

The background image shows a busy fishing boat deck. Several workers are visible, including one in a yellow jacket and another in a red jacket with a bucket hat, both focused on handling a large, dark fishing net. The net is overflowing with a large quantity of small, silvery fish. The deck is cluttered with various pieces of equipment, including blue buckets and a large metal bowl. The scene is set outdoors, with a wooden structure and other parts of the boat visible in the background.

FISH for the PEOPLE

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Steering the Development of Southeast Asian Fisheries

Towards Sustainability



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Editorial

In response to the widespread regional concern over unsustainable fisheries practices during the 20th century that seemed to have affected the region's food security as well as the economic and social well-being of the peoples in the ASEAN region, the ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security in the New Millennium "Fish for the People" was convened in Bangkok, Thailand almost ten years ago in November 2001. The focus of such Conference was on fisheries issues of specific concern to the region coupled with efforts to coordinate policies and actions within the region to be harmonized with those at the international level. As an outcome, the recommendations on the various issues raised during the November 2001 Conference and those raised during the series of consultations at national and regional levels, formed the basis for the development of the Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region, which the SEAFDEC-ASEAN Ministers concerned with fisheries adopted during the said Conference. Henceforth, the 2001 Resolution and Plan of Action served as regional policy directives and guidelines for the sustainable development of fisheries in the ASEAN region.

This Special Issue of Fish for the People reviews the major achievements and impacts of the implementation of the 2001 Resolution and Plan of Action as well as reflects some forms of mitigation strategies initiated by the ASEAN Member Countries to address the emerging issues that have threatened the sustainable development of their respective fishery sectors. It should be considered however that, in spite of the efforts of the SEAFDEC-ASEAN countries to address such impeding issues, the regions' fishery resources continued to deteriorate not only because of anthropogenic activities but also due to the emerging fisheries-related issues and initiatives during the early 21st century. Thus, the ASEAN and SEAFDEC

decided to organize from 13 to 17 June 2011, the sequel ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security Towards 2020 “Fish for the People 2020: Adaptation to a Changing Environment” in Bangkok, Thailand. The Conference is mainly aimed at addressing the concerns on the current fisheries situation and emerging issues that impede the sustainable development and the contribution of fisheries to food security in the ASEAN region. As envisaged, the new decade Resolution and Plan of Action on Sustainable Fisheries for Food Security in the ASEAN Region would be developed taking into consideration the series of preparatory processes and technical consultations, and to be considered for adoption by the ASEAN-SEAFDEC Senior Officials and Ministers responsible for fisheries during the June 2011 Conference.

The 2011 Resolution and Plan of Action would again serve as regional policy framework and guiding principles for the ASEAN countries in achieving sustainable fisheries for food security during the coming decades while also responding to the changing environment. Moreover, one of the objectives of the 2011 ASEAN-SEAFDEC Conference is to support the ASEAN in achieving the ASEAN Community Building towards 2015, particularly on the contribution of the fisheries sector to economic development, food security, and poverty alleviation, taking particular attention on the emerging challenges and issues confronting the countries in the region. After the Conference and guided by the 2011 Resolution and Plan of Action, SEAFDEC would implement programs and activities in the ASEAN countries that are relevant to the promotion of sustainable fish production as well as towards addressing emerging issues that hinder the efforts of the ASEAN countries to achieve food security. These plans would be carried out by SEAFDEC in cooperation with the ASEAN under the ASEAN-SEAFDEC collaborative mechanism.

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Steering the Development of Southeast Asian Fisheries Towards Sustainability

Chumnarn Pongsri, Kenji Matsumoto and Virgilia T. Sulit

The Southeast Asian Fisheries Development Center (SEAFDEC) is a regional treaty organization established in 1967 and mandated to develop the fisheries potentials of the Southeast Asian region through rational utilization of the resources for food security in the region. SEAFDEC comprises 11 Member Countries, namely: Brunei Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam. SEAFDEC operates through its Secretariat in Thailand and four technical Departments: the Training Department (TD) in Thailand, Marine Fisheries Research Department (MFRD) in Singapore, Aquaculture Department (AQD) in the Philippines, and Marine Fishery Resources Development and Management Department (MFRDMD) in Malaysia. SEAFDEC through the technical Departments conducts fishery R&D activities in the ASEAN countries under interdisciplinary approaches covering responsible fisheries and aquaculture technologies and practices, post-harvest technology and practices, fisheries management concepts and approaches, and policy and advisory services, among others. The Council of Directors representing the Member Countries is the policy-making body of SEAFDEC while the Secretary-General serves as the chief administrator of SEAFDEC.



since 1967, had proven to be practical and professional in many tangible aspects of fisheries technology including a wealth of information on national and regional fisheries development, and had gained familiarity with the issues and concerns confronting the fisheries sector in the countries of the Southeast Asian region, it had become necessary for SEAFDEC to set sights beyond its current horizon and to actively pursue an integrated approach to fisheries management in order that the Member Countries could achieve long-term and significant gains in food fish supply and economic growth. In this regard, SEAFDEC was mandated by the SEAFDEC Council starting in 1998 to play a more active role as the regional collaborating platform and formalize its cooperation with the ASEAN for the sustainable development of fisheries in the region in the midst of the fast evolving global fisheries situation. Given such scenario, the SEAFDEC Council adopted the strategies (**Box 1**) that would be used as guide for SEAFDEC to realize the goals set in its mandate while at the same time address the issues and concerns spelled out in the global fisheries arena.

In the mid 90s, various international fisheries instruments with analogous objective of promoting sustainable development of fisheries were adopted globally. The most relevant of the fisheries instruments included the latest United Nations Convention on the Law of the Sea (UNCLOS), the FAO Code of Conduct for Responsible Fisheries (CCRF), the Kyoto Declaration on the Sustainable Contribution of Fisheries to Food Security, and the Rome Declaration on World Food Security. Such instruments called for concerted efforts towards the conservation and sustainable management of the fishery resources, strengthening scientific research for sustainable development of fisheries and aquaculture, adjusting capacity to be commensurate with long-term stock productivity, increasing the availability of fish and fisheries products for human consumption, and eliminating the unsustainable patterns of fish consumption and production.

During that same period while SEAFDEC marked the 30th anniversary of its establishment, the SEAFDEC Council considered it an opportune time to review the policies and operations of SEAFDEC in the light of the evolving regional and international fisheries scenario. Although SEAFDEC after having existed for 30 years

Box 1. Strategies to be used by SEAFDEC as guide in promoting sustainable development of fisheries

- Placing emphasis on regional issues and anticipated external problems
- Promoting efficient and sustainable uses of fisheries resources
- Facilitating intra-regional exchange of expertise and information
- Strengthening mechanisms for regional collaboration
- Avoiding duplication of efforts
- Increasing visibility of SEAFDEC activities

Source: SEAFDEC (1998)

Table 1. Total fish production of Southeast Asia: 1998-2008 (QTY in '000 metric tons; VAL in US\$ '000 000)

Fisheries Sub-sectors	1998		2000		2002		2004		2006		2008	
	Qty	Val	Qty	Val	Qty	Val	Qty	Val	Qty	Val	Qty	Val
Marine Capture	11,448.4	4,057.5	12,052.4	6,141.9	12,756.4	8,080.3	13,380.8	7,404.8	13,938.8	9,091.3	13,814.4	12,336.0
Inland Capture	947.8	242.6	1,330.1	391.4	1,516.7	569.2	1,429.2	541.9	2,107.1	596.9	2,381.7	2,215.4
Aquaculture	3,258.1	4,664.2	3,860.2	5,323.4	5,027.6	6,225.2	6,243.7	7,201.8	8,348.2	5,778.0	11,064.0	14,032.2
TOTAL	15,654.3	8,944.3	17,242.7	11,765.7	19,300.7	14,874.7	21,053.7	15,148.5	24,394.1	15,466.2	27,260.1	28,583.6

Source: SEAFDEC Fishery Statistical Bulletin for the South China Sea Area: 1998-2007, and SEAFDEC Fishery Statistical Bulletin of Southeast Asia 2008

Contribution of the Region's Fisheries to Food Security

Fisheries in the Southeast Asian region had been playing very significant role in providing food security to the peoples at all levels. From the total fisheries production of 15,654.3 thousand metric tons in 1998 valued at US\$ 8,944.3 million, by 2008 the production quantity increased to 27,260.1 thousand metric tons valued at US\$ 28,583.6 million (Table 1), increasing at an annual rate of about 6% in terms of quantity and about 9% in terms of value. Although the ten-year production from marine capture fisheries had been slowly increasing, production from inland capture fisheries and from aquaculture during the same period showed significantly increasing trend.

