user-friendly and enhancing their capability of providing real time data. It has also become necessary that the availability of offline records, internet, improved capacity of data storage, and data security, should be ensured at lower costs. The fast evolution of such technologies in the fisheries sector over the past years, *e.g.* machine learning and use of robot, sensors or Artificial Intelligence (AI), had been happening. Although these had already been introduced and tested in MCS and for combating IUU fishing in the region, some of the new technologies are still beyond the limit of human knowledge to be able to efficiently use them, and it is in these aspects that SEAFDEC and the AMSs have been monitoring the changes and developments.

For example, the human observers' onboard program might still be useful, while adjustments are being made with regard to the use of onboard digital cameras and recorders which still requires humans to review the footage of the information collected in the form of video clips. Nevertheless, with huge amount of data, the AI could be useful in compiling and analyzing the data. Such technology is therefore useful for improving effective fisheries management.

Many countries had been affected by the COVID-19 crisis in 2020–2021. Nevertheless, the countries continued to develop and implement their respective national measures, especially those that concern the health of laborers or crew onboard fishing vessels. As a result, the relevant national agencies had also adjusted the modes of work of fishers but also making sure that IUU fishing activities are prevented from occurring during this critical time. The use of the aforementioned novel technologies and innovations should therefore be promoted as these could be useful tools for remote monitoring and control of fishing activities at sea, and thus, support the governments' efforts in maintaining the fish stocks and in combating IUU fishing in their respective waters amidst the present crisis.

6.1.2 Management Concepts and Approaches

6.1.2.1 Ecosystem Approach to Fisheries Management (EAFm) and Ecosystem Approach to Aquaculture (EAA)

Ecological approach in fisheries (EAF) is a strategy that aims for the promotion of sustainable development, and the application of an ecosystem approach balances the fulfillment of the three objectives of the Convention on Biological Diversity (CBD): conservation, sustainable use, and fair and equitable sharing of the benefits arising from the utilization of genetic resources (Staples & Funge-Smith, 2009). The EAF was therefore devised as a tool to support the implementation of the FAO Code of Conduct for Responsible Fisheries (CCRF) with respect to the sustainable exploitation of fishery resources worldwide.

Ecosystem Approach to Fisheries Management

Ecosystem Approach to Fisheries Management or EAFM is one of the approaches currently being used in fisheries management (Jaya & Zulbainarni, 2015; Kusnandar & Mulyani, 2015). Applicable not only for the sustainable management of marine and coastal fisheries but also for inland fisheries and aquaculture, the EAFM approach is aimed at achieving an integrated, comprehensive, and sustainable fisheries management while balancing the socioeconomic aspects, knowledge, information, and the uncertainties about abiotic-biotic components and human interactions in the ecosystem.

Thus, EAFM has been used as an approach to improve fisheries management that has already existed but might had been conventionally applied by focusing on the target aquatic species (commodities or economic components) without looking at the interactions and relationships among the various aspects of the ecosystem. Several things had led to this paradigm change and could include increased understanding of the strong interaction among the fishery resources, and interaction of the fishery resources with the environment; of the ecosystem services for human life that need to be maintained and cared for to be sustainable; as well as of the ecosystem functions for humans and the environment—awareness of the many factors of uncertainties about the functions and dynamics of the ecosystems.

The application of the EAFM has already been globally accepted and endorsed in many international fora and countries. The approach, which represents a move away from the usual fisheries management systems that focused only on the sustainable harvest of target species, anchors toward systems and decision-making processes that balance environmental well-being with human and social well-being, within improved governance frameworks. The EAFM helps to manage fisheries more holistically; reduce user group conflicts; help unlock financial resources; enhance cooperative work with other stakeholders, and better resolve fisheries issues and challenges. The EAFM is not only applicable for marine and coastal fisheries management, but its concept and principles could also be used and applied to inland fisheries management, *i.e.* the Ecosystem Approach to Inland Fisheries or EAFm, as well as to aquaculture or the Ecosystem Approach to Aquaculture (EAA). Together with EAFm and EAA, EAFM is a strategy for the integration of the fisheries and aquaculture activities within the wider ecosystem in order that the promotion of sustainable development, equity, and resilience of interlinked social-ecological systems, is in place.

- Applying the EAFM in the Southeast Asian countries

In the Southeast Asian region, EAFM has been acknowledged as an applicable concept and approach which can be applied in the different scales of fisheries management, whether in marine, coastal, and inland environments, as well as in aquaculture. For being holistic, the EAFM framework is doable and the concept has already been adopted by a number of the Southeast Asian countries through various pilot projects that introduce and promote its application.

