing ground of the country. A closed season has been in place in

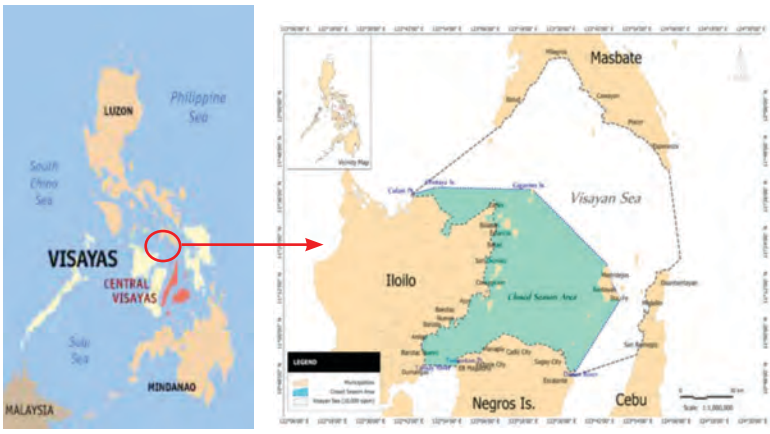

Figure 2. Part of the Visayan Sea in central Philippines, declared as closed season area by BFAR

the Visayan Sea since 1939, to conserve sardines and herring. A BFAR Fisheries Administrative Order expanding the protection to include mackerel, running from 15 November to 15 March every year in selected areas of the Visayan Sea, was promulgated in 1989 but only strictly implemented in 2012 — a year after the closed season was implemented in Zamboanga Peninsula for the first time in December 2011.

In contrast to the Zamboanga Peninsula case, a recent studies by Napata *et al*. (2020a) and Napata *et al*. (2020b) found that catch per unit of effort (CPUE) of fishers surveyed had decreased substantially since the strict enforcement of the closed season in the Visayan Sea began in 2012. This was based on results of their interview of 200 people involved in the local fishing industry, from fishers to processors to traders and buyers.

The mean CPUE of municipal and small-scale commercial fishers before the strict implementation of the closed season started was 358 kg per day, but decreased to 197 kg after 2012, based on data collection conducted from September to December 2015. That period covered two months of the closed season and two months of the open season, the study noted. Moreover, the results also showed that 45 % of the fishers interviewed said they continued to fish during the ban, but following the guidelines meant they had to travel further, take more risks, and expend more resources to travel beyond their traditional fishing grounds to reach parts of the Visayan Sea that were still open for fishing.

Artisanal fishers during the closed fishing season in the Visayan Sea

(Image by Ouie Sanchez for USAID Fish Right)

Napata *et al*. (2020a) also noted that the ban in the Visayas was repeatedly violated, as indicated in the visible infrared imaging radiometer suite (VIIRS) images provided by the U.S. National Oceanic and Atmospheric Administration's Earth Observation Group, showing vessels that continue to operate in the prohibited areas at night. One of the major reasons cited by the respondents for non-compliance is the lack of secondary source of livelihood, as more than 60 percent of the respondents have no alternative livelihood and [are] solely dependent on the sardine industry.

On the other hand, the processors (fish dryers) and traders based around the Visayan Sea responded that sardine production increased, but attributed this to supplies coming from outside the restricted area and from neighboring provinces. The study of Napata *et al*. (2020a) therefore noted two key differences between the closed season in the Visayan Sea and that in Zamboanga Peninsula.

First, the closure in Zamboanga Peninsula is industry-led, and monitoring is carried out with the help of the Philippine Coast Guard and the Police Maritime Group. Enforcement in the Visayan Sea is monitored by the local government units. Second, while the closure in the Visayan Sea was applied to fisheries of all sizes, the closure in Zamboanga Peninsula affects only commercial fishers, leaving small municipal fishers free to continue their trade.

Napata *et al*. (2020a) and Napata *et al*. (2020b) also noted that the closed season policy has economic implications, which led to non-compliance. In the case of the Visayan Sea, there is a need to provide the stakeholders with livelihood programs to diversify their source of income, especially those who are highly dependent on sardine fisheries.

The closed fishing season in the Visayan Sea covers both commercial and artisanal fishers

(Image by Ouie Sanchez for USAID Fish Right)a

A New National Law

A new central government policy, the National Sardines Management Plan (NSMP) had been recently hatched and many stakeholders expressed the hope that this new law would herald the introduction of more rigorous and evidence-based fisheries policies nationwide. Approved in June 2020, the five-year NSMP seeks to further develop science-based management of sardine fisheries through harvest control measures, data gathering, and stronger implementation of fisheries laws, among other measures. Specifically, NSMP aims to "guide coordinated management" across the various Philippine fishery management areas (FMA), the borders of which had been first defined by BFAR in 2019. Under the NSMP, the Philippine Government and other industry stakeholders can craft and implement targeted fisheries management that could not only protect the seascape but also provide livelihood for communities.