Specifically in 2008, the region's fisheries production accounted for about 19% of the world's total fisheries

production of about 142.3 million metric tons (FAO, 2010). In terms of exports, data in 2007 showed that the world's total export of fisheries commodities was 39,788,511 metric tons of which more than 15% was contributed by the Southeast Asian countries (6,061,416 mt). Thailand topped the region's exporting countries contributing about 41% of the region's export of fisheries commodities followed by Vietnam at 25% (FAO, 2010).

In order that such trend could be sustained and the contribution of fisheries to food security in the region is enhanced, SEAFDEC continues to strengthen its collaboration with the ASEAN countries through the ASEAN-SEAFDEC collaborative mechanism and gives due attention to addressing the problems and constraints in the fisheries management with an objective of reversing the current state of the region's fisheries resources which had been observed to be at the brink of serious deterioration. In such way, the gap between supply and demand for fish and fisheries products would be bridged while at the same time ensuring that the balance between conservation and exploitation of the fisheries resources is maintained.

The ASEAN and SEAFDEC Collaborative Mechanism

While SEAFDEC had also been mandated to take a regional approach to program formulation in response to anticipated global threats, ways and means were explored by SEAFDEC for the establishment of a formal working mechanism with the ASEAN in the promotion of sustainable fisheries development in the Southeast Asian region. Considering the common mission of promoting sustainable fisheries development in Southeast Asia, the mechanism for an ASEAN-SEAFDEC collaboration was established in 1998, giving birth to the so-called ASEAN-SEAFDEC Fisheries Consultative Group (FCG) for Sustainable Development of Fisheries in Southeast Asia. Under the FCG collaborative mechanism, fisheries policies, programs and activities have been developed and implemented in the ASEAN countries



Box 2. ASEAN-SEAFDEC FCG Programs

Programs initiated in 1998

1. Upgrading the traditional fish processing industries in Southeast Asia (MFRD)
2. Promotion of mangrove-friendly aquaculture in Southeast Asia (AQD)
3. Conservation and management of sea turtles in Southeast Asian countries (MFRDMD)
4. Regionalization of the Code of Conduct for Responsible Fisheries (SEAFDEC Secretariat and all Departments)
5. Development of fish disease inspection methodologies for artificially-bred seeds (AQD)
6. Fish trade and environment (SEAFDEC Secretariat)
7. Coastal Resource Management (TD)

Special Five-Year Program (2002-2005)

8. Fisheries Management (TD, MFRDMD, SEAFDEC Secretariat)
 - Towards decentralized management for sustainable fisheries in the ASEAN region
 - Improvement of fishery statistical systems and mechanisms
 - Responsible fishing gears and practices
 - Resource enhancement
 - Identification of indicators for sustainable development and management of capture fisheries in the ASEAN region
 - Information gathering for capture inland fisheries in ASEAN countries
 - Harvesting of under-exploited resources
9. Integrated Regional Aquaculture Project (AQD)
 - Aquaculture for rural development
 - Supply of good quality seeds
10. Utilization of Fish and Fishery Products (MFRD)
 - Maximizing the utilization of fish catch
 - Fish quality and safety management systems
11. Information collection for sustainable pelagic fisheries in the South China Sea (TD, MFRDMD, MFRD)
12. Digitized Atlas (All Departments)
13. Application of HACCP in the fish processing industry in Southeast Asia (MFRD)

ASEAN-FCG Programs (initiated from 2003 and onwards)

14. Accelerating awareness and capacity-building in fish health management (AQD)
15. Activities related to climate change and adaptation in Southeast Asia with special focus on the Andaman Sea (SEAFDEC Secretariat)
16. Assistance of capacity building in the region to address international trade-related issues (SEAFDEC Secretariat)
17. Capacity improvement of fisheries community for fisheries management and alleviation of poverty
18. Chemical and drug residues in fish and fish products in Southeast Asia: Biotoxins monitoring (MFRD)
19. Chloramphenicol and nitrofurans residues in aquaculture fish and fish products (MFRD)
20. Deep sea fisheries resources exploration of the Southeast Asian waters (TD)
21. Development of fish disease surveillance system (AQD)
22. Development of integrated inland fisheries management in the ASEAN countries (MFRDMD)
23. Development of regional database for fisheries management (TD)
24. Development of technologies and human capacity building for sustainable aquaculture (AQD)
25. Environmental related tasks in Southeast Asia (SEAFDEC Secretariat)
26. Fisheries resources survey and operational plan of M.V. SEAFDEC 2 (TD)
27. Food safety of aquaculture products in Southeast Asia (AQD, MFRD)
28. Good laboratory quality management in ASEAN member countries (MFRD)
29. Human Resource Development (HRD) for poverty alleviation and food security by fisheries intervention for the fisheries communities in the ASEAN region (SEAFDEC Secretariat)
30. Improvement of fishery statistics and information for planning and management of fisheries in the ASEAN region (SEAFDEC Secretariat)
31. Information collection of highly migratory species in Southeast Asian waters (TD)
32. Management of fisheries and utilization of sharks in Southeast Asia (SEAFDEC Secretariat, MFRD, MFRDMD)
33. Promotion of "One Village, One Fisheries Products (FOVOP)" system to improve livelihood for the fisheries communities in the ASEAN region (SEAFDEC Secretariat)
34. Promotion of rights-based fisheries and co-management towards institutional building and participatory mechanism for coastal fisheries management (TD)
35. Promotion of sustainable and region-oriented aquaculture (AQD)
36. Quality assurance system for small- and medium-sized fish processing establishments in ASEAN member countries (MFRD)
37. Rehabilitation of fisheries resources and habitats/fishing grounds through resource enhancement (TD)
38. Research and analysis of chemical residues and contamination in fish, fish products and the environment such as fishing ground and aquaculture field (MFRD)
39. Research and development (R&D) of stock enhancement for species under international concerns (AQD, TD, MFRDMD)
40. Research and management of sea turtles in foraging habitats in the Southeast Asian waters (MFRDMD, TD)
41. Research for stock enhancement of sea turtles (MFRDMD)
42. Resource enhancement of international threatened and over-exploited species in Southeast Asia through stock release (AQD)
43. Responsible fishing technologies and practices: Fishing in harmony with nature (TD)
44. Seafood Safety Information Network (MFRD)
45. Strengthening small-scale fisheries management through the promotion of rights-based fisheries and co-management (TD)
46. Support to tsunami rehabilitation of affected countries (SEAFDEC Secretariat)
47. Sustainable utilization of potential fisheries resources and reduction of post-harvest losses (TD)
48. Tagging program of economically important pelagic species in the South China Sea and Andaman Sea (MFRDMD)
49. The use of indicators for sustainable development and management of capture fisheries in the ASEAN region (MFRDMD)
50. Traceability systems for aquaculture products in the ASEAN region (MFRD)
51. Utilization of freshwater fish in the ASEAN member countries for value-added products (MFRD)

allowing for the effective mobilization and utilization of the limited resources without unnecessarily duplicating efforts.

In order to assure that the efforts of the ASEAN and SEAFDEC are sustained especially in addressing the challenges that have possible impacts on the development and management of fisheries, and in support of the implementation of various activities that would benefit the countries in the region, the ASEAN-SEAFDEC Strategic Partnership (ASSP) was formalized in 2007. From such strengthened partnership, a number of programs and activities have been implemented by SEAFDEC in the ASEAN countries under the ASEAN-SEAFDEC FCG/ASSP framework. The ASEAN-SEAFDEC collaborative mechanism was envisaged to lead to the sustainable development of fisheries as well as to the upliftment of the economic well-being of the peoples in the Southeast Asian region. In addition to the technical programs, the areas of collaboration between the ASEAN and SEAFDEC also covered among others, cooperation in the implementation of the ASEAN Roadmap for the Integration of the Fisheries Sector, the establishment of the ASEAN Fisheries Consultative Forum (AFCF), and the ASEAN Shrimp Alliance (ASA).

Moreover, under the FCG collaborative framework, the ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security in the New Millennium: “Fish for the People” was organized in November 2001 in response to the widespread regional concern over the unsustainable fisheries practices, which had negatively affected the supply

of fish and fisheries products as well as the socio-economic well-being of the peoples in the region. The Resolution and Plan of Action adopted during the 2001 Millennium Conference (SEAFDEC, 2001) provided regional policy direction and guiding principle for the development of programs relevant to the sustainable development of fisheries in the ASEAN region, under the FCG framework.