In the Philippines for example, EAFM is mainstreamed in the plans and programs of its Bureau of Fisheries and Aquatic Resources (BFAR), especially the concept of formulating the EAFM Plans in the 12 fisheries management areas (FMAs) that cover the entire waters of the Philippines in accordance with Fisheries Administrative Order 263. Among the successful cases of EAFM implementation in the Philippines, include the EAFM projects in Balayan Bay in Batangas Province and Samar Sea in Eastern Visayas between the Provinces of Leyte and Samar, and also the EAFM incorporated in the Fishing Closed Season Regulations enforced in Zamboanga, Palawan, Davao Gulf, and in the Visayan Sea (bounded by the islands Masbate to the north, Panay to the west, Leyte to the east, and Cebu and Negros to the south).

In Indonesia, the management measures implemented have resulted in positive aspects such as the high pressure in combating IUU fishing practices, sustainability of the resources, and welfare of the fishers. While the marine fishery management plans of the country's 11 Fishery Management Areas are being updated, the management plans for inland fisheries have been developed for verification prior to their implementation.

In Thailand, its Department of Fisheries (DOF) has been promoting the transfer of knowledge on fishery resources management using an ecological approach, to the fishing communities. The sustained efforts of DOF to provide budgetary support to the country's EAFM activities have led to the development of more than 20 fisheries management sites not only in coastal but also in inland fishing communities that adopt the EAFM approach.

In general, many projects that apply the EAFM concept and principles had been implemented in the Southeast Asian countries. These include:

- Cambodia:
  - Lower Mekong Basin Wetland Management and Conservation Project
  - EAFM learning in Trapeang Ropov fishing areas
  - Flooded forest rehabilitation in Siem Reap Province
- Malaysia
  - Establishment of EAFM in Lawas, Sarawak, Malaysia (marine & coastal)
- Indonesia:
  - Coral Reef Rehabilitation and Management Program-Coral Triangle Initiative (COREMAP-CTI) Project
  - Sustainable development of ecosystem resources in the Indonesian Seas Large Marine Ecosystem (ISLME) by FAO (GEF 5)
  - The Indonesian GEF Coastal Fisheries Initiative (CFI) in Eastern Indonesia
- Lao PDR:
  - Fisheries management in Nam Kadun, Bolikhamsai Province
- Myanmar:
  - Ecosystem Approach to Fisheries Management Area in Aung Kan Thar Village, Mon State
- Philippines:
  - Balayan Bay EAFM in Batangas Province
  - Samar Sea EAFM in Eastern Visayas
  - Fishing Close Season Regulations, *e.g.* Zamboanga, Palawan, Davao Gulf, Visayan Sea
- Thailand:
  - Aquatic bank project at Nong Tod Yia, Yasothon Province
  - Community-based Ecosystem Approach to Fisheries Management at Baan Aoa Kung and Baan Koh Ma Praw, Phuket Province
  - Community-based Ecosystem Approach to Fisheries Management at Baan Hin Lard, Baan Khow Pilaiy and Baan Kokhai, Phang-nga Province
  - Community-based Ecosystem Approach to Fisheries Management at Baan Hin Row, Baan Aou Thong Lang and Baan Pak Khong, Krabi Province
  - Community-based Ecosystem Approach to Fisheries Management at Baan Pak Don Sak and Baan Koh Raad, Don Sak, Surat Thani Province
  - Community-based Ecosystem Approach to Fisheries Management at Pak Nam La Mea, La Mea, Chumphon Province
  - Ecosystem Approach to Inland Fisheries Management at Ubol Ratana Dam, Khon Kaen Province
  - Fisheries communities based on Ecosystem Approach to Fisheries Management in Sawee, Chumphon Province
  - Fisheries communities based on Ecosystem Approach to Fisheries Management at Bang Ma Prow and Baan Pak Na, Langsuan, Chumphon Province
  - Happy with fisheries at Saroy Sub-district, Wang Chin District, Phrae Province
  - Pilot Learning Site for Ecosystem Approach to Fisheries management at Baan Nai Nang, Krabi Province

Through the application of EAFM, fisheries management systems adopted in the region that used to focus only on the sustainable harvest of target species have gradually moved towards systems and decision-making processes that

balance environmental well-being with human and social well-being, within improved governance frameworks. The EAFM approach has therefore helped in the more holistic management of fisheries, and as a result user group conflicts had been considerably reduced; financial resources unlocked; cooperation of concerned stakeholders enhanced, and fisheries issues and challenges resolved and addressed.