During the interview with *Ms. Gloria Estenzo Ramos*, Vice President of Oceana Philippines, an international ocean conservation group, she said that she believed in the integrity of the NSMP and called for its stringent implementation. The sustainable management of sardine fisheries is one of the goals of the NSMP, and part of its objectives is to determine the impact of the closed season and support the provision of job opportunities during the closed season. She then recommended that the use of technology should be promoted, *e.g.* VIIRS — which typically collects images and radiometric data to provide information on the Earth's clouds, atmosphere, oceans and land surfaces — to detect violations, especially during the closed fishing season for sardines.

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Large-scale commercial fishing vessels resume fishing operations after the closed fishing season in the Zamboanga Peninsula was lifted in 2018

(Image courtesy of BFAR)

About the Author

Mr. Bong S. Sarmiento is reporter, and author of news articles and features for Mongabay, a U.S.-based non-profit conservation and environmental science news platform. Mongabay.com is a web site that publishes news on environmental science, energy, and green design, and features extensive information on tropical rainforests, including pictures and deforestation statistics for countries of the world. Mongabay.com is the primary distribution platform for content produced under Mongabay.org.

CALENDAR OF EVENTS

Date	Mode/Venue	Event	Organizer(s)
2021			
26–29 October	Online training	Regional Training Course on Implementation of Port State Measure for Inspection	SEAFDEC/TD
27–28 October	Online workshop	Regional Workshop on Action Plans for Supporting the Livelihood and Well-being of Small-scale Fishers in the Member Countries	SEAFDEC/TD
15–17 November	Virtual meeting	44th Meeting of the Program Committee Meeting (PCM)	SEAFDEC Secretariat
22–25 November	Online meeting	29th Session of the Asia and Pacific Commission on Agricultural Statistics (APCAS29)	FAO
22–26 November	Online training	Regional Training Course on the Relationship Between Ocean Environment Variability and Marine Resource Abundance and Oceanographic Sampling	SEAFDEC/TD
24–25 November	Virtual meeting	24th Meeting of the Fisheries Consultative Group of the ASEAN-SEAFDEC Strategic Partnership (FCG/ASSP)	SEAFDEC Secretariat
30 November	Online meeting	1st Meeting Workshop for the Ecosystem Approach to Fisheries Management (EAFM) in the Pilot Site of Tonle Sap Lake, Cambodia	SEAFDEC/TD
30 November	Online meeting	6th Steering Committee Ad-hoc Meeting for the Fisheries *Refugia* Project	SEAFDEC/TD
30 Nov–3 Dec	Online training	Regional Training Course on Geographic Information System (GIS) for Aquaculture	SEAFDEC/TD
8-22 November	Online training	Training Course on Community-based Freshwater Aquaculture for Remote Rural Areas of Southeast Asia	SEAFDEC/AQD
23-26 November	Online training	Training Course on Feeds and Feeding Management	SEAFDEC/AQD
1–2 December	Kuala Terengganu, Malaysia	Workshop on Conservation of Sharks and Rays Through Parasites' Perspective	SEAFDEC/MFRDMD
2 December	Virtual meeting	SEAFDEC Department Chiefs' Meeting	SEAFDEC Secretariat
6–7 December	Kuala Terengganu, Malaysia	Workshop on Landing Data Analysis of Sharks and Rays by Species to Determine Value of Maximum Sustainable Yield (MSY)	SEAFDEC/MFRDMD
9, 13–17 December	Bangkok,Thailand (and online)	Consultative Planning and Training Workshop on Stock Assessment in Support the Implementation of the International Commitments for Sustainable Use of Fisheries Resources in Southeast Asia	SEAFDEC Secretariat
10 December	Online meeting	2nd Meeting Workshop for the Ecosystem Approach to Fisheries Management (EAFM) in the Pilot Site of Tonle Sap Lake, Cambodia	SEAFDEC/TD
13–17 December	Online training	Training Course on Mangrove Crab Hatchery Operations	SEAFDEC/AQD
14–16 December	Krabi Province, Thailand	National Workshop to Develop the Fisheries Management Plans for Krabi Province, Thailand	SEAFDEC/TD
19–23 December	Kuala Terengganu, Malaysia	Workshop on Seerfish in the Malaysian Waters by using ASPIC in collaboration with DOF Malaysia	SEAFDEC/MFRDMD
2022			
26–28 January	Online training	Online Training on the Use of eACDS Application in the Part of Movement Document (MD), Statement of Catch (SC), and Catch Certification (CC) for Myanmar	SEAFDEC/TD
21–22 February	Online workshop	2nd Regional Workshop on the Study on Impacts of COVID-19 Pandemic on the Fisheries Sector of the ASEAN SEAFDEC Member Countries	SEAFDEC Secretariat
21–24 February	Online training	Training on Gender Awareness and Gender Mainstreaming in Fisheries in Indonesia	SEAFDEC/TD
2 March	Online meeting	Special Meeting on Policy Briefs: COVID-19 Impact Mitigation in Fisheries and Aquaculture of Southeast Asia	SEAFDEC Secretariat
8–9 March (Tentative)	Online meeting	5th Meeting of the Regional Scientific and Technical Committee (SEAFDEC/UNEP/GEF Fisheries Refugia Project)	SEAFDEC/TD/ Fisheries *Refugia* Project
8–11 March	Dhaka, Bangladesh	36th Session of the FAO Regional Conference for Asia and the Pacific	FAO
14–15 Mar	Online workshop	Regional Workshop on Roadmap on M&E RES&POA-2030	SEAFDEC Secretariat
15–16 Mar	Online workshop	Regional Validation Workshop on GOTFish Project	FAO
28–31 March	Bangkok, Thailand and online	9th Asia-Pacific Forum on Sustainable Development	UN/ESCAP
25–26 May (Tentative)	Bangkok, Thailand and online	7th Meeting of the Project Steering Committee (SEAFDEC/UNEP/GEF Fisheries *Refugia* Project)	SEAFDEC/TD/ Fisheries *Refugia* Project
8-10 June	Online	Shrimp 2022: Recovery through resilience and innovation	INFOFISH