Furthermore, in an effort to pursue the momentum that was initiated during the 2001 Conference, the Special Five-Year Follow-up Program on the Contribution of Sustainable Fisheries for Food Security in the ASEAN Region was formulated and implemented from 2002 to 2005. The Special Five-Year Program was aimed at assisting the ASEAN countries in the implementation of the 2001 Resolution and Plan of Action. In addition to the programs that had been implemented since 1998 under the ASEAN-SEAFDEC FCG collaborative mechanism, the Special Five-Year Program was implemented as part of such mechanism. Later on, more programs have been carried out under the FCG/ASSP framework (**Box 2**).

Meanwhile in the international arena, additional requirements have been developed and adopted to ensure the global sustainability of fisheries. With the continued deteriorating state of the fishery resources in the Southeast Asian region and the emerging fisheries related issues and initiatives during the past decade that need to be addressed, the ASEAN and SEAFDEC called for the organization of a sequel forum. The ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security



Towards 2020 “Fish for the People 2020: Adaptation to a Changing Environment” is therefore scheduled for 13-17 June 2011 in Bangkok, Thailand. The Fish for the People 2020 Conference is envisaged to address the priority issues that threaten and impede the sustainable contribution of fisheries to food security in the region.

The 2011 Conference would also come up with the regional policy framework and priority actions in enhancing the contribution of fisheries to food security and to the well-being of the peoples in the ASEAN region while also responding to the changing environment. Moreover, the recommendations from the technical preparatory process of the Conference would serve as inputs for the development of the new decade Resolution and Plan of Action, particularly in the formulation of follow-up activities taking into consideration the priority issues and challenges that continue to confront the fisheries sector in our region. As a follow-up to the outcomes of the 2011 Conference, consultations would be held to facilitate the planning and implementation of programs and activities in line with the new Resolution and Plan of Action, and taking into consideration the outcomes from the Technical Session. The themes for the Technical Session of the Conference are shown in **Box 3**. SEAFDEC would therefore sustain its programs and activities in line with the new Resolution and Plan of Action, and ensure that through sustainable development, fisheries could enhance its contribution to food security in the ASEAN region.



Role of SEAFDEC in the Sustainable Development of Fisheries in the ASEAN Region

Since its establishment in 1967, SEAFDEC through its Secretariat and four technical Departments has been conducting R&D programs and activities in the ASEAN region covering the areas of responsible fishing technologies and practices, sustainable fisheries management, responsible aquaculture development, and fishery post-harvest technologies. In addition, SEAFDEC has also been supporting the ASEAN countries in the formulation of regional fisheries policies to safeguard the countries’ interests. With the formulation of the FCG collaborative mechanism and the establishment of the ASSP later, the FCG/ASSP collaborative framework has paved the way for SEAFDEC to work closely with the ASEAN countries in the implementation of programs and activities



Box 3. Themes for the Technical Session of the 2011 Conference

<p>1. Enhancing governance in fishery management Governance which encompasses the institutional arrangements for stakeholders in the society to extract fishery resources, will determine how well societal problems are resolved and opportunities are created for enhancing social welfare. This theme is envisaged to pave the way for enhancing the role of governance in managing fisheries in the ASEAN region, which could be implemented in the context of an ecosystem approach to fisheries as articulated in the global Code of Conduct for Responsible Fisheries.</p>
<p>2. Sustainable aquaculture development It has been predicted that demand for food fish would increase by 2020, likewise for aquaculture which has been predicted to grow to meet the deficit in food fish needs. Therefore, challenges will have to be addressed in order that aquaculture could effectively contribute to the region's sustainable development. Thus, this theme is a step towards the final formulation of a roadmap for sustainable aquaculture development in the region for the next decade and beyond.</p>
<p>3. Ecosystem approach to fisheries Ecosystem approach to fisheries is an important factor that could complement the existing fisheries management approaches. A comprehensive ecosystem approach to fisheries management would require fisheries managers to understand the complex ecological and socio-economic environments in which fish and fisheries exist, and should be able to anticipate the effects that fisheries management will have on the ecosystem and the effects that ecosystem change will have on fisheries.</p>
<p>4. Post-harvest and safety of fish and fisheries products The post-harvest sector is important in fisheries as it deals with activities after capture from handling the catch on-board and on-shore, processing, distribution and marketing including the control systems for managing the safety and quality as well as traceability of such products. Although currently in the region, most fish is utilized, but much of the catch landed is of poor quality and utilized for non-human consumption. Therefore, methods of optimizing the utilization of fish catch should be established for the greater value of the fish and fisheries products, and to comply with the standards and requirements of the importing countries.</p>
<p>5. Emerging requirements for trade of fish and fisheries products Recently, the fisheries sector has seen dramatic changes in terms of requirements to guarantee good quality, healthy products and other related aspects to ensure that fish and fisheries products are safe for human consumption. In addition, there are standards imposed by importing products on products being exported, which need to be complied with. Therefore, this theme would address the central aspects of trade in fish and fisheries products which is vital to the economies of the region considering the large quantity of fish and fisheries products traded in international market.</p>
<p>6. Climate change adaptation and mitigation towards food security The Southeast Asian region is most vulnerable to climate change due to its long coastlines, high density of population and economic activities in coastal areas and heavy reliance on natural resources. Climate change has already affected the region, therefore the immediate need for improved fisheries management, restoration of important and protective habitats, and creation of alternative and diversified livelihoods should be addressed and considered high priority. This theme is envisaged to project on how to mitigate the impacts of climate change to fisheries and aquaculture in relation to aforementioned need.</p>
<p>7. Livelihood among fishing communities and prospects of employment in fisheries-related activities The development of the ASEAN Community from the point of view of social aspects, labor requirements and the rights of coastal and inland communities to a decent livelihood would be the key issues to be considered under this theme. It is envisaged that sustainable fisheries management should ensure that in addition to the promotion of how to manage the fish, the well-being and the rights of all those involved in various aspects of fisheries should also be protected.</p>
<p>8. Sustaining food supply from inland fisheries This theme would focus on the need to safeguard food security from inland fisheries from the context of fisheries providing direct and indirect employment opportunities, income and nutrition, among others. The sustainable development of inland fisheries towards sustainable community-based inland fisheries resource management would therefore be given focus. In addition, the integration of fisheries with multiple inland water resource use would also be emphasized considering that the competition for water and aquatic habitat is the most critical challenge in inland fisheries as well as the increasing competition for water from the other economic sectors.</p>

that support the sustainable development of fisheries in the respective countries in the region.

With funding support that mostly come from the Government of Japan through its Ministry of Foreign Affairs and later through the Japanese Trust Fund (JTF), significant achievements have been attained by SEAFDEC from the implementation of such activities while technologies have been developed, which in turn have been disseminated to the region through training, workshops, seminars and massive dissemination of information. Results from the various programs and activities have been compiled as proceedings, technical reports, scientific articles, annual reports, internal publications of the Departments as well as in the Special Publication Fish for the People and in the SEAFDEC Newsletter.

Thus, the achievements from the implementation of such programs as summarized in **Box 4**, have been recognized not only as results of technical initiatives but have been used as basis by the ASEAN countries for the formulation of their respective national fisheries policies. Furthermore, SEAFDEC has also been providing assistance to the ASEAN countries in collectively addressing international fisheries issues that could impede the sustainable development of fisheries in the region.

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Box 4. Summary of the contributions of SEAFDEC towards the sustainable development of fisheries in Southeast Asia

Promotion of sustainable fisheries management

The adoption of the CCRF in the region was enhanced through the Regionalization of the CCRF undertaken by SEAFDEC taking into consideration certain specificities in the region's fisheries structures as well as the unique cultural and socio-economic situations of the region. The resulting set of regional guidelines which have been disseminated to the region included those for Responsible Fishing Operations, Responsible Aquaculture, Responsible Fisheries Management, Responsible Post-harvest Practices and Trade, and the Supplementary Guidelines on Co-management using Group User Rights, Fishery Statistics, Indicators, and Fisheries *Refugia*. In sustaining its support to the ASEAN countries for the implementation of the CCRF through the Regional Guidelines, SEAFDEC has broadened its activities demonstrating in the process significant results that led to the further development of fisheries in the respective countries. The ASEAN countries then intensified the promotion of the Regional Guidelines by translating these into their respective national languages and conducting national activities in the aspects of the Regional Guidelines. As a result, the CCRF has contributed significantly to the development of responsible fisheries in the ASEAN countries and had been used as basis for the formulation of the relevant national policies and plans of the respective countries.