The integrated fisheries management schemes using the EAFM approach that are being promoted in the region have also manifested in the roles that government plays in encouraging the communities to participate in addressing environmental issues and concerns for the sustainability and preservation of the ecosystem and the environment which is their source of life. Therefore, fisheries management should not be separated from these three inseparable dimensions: the fishery resources and their ecosystems, utilization of the fishery resources for socioeconomic interests of communities, and the fisheries policies governing the community initiatives.

- SEAFDEC initiatives in promoting the EAFM

From 2014 to date, SEAFDEC has been playing a significant role in transferring the knowledge gained from a training course on EAFM in 2014, *e.g.* by simplifying the E-EAFM training materials developed by many organizations and initiatives, such as FAO, US National Oceanic and Atmospheric Administration (NOAA), SEAFDEC-Sweden Project, Bay of Bengal Large Marine Ecosystem (BOBLME), Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (CTI-CFF), IMA International, GEF, Norwegian Agency for Development Cooperation (Norad), Coral Triangle Support Project (CTSP), USAID, and so on, in order to make these materials suitable for the region. Such materials had been introduced to the region through the training courses on Essential EAFM (E-EAFM), Training of Trainers on EAFM (TOT-EAFM), and training on EAFM for Leaders, Executives and Decision Makers (LEAD EAFM). With a total of about 150 participants in the regional training courses conducted by SEAFDEC/TD and more than 444 participants in the national training sessions organized by the respective Southeast Asian countries under the supervision of the SEAFDEC/TD Team during 2014–2021, a total of about 594 persons from SEAFDEC Member Countries had been trained on the application of the EAFM concept and principles by SEAFDEC/TD.

Moreover, through the Japanese Trust Fund Project "Human Resource Development" and the Small-scale Fisheries Project of SEAFDEC/TD, support has been extended to some AMSs for enhancing the capacity of their respective national key officers in the implementation of the EAFM concept at the learning sites, *e.g.* in Myanmar, Cambodia, Lao PDR, and Thailand. This activity is meant to strengthen the knowledge and capacities of the core EAFM team in each country on the concepts related to sustainable fisheries, and ensure that the teams apply the knowledge and skills gained from the EAFM training sessions in real situations. In June 2021, SEAFDEC/TD carried out an online survey on the impacts of the EAFM training and the usefulness of the EAFM implementation in the learning sites. Results of the survey were reported by representatives from the AMSs during the one-day meeting in July 2021, where the EAFM-Training respondents indicated that the knowledge that they gained from the EAFM training courses include the concept and key principles of EAFM, and the development of fisheries management plan that they considered important and useful, especially for the fisheries and extension officers. The respondents also mentioned that they fully apply the EAFM concept and principles in their actual work. Moreover, they also recognized the significance of promoting the EAFM concept to all levels of relevant stakeholders in fisheries.

From the implementation of sustainable fisheries management at the EAFM learning sites, many lessons could be obtained and learned. Firstly, such activities have demonstrated that in managing the fisheries holistically, many of the key EAFM principles could be adopted. Since the implementation of EAFM involves the challenge of identifying an appropriate scale for the fisheries management units, working with different groups of stakeholders and increasing stakeholders' participation, coordination, and cooperation, especially the women and those who are socially and economically disadvantaged, is crucial. Nonetheless, for effective stakeholders' engagement, the EAFM activities should also involve those who are not in the fisheries sector along with the community members who are most affected by the changing trend of fishery resources. Secondly, considering that the EAFM concept needs to address multiple objectives some of which are aimed at restoring fisheries habitats and resources while others could be aimed at promoting sustainable livelihoods, skills training on the production of value-added fisheries products and through other non-fisheries livelihood options should form part of the project activities. Moreover, having multiple objectives, the EAFM should be promoted to also take into account the need to understand the conflicts in fishing communities, their origins, and the challenges while the different stakeholders' groups with different interests are brought together to collaboratively alleviate those conflicts. Finally, the application of EAFM has led to building the understanding and enhanced awareness of habitat values and sustainable use of resources, adopting and revising rules and regulations to become more effective and responsive to international standards, and enforcing fisheries rules and regulations fairly and impartially, which have proven to be critical in the promotion of good governance.