Southeast Asian Fisheries Development Center (SEAFDEC)

What is SEAFDEC?

SEAFDEC is an autonomous intergovernmental body established as a regional treaty organization in 1967 to promote sustainable fisheries development in Southeast Asia. SEAFDEC currently comprises 11 Member Countries: Brunei Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam.

Vision

Sustainable management and development of fisheries and aquaculture to contribute to food security, poverty alleviation and livelihood of people in the Southeast Asian region

Mission

To promote and facilitate concerted actions among the Member Countries to ensure the sustainability of fisheries and aquaculture in Southeast Asia through:

i. Research and development in fisheries, aquaculture, post-harvest, processing, and marketing of fish and fisheries products, socio-economy and ecosystem to provide reliable scientific data and information.
ii. Formulation and provision of policy guidelines based on the available scientific data and information, local knowledge, regional consultations and prevailing international measures.
iii. Technology transfer and capacity building to enhance the capacity of Member Countries in the application of technologies, and implementation of fisheries policies and management tools for the sustainable utilization of fishery resources and aquaculture.
iv. Monitoring and evaluation of the implementation of the regional fisheries policies and management frameworks adopted under the ASEAN-SEAFDEC collaborative mechanism, and the emerging international fisheries-related issues including their impacts on fisheries, food security and socio-economics of the region.


Secretariat


TD


MFRD


AQD


MFRDMD


IFRDMD

SEAFDEC Addresses

Secretariat

P.O. Box 1046
Kasetsart Post Office
Bangkok 10903
Thailand
Tel: (66-2) 940-6326
Fax: (66-2) 940-6336
E-mail: *secretariat@seafdec.org*
http://www.seafdec.org

Training Department (TD)

P.O. Box 97
Phrasamutchedi
Samut Prakan 10290
Thailand
Tel: (66-2) 425-6100
Fax: (66-2) 425-6110 to 11
E-mail: *td@seafdec.org*
http://www.seafdec.or.th

Marine Fisheries Research Department (MFRD)

52, Jurong Gateway Road,
#14-01, Singapore 608550
Tel: (65) 9046-4787
Fax: (65) 6334-1831
E-mail: *Ong_Yihang@sfa.gov.sg*
http://www.seafdec.org

Aquaculture Department (AQD)

Main Office:
5021 Tigbauan, Iloilo, Philippines
Tel: +63 33 330 7000
Fax: +63 33 330 7002
Manila Office:
Room 100-E, Ground Floor
Philippine Social Science Center (PSSC)
Commonwealth Avenue, Diliman
1101 Quezon City, Philippines
Tel & Fax: +63 2 8927 7825
E-mail: *aqdchief@seafdec.org.ph*
http://www.seafdec.org.ph

Marine Fishery Resources Development and Management Department (MFRDMD)

Taman Perikanan Chendering,
21080 Kuala Terengganu, Malaysia
Tel: (609) 617-5940
Fax: (609) 617-5136
E-mail: *mfrdmd@seafdec.org.my*
http://www.seafdec.org.my

Inland Fishery Resources Development and Management Department (IFRDMD)

Jl. Gub. HA. Bastari No.08
RT.29 RW.27 Kel. Silaberanti
Kec. Seberang Ulu I, Jakabaring, Palembang 30252
Sumatera Selatan, Indonesia
Tel: +627115649600; Fax: +627115649601
E-mail: *ifrdmd@seafdec.id*
http://www.seafdec.id

The third prize winner, *Lee Huan*, from the national drawing contest in Singapore

National Drawing Contests were organized in all ASEAN-SEAFDEC Member Countries as part of the preparatory process for the ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security Towards 2020 "Fish for the People 2020: Adaptation to a Changing Environment" held by ASEAN and SEAFDEC in June 2011 in Bangkok, Thailand, in order to create awareness on the importance of fisheries for food security and well-being of people in the region.