Advocating responsible marine fishing technologies

The coastal fisheries resources of Southeast Asia had been over-exploited because of increasing demand for fish and fisheries products as well as the modernization of fisheries technology. In view of the nature of the region's fisheries which is small-scale, the fishers are vulnerable to intense competition in limited fishing grounds and often encountering conflicts with their fishing operations over the decreasing resources. SEAFDEC therefore improved marine fishing technologies in order to address the critical problems of the small-scale fishers through the promotion of selective fishing gear and practices. Specifically, the use of Juvenile and Trash Fish Excluder Devices (JTEDs) was advocated in the ASEAN countries after which a number of fishing fleets in the Philippines have been installed with JTEDs while in other countries research on the use of JTEDs had been continuing. Moreover, the set-net technology was also improved for sustainable coastal fisheries in the region. In a few pilot sites in Southeast Asia, the results had demonstrated that the set-net is an environment-friendly fishing gear, and could promote cooperation among the local small-scale fisheries, and that the set-net can be used in coastal fishing grounds without disrupting the biodiversity of the coastal areas.

Development of responsible and sustainable aquaculture

Aquaculture in the region has developed so fast that in 2008, about 16% of the world's total production from aquaculture (68,327.4 mt) was contributed by the countries of Southeast Asia (11,064.0 thousand metric tons valued at US\$ 14,032.2 million), and in terms of value the region contributed about 13% to world's aquaculture production valued at US\$ 105,874.0 million (FAO, 2010). However, the rapid growth of the region's aquaculture was capped by concerns of food safety. SEAFDEC therefore addressed such concern through a long-term strategy by implementing projects which are dovetailed towards making the region's aquaculture development not only technically feasible and environment-friendly but also economically viable and socially equitable. In order to attain such objective, R&D as well as human capacity building had been intensified for the effective and efficient transfer of aquaculture technologies to the rural fishfarmers. Moreover, through the promotion of fish disease management, healthy and wholesome aquaculture had been attained by the countries in the region.

Promotion of safe and wholesome fishery products

SEAFDEC has been conducting projects that aim to advance the production of safe and wholesome products, and increase the availability of such products for human consumption, by maximizing the utilization of fish catch and minimizing wastage of the fish resource. The application of the Hazard Analysis and Critical Control Point (HACCP) was promoted to ensure food safety in fish processing of products for export while improvement of the traditional products was advocated for domestic consumption. Through the application of HACCP, the ASEAN countries ensure the safety of the region's fish and fisheries products. Moreover, the technology developed in chemical and drug residue testing has been transferred to the ASEAN countries allowing for the building up of science-based knowledge that enhances the capability of the countries to detect residues in fish and fisheries products, and manage the quality and safety of their products.

Intensification of fishery resources research

Many fishing grounds in the region should be conserved in order that fisheries could continue to play the role of contributing to the region's food security and economy. The very nature of the region's fisheries where ownership is not defined makes it difficult to manage the straddling stocks resulting in excess capacity and overfishing, and subsequently to the over-exploitation of the resources. In view of such situation, SEAFDEC has promoted the sustainable management of shared stocks while also managing fishing capacity, addressing the issues of illegal, unreported and unregulated (IUU) fishing, and assisting the countries in strengthening their monitoring, control and surveillance (MCS). Moreover, Through the assistance of SEAFDEC, surveys of the countries' fishing grounds and deep sea resources had been carried out for sustainable development of fisheries. During the surveys, the research vessels of SEAFDEC as well as those of the participating Member Countries had been used. The findings of the surveys provide better understanding of the status of the resources and serve as scientific evidence for management.

Marine resources conservation, management and enhancement

The efforts of SEAFDEC to advocate fisheries management mechanisms has led to the development by the countries of their own policies and frameworks to manage their respective fisheries. However, considering the deteriorating state of the region's fisheries resources due to human intervention, SEAFDEC has advanced the conservation and management of the resources as options to attain increased fish production and comply with regional and international conservation measures. Thus, the countries have rectified their management policies by gradually introducing decentralized rights-based fisheries and fisheries co-management systems, as well as the protection and rehabilitation of important aquatic resource habitats, and stock enhancement. Moreover, efforts in the conservation and management of sea turtles led to the establishment of a regional mechanism for research and conservation, and the use of selective fishing gear to reduce the incidental catch of sea turtles in fishing operations. Stock enhancement of sea turtles had also been promoted as well as for other threatened aquatic species.

Improvement and harmonization of information for fisheries management

SEAFDEC has been undertaking activities to strengthen the national fisheries statistical systems of the countries in the region to serve as basis for understanding the status and conditions of the fishery resources. The statistical systems in the region had also been harmonized with those of international standards in order to facilitate the reporting of fisheries statistics to FAO and SEAFDEC. The development of the Regional Framework for Fishery Statistics of Southeast Asia has paved the way for the improvement of the collection and compilation of fisheries statistics by the ASEAN countries as well for the better understanding of the role of fisheries statistics in the management of their respective fisheries resources. The fisheries data and information provided by the countries to SEAFDEC had been compiled into the Fishery Statistical Bulletin of the South China Sea Area which was renamed in 2010 as the Fisheries Statistical Bulletin of Southeast Asia.

Box 4. Summary of the contributions of SEAFDEC towards the sustainable development of fisheries in Southeast Asia (Cont'd)

Facilitating discussions on international fisheries-related issues

SEAFDEC has provided avenue for the ASEAN countries to discuss international fisheries-related issues through the regional technical consultations. Such consultations had enabled the countries to respond to international initiatives and to develop common positions and policy options reflecting ASEAN fisheries in international fora especially on the issues related to the proposed listings of aquatic species which are economically important for the Southeast Asian region in the CITES Appendices. Moreover, the study of SEAFDEC on the management of fisheries and utilization of sharks in Southeast Asia led to the development of National Plan of Action on Sharks by the respective countries in line with the International Plan of Action on Sharks, to ensure that conservation and management of sharks in the countries are in place.

Enhancing visibility and public awareness of SEAFDEC initiatives and efforts

While intensifying the promotion of its visibility, SEAFDEC through the Secretariat and four technical Departments has been implementing information programs and activities including the Center-wide Information Network, and in order to supplement such efforts the SEAFDEC Council adopted the SEAFDEC Information Policy and Plans including the SEAFDEC information strategy, which served as basis for the development of tools for the promotion of SEAFDEC activities and disseminating SEAFDEC information. The various publications of SEAFDEC that include proceedings, technical papers, scientific articles, as well as newsletters and the Special Publication Fish for the People, had been instrumental in providing the public with better understanding of the activities SEAFDEC especially its role in promoting the sustainable development of fisheries for food security of the peoples in the Southeast Asian region.

SEAFDEC. 1998. Report of the Thirtieth Meeting of the SEAFDEC Council, Brunei Darussalam, 17-21 March 1998; pp 81-83

SEAFDEC. 2001. Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 7 p

SEAFDEC. 2006. Fishery Statistical Bulletin for the South China Sea Area 2002-2003. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 173 p

SEAFDEC. 2010. Fishery Statistical Bulletin for the South China Sea Area 2007. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 165 p

SEAFDEC. 2010a. Fishery Statistical Bulletin of Southeast Asia 2008. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 135 p

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Enhancing Management of Fishery Resources through Intensified Efforts in Habitat Conservation and Rehabilitation

Ahmad Ali, Raja Bidin Raja Hassan and Yuttana Theparoonrat

Since the coastal fishery resources in the Southeast Asian region have been characterized as overfished, the need to develop conservation measures has been considered urgent in order that coastal fisheries can continue to satisfy the demand for and sustain the supply of food fish. In this regard, national and regional efforts had put emphasis on enhancing fishery resources management through habitat conservation and rehabilitation. Specifically, efforts have been exerted in addressing the need to increase the traditional incomes of fishers, protect the coastal waters from destructive fishing gears, set up fish enhancing devices, rehabilitate the coral reefs, and create new fish *refugias* to replace the natural refuges that had been destroyed or no longer exist. The existing and present national and regional efforts in enhancing management of fishery resources through artificial reefs (ARs) programs that include the installation of fish enhancing devices, establishment of fish *refugias* and marine protected areas, stock enhancement, as well as the issues and lessons learned as consequences of these programs, are discussed in this article.