Ecosystem Approach to Aquaculture

As for aquaculture, the production of which can be categorized as the output of extensive, semi-intensive, and intensive culture systems, this sub-sector has become the fastest-growing food activity globally and has expanded sevenfold during the past decade, contributing substantially to the region's food security, employment generation, and foreign exchange earnings. In 2018, approximately 46 % of all fish eaten globally came from aquaculture (FAO, 2020b). The rapid growth of the aquaculture sector worldwide and the interaction of aquaculture activities with other economic sectors and natural resource users require a responsible and integrated approach to aquaculture development.

A similar approach – the ecosystem approach to aquaculture (EAA) is "a strategy for the integration of the activities within the wider ecosystem in order that sustainable development, equity, and resilience of interlinked social-ecological systems are promoted in the aquaculture sub-sector" (Soto *et al*., 2008; FAO 2010c). The three principles in the EAA ensuring that aquaculture as a strategy contributes positively to sustainable development (FAO, 2010c) are shown in **Box 21**:

Way Forward

Although the EAFM is well recognized in the Southeast Asian region, however, based on the review of the challenges and suggestions from the SEAFDEC Member Countries on the achievements of the EAFM in the region, there are some issues that need to be taken into action to ensure that the EAFM is fully used and implemented. These include the promotion of the EAFM concept which should be continued together with the strengthening of collaboration and coordination among the regional EAFM networks. Capacity building for all relevant stakeholders should also be sustained to enhance the understanding of more numbers of fisheries officers and communities of the concept and principles of EAFM. The consistency of the EAFM activities carried out in the communities should be strengthened, and the EAFM communities to be expanded and integrated with other related fields (*e.g.* ecologically-based tourism, local fish market village, community learning center). Additionally, full efforts should be put in place in the work process to maintain the achievement of EAFM in each country. The suggestion of Indonesia for SEAFDEC/TD to strengthen the EAFM implementation in Southeast Asia should be considered, and that it is also important for the Southeast Asian countries to develop the legal basis to support the promotion of EAFM implementation in the whole Southeast Asian region.

There is still needed to build the capacities and skills of relevant stakeholders on the application of the EAFM concepts, principles, steps in management planning, and EAFM implementation. In certain AMSs, such as Thailand and Indonesia, EAFM is being integrated into formal educational programs at universities and colleges. EAFM is also being formally adopted by the fisheries departments of several AMSs and is used as the framework for managing their respective national fisheries. The E-EAFM course itself is a living program that continues to be shared and modified to suit the capacity-building needs of learners. Meanwhile, the national, regional, and international EAFM networks and/or technical working groups are being established in partnership and collaboration with national fisheries and other regional and international organizations. For example, SEAFDEC is collaborating with FAO for the GEF Project on Promoting the Blue Economy and Strengthening Fisheries Governance of the Gulf of Thailand through the Ecosystem Approach to Fisheries" (GoTFish Project), and with FAO and BOBLME for the project on Sustainable Management of Fisheries, Marine Living Resources and their Habitats in the Bay of Bengal Region for the Benefit of Coastal States and Communities: Support to SEAFDEC Member Countries aimed at promoting EAFM knowledge and implementation in the AMSs.

6.1.2.2 Community-based and Co-management

The primary purpose of fisheries management is to establish an appropriate system of management rules based on defined objectives, as well as a mix of management

Box 21. Principles in the EAA to ensure that aquaculture contributes positively to sustainable development (FAO, 2010c)

Principle 1: *Aquaculture development and management should consider the full range of ecosystem functions and services, and should not threaten the sustained delivery of these to society.*
Developing aquaculture in the context of ecosystem functions and services is a challenge that involve defining ecosystem boundaries (at least operationally), estimating some assimilative and production carrying capacities, and adapting farming practices accordingly. The mix of ecosystem services will depend on wider management practices, and the trade-off among different services must be acknowledged. This is especially important in the case of ecosystem functions that are unique, essential, or threatened to ensure their preservation.

Principle 2: *Aquaculture should improve human well-being and equity for all relevant stakeholders.*
This principle seeks to ensure that aquaculture provides equitable opportunities for development and equitable sharing of its benefits. This includes ensuring that it does not result in any undue detriment for any groups within society, especially the most vulnerable. Both food security and safety are to be promoted as key components of well-being.

Principle 3: *Aquaculture should be developed in the context of other sectors, policies, and goals.*
This principle recognizes the interactions between aquaculture and the larger system, in particular, the influence of the surrounding natural and social environments on aquaculture practices and results. This principle also acknowledges the opportunity of coupling aquaculture activities with other production sectors to promote materials and energy recycling and better use of resources in general.