The coastal waters of Southeast Asia comprise a rich ecosystem characterized by the existence of areas with extensive coral reefs and seasonal up-welling, as well as the presence of dense mangrove forests enriched with nutrients from land. These areas are critical to a broad range of aquatic organisms during their life cycle from breeding, spawning, nursing and growing, hosting the feeding zones of aquatic species that are economically important, and serving as important source of recruitment of a wide diversity of fish species. In view of the economic benefits that these areas could provide, human settlements have mushroomed in coastal areas leading to the significant deterioration of the quality of the ecosystem as a result of continued and increasing human activities. More specifically, the commercially important fishery resources in the region have declined due to many factors that include overfishing, illegal fishing, use of destructive fishing practices, and environmental degradation. Massive clearance of mangrove forests for aquaculture, urbanization, industrialization, wood fuel, timber and the like, could bring about large temporary economic benefits to certain groups of people or the governments but in the end, the breeding, nursery and feeding areas of many aquatic species such as fishes, crustaceans, and mollusks have been destroyed and lost. For example, sand mining destroys the natural habitats of many commercial fish species while the use of dynamites in fishing could seriously destroy the coral reefs which

serve as the natural habitats for the highly economic and commercially important demersal fishes such as groupers, humphead wrasse, snappers and others.

In addressing such concerns, most countries in this region have deployed artificial reefs (ARs) to restore the depleting coastal fisheries resources, prevent encroachment of trawlers, reduce conflict between commercial and traditional fishers, and increase the opportunities for small-scale fishers to improve and sustain their incomes from fishing. Other measures have also been promoted such as the installation of fish enhancing devices, promotion of stock enhancement through re-stocking, development of fish *refugias*, seasonal closure of breeding grounds, and establishment of marine protected areas or marine parks. Fish *refugia* is the spatially and geographically defined inland, marine or coastal areas in which specific management measures are applied to sustain important species (fisheries resources) during the critical stages of their life cycle. The establishment of fish *refugia* had been intensified in Thailand, Vietnam and Cambodia. Other man-made structures including aquaculture facilities, breakwaters, oil platforms, oil and gas pipe lines, stationary fishing gears, and jetties have also enhanced the biodiversity of aquatic organisms including fish. Thus, strengthening the linkages between resource enhancement activities and integrated coastal fisheries management with particular



Above: Fishes aggregate and improve the environment in AR areas (Photo: Japanese Institute of Technology on Fishery Port, Ground and Communities (JIFIC) in Sato, 2009); and Left: Monitoring the environment in ARs (Yuttana, 2009)

emphasis on decentralized rights-based fisheries has been promoted in the Southeast Asian region for the sustainable development of coastal fisheries for food security.

However, it should be considered that the use of ARs can result in positive social and economic benefits if fishing effort is regulated but it could result in further overfishing if uncontrolled. Therefore, ARs should be installed under a strict management system within certain regulated areas. AR programs need proper planning and management at the national and regional levels while the implementation of any AR-related activity must be based on scientific knowledge and multi-discipline expertise. In the process, it is necessary to strike a balance between the objectives and benefits of the AR projects in terms of the environmental, economic and social aspects in fish production for food security.

SEAFDEC Initiatives and Activities on Fishery Resource Enhancement

During the ASEAN-SEAFDEC Millennium Conference in 2001, it was emphasized that the degradation of aquatic environment in the ASEAN region would lead to the declining of fisheries productivity and reducing the food fish supply for the local people. Therefore, the 2001 Conference recommended that efforts on resource enhancement activities should focus on: (1) integrated installation of artificial habitats in inshore waters with careful pre-assessment of the environmental and socio-economic impacts; (2) re-stocking exercises with careful assessment of the economic feasibility and environmental impacts; (3) establishment of Marine Parks to protect fragile ecosystem; and (4) development of management practices to effect seasonal closures of spawning areas in accordance with sustainable management requirements.

Specifically, in order to enhance the fisheries resources, the 2001 Conference presented several recommendations which included the need for respective countries to take measures for restoring critical inshore habitats which have been extensively degraded by various human activities; assess the feasibility and environmental impacts of artificial reefs and other man-made structures in inshore waters; promote re-stocking activities; encourage culture-based fisheries in inland waters; enhance marine engineering capabilities in the construction, installation and placement of resource enhancement structures; enhance the inshore habitats through artificial reefs for successful re-stocking program; conduct research on released species' potential recapture rate and impact on the ecosystem; ensure optimal recapture of the released stock through effective management measures, including predator control; develop marine parks in limited areas to protect the fragile coastal



Hatchery-bred abalone settling inside PVC pipe after release into the waters
(Photo: AQD 2010)

ecosystem; and promote the seasonal closure of specific areas to protect broodstock and juveniles of certain commercially viable species under rights-based fisheries management as alternative measures to marine protected areas.

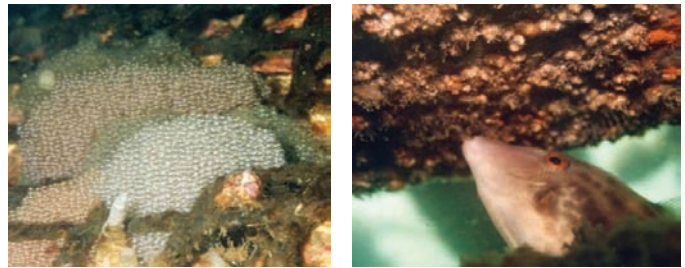
SEAFDEC has been implementing resource enhancement project, where three main activities were carried out, namely: survey and data collection on the environment in ARs, set-net and marine cages in Malaysia and Thailand together with another SEAFDEC program on management of sustainable coastal fisheries; workshop on ARs and stationary fishing gear, design and construction and marine protected areas in 2003 and 2004 (in Thailand), 2009 (in Malaysia and Thailand), and 2010 in Japan; and short-term Regional Training Course in Resource Enhancement Methodologies in 2003.

Meanwhile, the SEAFDEC Aquaculture Department (AQD) initiated an activity on ARs in 1991 at Malalison Island in Culasi, Antique of western Philippines, where a project on community-based fishery resources was implemented. The project was aimed at developing the local fishers into a strong and independent association to be able to effectively manage the Island's resources. The project has been turned-over and now managed by the Fishermen's Association of Malalison Island. With an ultimate goal of rehabilitating the Island's fish and marine benthic communities, AQD had been monitoring the status of the flora and fauna communities since the start of the project in 1991 (Balgos, 1995).

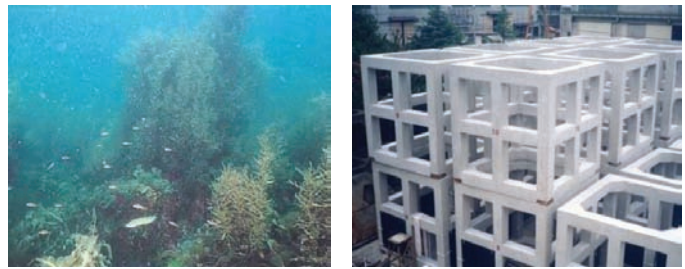
In 2000 and 2001, the SEAFDEC Marine Fishery Resources Development and Management Department (MFRDMD) through the SEAFDEC Program on Marine Conservation and Stock Enhancement, had successfully completed a study on the construction and setup of durable fish aggregating device for coastal fishers, and published a "Guide to Make and Set Durable Artificial Reef Fish Aggregating Devices (ARFADs) for Coastal Areas" (Ahmad *et al.*, 2004). Moreover, the SEAFDEC Training Department (TD) also conducted program on Rehabilitation of Fisheries Resources and Habitat/Fishing Ground through Resource Enhancement from 2001 to 2005. The program focused on experiments on the suitable designs/models of the resource enhancement tools for coastal areas and on the

use of synthetic fiber for the construction of the devices for long lasting durability in seawaters, and subsequently the technique was introduced to various fishing communities in Thailand and Malaysia.

Furthermore, stock enhancement is one of the regular programs of AQD which has been conducted since 2000, focusing on mollusks such as abalone, top shell, window-pane shell, and giant clam as well as on sea horses. Under this project, stock enhancement which refers to the stocking of hatchery-produced seeds for the public good without the intention of benefiting an exclusive user groups, is envisaged to be socially desirable and recognized as one of the important tools for fishery management. The stock enhancement project of AQD covers research on seed production, permanent marking, packing techniques and transportation methods, workshops, monitoring and evaluation as well as training and raising public awareness through intensified information campaign and publications.



Left: Eggs of greenling *Hexagrammos otakion* on ARs
 Photo: JIFIC in Sato, 2009; and
 Right: Black scraper nibbling on attached organisms in ARs
 (Photo: JIFIC in Sato, 2009)



Examples of AR structures in Japan:
 Left: to create seaweed beds;
 Right: to promote coastal fisheries (Source: Sato, 2009)

Fishery Resource Enhancement and Habitat Rehabilitation Activities in Japan and Southeast Asian Countries: Synthesis

Japan

Japan is the most experienced and advanced country in terms of using ARs to maximize fisheries production through specific design appropriate for installation in seaweed beds, spawning grounds, shelters, among others. Stationary fishing gear especially set-net as introduced by Japan and now adopted in many countries does not only serve as a tool for catching fish but also provides substrate and shelter for high diversity of flora and fauna. Set net has therefore been considered an environment-friendly and selective fishing gear.

Many countries in this region have learned from the experience of Japan on ARs and set-net technology, and are now trying to implement their own projects. Japan has designed various ARs depending on the management and purpose, such as ARs to protect the main resources, create seaweed beds, promote coastal fishing activity, and

propagate new resources. Sato (2009) reported that in a study in Japan which aimed to monitor the distribution of marine life around ARs, the results have shown that planktons usually swim around the sheltered areas near ARs, sessile organisms and other periphytons settle in ARs but could vary depending on the environment and materials used in constructing the ARs, and the change in the distribution of benthos around ARs was strongly related to the change in the sediments of the sea bottom. He added that ARs play important roles in enhancing the living environment of the marine resources by serving as spawning and feeding grounds for many fishes as well as providing shelters and resting areas for many species of fishes.

Brunei Darussalam

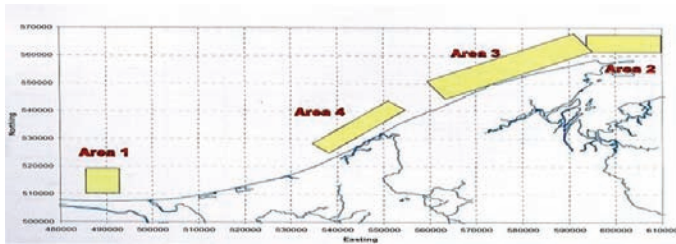
The Artificial Reefs Project of Brunei Darussalam was initiated in 1985 using discarded vehicle tires with the main objectives of enriching the marine resources, protecting the marine habitats and creating new fishing grounds. Other materials used to construct ARs included concrete piles, weld pipes and abandoned oil-rig platforms. The structures created by the country's oil industry such as oil



Samples of AR structures in Japan
 Source: Takagi, et al., 2009



Triangular pyramid ARs in Brunei Darussalam



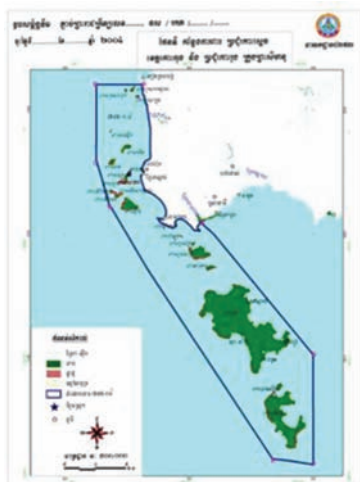
Marine protected areas with ARs installed in Brunei Darussalam

platforms, oil pipe lines and shipwrecks abandoned during the World War II, have also become new habitats for various fish species as well as other flora and fauna. Recently, small sized ARs measuring 2.5x2.5x2.5 m and triangular pyramids measuring 4x4x6 m have been deployed in 10-30 m deep coastal waters.

However, most ARs made from tires and triangular stainless steel had been buried in the sea bottom due to natural processes. Therefore, site selection is necessary before deploying ARs. Nevertheless, the deployment of abandoned oil platforms was in accordance with the Guidelines for the Decommissioning, Abandonment and Restoration of the Oil and Gas Industry Asset 2009. Until at present, no specific monitoring of the biological and socio-economic aspects of the country's ARs was carried out due to lack of expertise and manpower. Meanwhile, two marine protected areas were established in Selirong Island and Pelong Rocks in 2003, and fishing activities are restricted in areas with off-shore facilities including oil rigs.

Cambodia

Using concrete modules and logs, the Artificial Reefs Program initiated in Cambodia in 1991 aimed to provide habitats and improved the fish stock in the Great Tonle Sap Lake at depths of less than 10 meters and later, some related activities used rocks and tree trunks. While there is less concern on installing ARs in marine than in inland waters, 13 protected areas called fish sanctuaries have already been established in the Great Lake since 1979. These sanctuaries serve as refuge for freshwater fishes to spawn



Marine protected area in Koh Sdach ND, Koh Rong archipelago, Cambodia

between flood seasons. Any kinds of fishing activities in the sanctuaries are forbidden except for research purposes but with permission from the Fisheries Administration of Cambodia. Mangrove forests along the country's coastline are also protected and developed as fish sanctuaries.

Other measures had also been undertaken by the Ministry of Environment under the Royal Decree on the Creation and Designation of Protected Areas. Since 1993, the Ministry had established 23 protected areas in collaboration with the United Nations Environment Programme (UNEP) to conserve wildlife and their habitats, four National Parks in the coastlines (366,250 ha), one wildlife sanctuary (357,500 ha), and multiple use area covering 27,700 ha. Legislations have been established since 1997 to promote the conservation of natural resources and coastal development as well as to implement community-based on natural resource management. The coral reef ecosystem within these areas has been reserved for spawning, feeding and nursery grounds of marine aquatic species.

In order to reduce the impact of fishing activities in coastal and marine environment, the country has promoted licensing of fishing boats and fishing gears, elimination of trawling activities in less than 20 m deep coastal areas, and improving control and monitoring system. Moreover, the country also prohibits the use of destructive fishing gears and rehabilitates degraded coastal resources and ecosystem through its Management Strategy Plan which includes co-management, installation of ARs and establishment of seasonal protected *refugias* in collaboration with the UNEP/Global Environment Facility (GEF) South China Sea Program, International Union for Conservation of Nature (IUCN), Ministry of Fisheries of Vietnam, Fisheries Administration of Cambodia, and the Ministry of Environment Cambodia.

Indonesia

Efforts undertaken by the Government of Indonesia in habitat conservation and rehabilitation included the implementation of activities that focused on rehabilitation of coral reefs using multi-design ARs, where the development of ARs has been initiated by the Fishery Agency (DKI) of Jakarta Province in 1980-1988 by sinking the former frames of buses and rickshaws. In 1990-1993, the Directorate of Fishery of the Ministry of Agriculture developed ARs using car tires which were installed in six provinces, namely: North Sumatra, Lampung, Central Java, East Java, West Java, and Bali. The Directorate of Fisheries Research and Development also supported the development of ARs using cube-shaped hollow-concrete materials and car tires arranged in pyramids. Reports showed that installation of ARs resulted in some biological and ecological impacts as some ARs were able to attract marine life and various



Various AR modules used in Indonesia

traditional gears under the Fisheries (Maritime) Regulation 1967. In 1980, the restricted water areas increased from three to five nautical miles from the shorelines of all states of West Malaysia and several islands. Some of the islands were later gazetted in 1994 as Marine Parks of Malaysia under the country's Fisheries Act of 1985.

The Fisheries Act 1985 also covers all aspects of fishing, Marine Parks, sea turtles, artificial reefs, and the use of destructive fishing methods. The establishment of Marine Parks was meant to provide special protection to the aquatic flora and fauna, specifically to protect, preserve and manage the natural breeding grounds and habitat of aquatic life with particular regards to rare or endangered species; to allow for the natural regeneration of aquatic life where such life has been depleted; to promote scientific study and research; to preserve and enhance other undamaged state and productivity of the environment; and to inculcate among the people the importance of avoiding irresistible damage to the environment.

Collection of marine organisms and fishing are prohibited within 2 nautical miles from the coastline of the Marine Parks except in an island where the protected area is only one nautical mile from the island. At state level, some islands especially in Sabah and Sarawak are also gazetted as protected areas where fishing and other unfriendly activities are prohibited. Under the new Fisheries Policy (1982-1983), the areas restricted from fishing were expanded and clearly defined into four zones. 'Zone A' from shoreline to five nautical miles, reserved for traditional owner operator vessels; 'Zone B' from five nautical miles and above from shoreline, for commercial gear of owner operated vessels below 39.9 GRT (Gross Registered Tonnage); 'Zone C1' from 12 nautical miles and above from shorelines for commercial gears of owner operated vessels 40 GRT and above; and 'Zone C2' for from 30 nautical miles and above from shoreline to the border of EEZ of Malaysia for commercial gears with vessels 70 GRT and above. Malaysia also enforces prohibitions on the use of destructive fishing gear and practices, and reduction of fishing capacity of trawlers in coastal waters. While the management of mangrove forests had been placed under the jurisdiction of the Forestry Department, plans to utilize mangrove swamps for any projects require mandatory Environmental Impact Assessment (EIA) and approval from the Department of Environment. The government also considers that introduction of ARs in the coastal waters would help in restoring the depleted coastal fisheries resources, prevent encroachment of trawlers, reduce conflicts between commercial and traditional fishers, conserve and rehabilitate the destroyed habitats, and increase the opportunities of small-scale fishers to improve and sustain their incomes from fishing.

species of reef fishes. In 2000, ARs were installed in some areas in NTB (West Nusa Tenggara), Bali, Central Java, West Java, and Jakarta, for various purposes such as tourism, habitat improvement, and as means of inhibiting the trawlers from getting closer to the coastal areas.

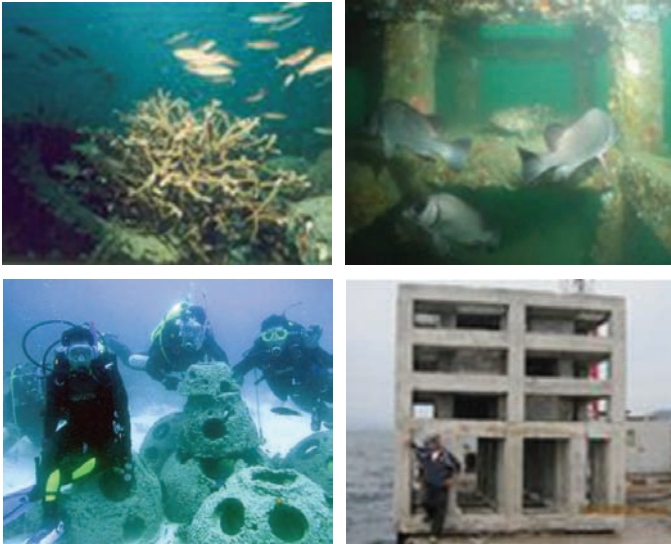
In the waters of the Saleh Bay, West Nusa Tenggara, installation of ARs was conducted in 2004 by the Research Institute for Marine Fisheries – Research Center for Capture Fisheries. The Bali Provincial Government also re-developed ARs in Tukadse waters, Karangasem regency from 2004 until today in an effort to improve marine tourism. Until 2010, the DKI of Jakarta Province continued to submerge every year considerable number of concrete ARs valued up to billions of Indonesian Rupiah and in various forms for the main purpose of rehabilitating and improving the fish stocks. The private sector also do their part in installing ARs in an effort to promote tourism, especially in the waters of Pemuteran, Buleleng, Bali.

Malaysia

The 1963 Fisheries Act of Malaysia includes regulations on fisheries exploitation through very strict limited entry or input management regime. In the waters less than three nautical miles from the shorelines of any state of West Malaysia and several islands, trawl fishing and purse seining are not allowed except fishing operations that make use of



Locations of Marine Parks in Malaysia



Top left: Coral growth on tire AR modules;
 Top right: Groupers and sweetlips inside soft bottom AR structures;
 Bottom left: Reef ball ARs
 Bottom right: Biggest ARs deployed in 2010 near Langkawi Island in Kedah, Malaysia, measuring 3.8x3.8x3.8 m and weighing 42 metric tons

During the initial stage, ARs were constructed and deployed by the Department of Fisheries Malaysia (DOFM) for conservation purposes. However, starting in 1985, the Fisheries Development Board of Malaysia locally known as LKIM began to be involved in constructing ARs for the purpose of aggregating fish to help the traditional fishers in harvesting more fish and increase their incomes. This structure was locally called *unjam-unjam* (Dianatul Azni, 2008). There are many designs of *unjam-unjam*, some are cuboids, cylindrical, pelagic, ceramics, FRC, piles, and others. The Marine Park Department was also seriously involved in the deployment of ARs focusing mostly on coral reef rehabilitation within the Marine Parks areas not more than two nautical miles from the islands. The Malaysian Maritime Enforcement Agency (MMEA) which is directly involved in enforcing the Fisheries Act 1985 had also deployed ARs using the confiscated fishing vessels.



Left: Pack of grey bamboo shark, *Chiloscyllium griseum* crowding under soft bottom ARs in Besut Terengganu, Malaysia illustrating the success of the structure as refuge for this species
 Right: Aggregation of adult Harry sweetlips (*Plectorhinchus gibbosus*) inside soft bottom ARs suggesting such ARs as preferred breeding ground for this species

According to Jothy (1982), installation of ARs during the 70s was initially meant to achieve two-pronged objectives, namely: (i) to increase the productivity of the marine environment in general and thereby, the resources of food fish through the development of sanctuaries on sea beds for fish and other related marine life; and (ii) to promote the recovery of the fishery resources in coastal areas that have been seriously depleted as a result of ill-managed fishery exploitation. In order to achieve these objectives, a number of activities had been carried out on an 'ad hoc' basis by researchers from Fisheries Research Institute (FRI) in Penang (Wong, 1991). In 1978, the ARs project was recognized as a development project of the DOFM under the Third Malaysia Plan (1976-1980). During the early period of the AR program, only discarded tires were used because these were free and readily available, relatively inexpensive to assemble into units for making modules, provide excellent substrates for attachment, indestructible in seawater, and reduce previous disposal problems by burning. Moreover, the successful use of tires as ARs which had been widely published in proceedings, journals and books, had encouraged the local fishery researchers of Malaysia to conduct experiments on ARs.

The development of tire ARs was continued until 1995, and up to 1994 the sites of tire ARs had increased to 75 where 3,145,856 pieces of tires were used. However, after 1995, the use of tires was forbidden because of claims by many parties that automobile tires could leach toxic matters to the marine environments. In this regard, Ahmad *et al.* (2008) conducted surveys using side scan sonar to monitor the status of tire ARs in Terengganu waters and found that all tire ARs deployed on open sea floor were destroyed through natural ocean processes especially from strong current and erosion of bottom sediments. Some tire ARs placed between islands was still in good condition but was colonized only by a few marine organisms and had attracted small assemblages of fish.

In 1989, PVC ARs were introduced near Pulau Langkawi in Kedah, but since PVC was not suitable for ARs especially in open sea because these can be easily destroyed by various fishing activities, the DOFM stopped using PVC since 1992. However, the Department of Marine Parks Malaysia continued the use of PVC as substrates for coral reef colonization within marine park areas especially in calm and close areas such as near jetties or sheltered bays. The first prefabricated ARs using reinforced concrete was launched in Malaysia in 1986, where two types such as concrete drainage culvert and concrete pipes were used. Since then, several modifications were made on the size and shape of ARs. Later, concrete lobster ARs was constructed and deployed in 1990 and the squid ARs in 1992. At the initial stage, the squid ARs attracted large number of squid

to aggregate, mate and lay their egg especially the *Sepia pharaonis* species. However, after the monsoon season almost all structures were found scattered on the sea floor which could be probably due to the fishing operations of illegal trawlers.

Another type of concrete ARs which were meant for recreational fishing was established in 1993 and in 1995 by a pioneering marine ranching project following the technology developed in Japan. The project was not successful due to many technical problems especially the construction which was not in accordance with the marine engineering construction guidelines. The lobster ARs made from ceramics were introduced in 1992, but achieved only about 40% of its objectives as the modules got buried in the sea floor. The DOFM therefore stopped the use of ceramics for the construction ARs since 1993. Derelict and confiscated fishing vessels made from wood were also used as ARs, but provided only short term benefits to fishers since the wooden hulls were attacked and destroyed by the dorado worms as well as by other natural processes such as strong and turbulent currents.

The reef ball ARs were deployed in various parts of Sarawak waters since 1998 by the DOFM and the Department of Forestry of Sarawak. In Peninsular Malaysia reef ball ARs were not widely used but were only deployed in Marine Park areas in Kedah and Terengganu for coral reef enhancement. These ARs were only suitable on hard bottom sea beds and not suitable to prevent illegal trawlers from getting into the soft bottom sea beds. The first oil platform converted to ARs in Malaysia was installed in 1968, but was observed to have collapsed in December 1975 and officially handed to DOFM in 2005. Now, these ARs are located in new sites in Sarawak waters at depths of about 21 meters, about 6.21 nautical miles from the coastline and used mainly for recreational fishing and scuba diving.

Starting in 2006, the DOFM focused on the design and construction of big sized reinforced concrete ARs for installation in hard and soft bottom sea beds. The structures considered various factors such as the fish behavior, marine engineering aspects, physical oceanography, and the target species, which were gathered from previous studies as well as references from various sources. The structures were constructed according to the British Standard 8110, and until the end of 2010, fifteen new designs of concrete ARs weighing between 6 to 42 metric tons/module and measuring between 1.6 to 3.8 m (length, width and height) were developed. The ARs were cuboids bio-active, ARs meant for soft bottom (4 designs), and two designs of the tetrapods ARs, recreational ARs, cube ARs, cuboids ARs, and lobster ARs (Ahmad *et al.*, 2010).

All monitoring activities in AR areas were conducted every 3-6 months after deployment to record the changes in the fishery resources as well as physical stability of the reef modules by researchers cum divers from the Research Division of DOFM based in Penang (Fisheries Research Institute), Terengganu (SEAFDEC/MFRDMD) and Sarawak (Fisheries Research Institute Sarawak Branch). More than 60 scientific and information papers, posters, pamphlets, book, videos, post-graduate thesis and proceedings have been published since the ARs program began in 1975, most of which were authored by researchers from the Research Division of the DOFM and universities in Malaysia. Artificial reefs deployed in 2006 have become a nursery and breeding ground not only for fish but also for lobsters and crabs. Fully gravid species were found within the AR structures during a series of visual observations conducted by researchers from DOFM and universities. The structures also function as substrates for highly diversified marine fauna and flora. More than 20 commercial fish species were recorded and among them are the high grade snappers (*Lutjanus* spp.), groupers (*Epinephelus* spp. and *Cephalopholis* spp.), Carangoides (*Caranx* spp.), stingrays, and spiny lobster (*Panulirus* spp.). In a study conducted by DOFM researchers, cuboid ARs deployed about 4 nautical miles from the coastline of Terengganu attracted both reef and commercial species of fishes including sharks and rays. More than 1800 tails of commercial species aggregated close to each module of the cuboid ARs which became the highest number recorded in Malaysia since 1975. The ARs also served as hindrance for illegal trawlers because the cod end of trawlers could get entangled with the ARs. In the latest findings in 2010, tetra-pod ARs deployed near a sea turtle sanctuary in 2006 has become a safe resting place for green turtles during the inter-nesting period. Adult green turtle *Chelonia mydas* was observed resting closed to the ARs in July 2010.

Myanmar

Rehabilitation of habitats by ARs has not yet been introduced in Myanmar considering that the country's coastal zones are still intact. However, other measures have been undertaken for habitat conservation and rehabilitation, which included controlling the fishing effort through proper licensing of fishing gear and fishing vessels, closed area, closed season, limitations on mesh size, and prohibition of destructive fishing activities. A total of ten fishing grounds identified as nursery areas of certain species have been gazetted as closed season for three months from June to August. Regulations on closed area are also implemented in three areas to avoid conflicts between traditional fishers and trawlers, where trawlers are not allowed to fish within these areas for the whole year. Under the Myanmar Marine Fisheries Law, fishing gears destructive to the environment and fisheries resources are banned, which include the pair

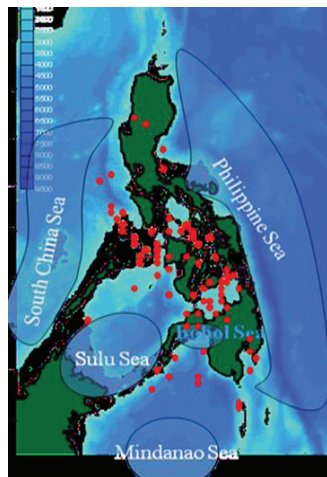
trawl, push net, purse seine net less than one inch mesh size, trawl net cod-end mesh size less than three inches and trammel gill net less than 1.5 inches; as well as fishing operations that make use of electric, poisons, chemicals, and explosives. Enforcement of the law is being carried out by the Myanmar Navy, Coast Guard, DoF Myanmar, Customs Department and police. Myanmar is the only country in the region which had gazetted a huge area from Ross Island to Lampi Island as Shark Protected Area under its Fisheries Law. Based on such regulation, shark fishing is totally prohibited in the area which caters only the tourism industry such as shark-watching for divers.

Philippines

AR projects in the Philippines started in 1977 using scrap tires and bamboo for experimental purposes by the Silliman University, University of the Philippines Marine Science Center, and Bureau of Fisheries and Aquatic Resources (BFAR). The project received assistance from the US Peace Corps and Japan Overseas Cooperation Volunteers in collaboration with local organizations including fishers' associations, civic organizations, diving groups, the Ministry of Human Settlements and the Natural Resources Management Center (Balgos, 1995). Encouraged by the successful experimental ARs, more projects using tires and bamboo were launched between 1985 and 1987 in all the regions of the country with the objective of enhancing the catch of small-scale fishers, where catch was decreasing while cost of fuel was increasing.

However, because of the short life span of bamboo ARs, any impact of these modules was not sustained. Therefore, bamboo ARs were later changed to concrete ARs. In 1990, the Philippine Council for Aquatic and Marine Research and Development (PCAMRD) launched a National Coral Reef Management Conservation Program which addressed the management of natural stocks in coral reefs with emphasis on community-based management (Balgos and Salacup, 1994). Tire and concrete ARs were deployed near several islands, and some ARs were deployed near a marine sanctuary in Negros Occidental in central Philippines. Fishing was not allowed during the year after deployment, while monitoring of fish and other fauna was conducted through fish visual census.

Locations of ARs in the Philippines



Concrete ARs used in the Philippines



In 1991, the construction of ARs for fishery resource and habitat enhancement was one of the measures adopted by the Fisheries Sector Program of the Department of Agriculture. The project involved the Provincial Fisheries Management Units responsible for the implementation, monitoring and evaluation of the project together with BFAR, the Department of Environment and Natural Resources (DENR), and various agencies and NGOs. The project installed ARs made from tires, concrete and bamboo in various places along the 500 km coastline in twelve bays of the country. Monitoring of the project was however, not conducted properly while most structures were observed to be poorly constructed.

Through BFAR, the Philippines formulated various management and conservation programs and policies such as the Coral Garden Project; Strengthening of the 'Bantay-Dagat Program'; implementation of monitoring control and surveillance program; and establishment of the Fisheries and Aquatic Resource Management Council (FARMC). All these programs aimed to conserve, manage and rehabilitate damaged reefs in identified sites; uplift the standard of living of the fisherfolk in local fishing communities; and identify and promote resource enhancement activities. Marine reserves have also been established and promoted in the Philippines by NGOs, local governments and the academe.

Singapore

Protection and conservation of fisheries in Singapore are regulated under the Fisheries Act (Chapter 111), where the use of poisons, explosives and trawl net are strictly prohibited. In order to enhance its marine resources, an AR program was initiated with the use of concrete blocks, tires and fiberglass. The first ARs were launched in 1989 under the ASEAN-US Coastal Resource Management Project using hollow concrete cubes and tires in pyramid modules, which were installed in 15 m deep waters in areas adjacent



Left: Concrete ARs used in Singapore; and
Right: Reef Enhancement Unit being promoted in Singapore

to a natural patch reef. The objective of this project was to restore and enhance the fish communities of degraded reefs (Chou, 1991).

Results from the monitoring activities showed significant increase in fish abundance and species diversity, and about 68 species from 26 families had been recorded. Fish abundance, density and size were higher at concrete ARs than in tire ARs. Adult fish like batfish and snappers have been observed close to the concrete modules while juveniles of various fishes preferred the tire ARs (Low and Chou, 1999). To enhance the coral reefs, a special fabricated AR unit called Reef Enhancement Unit (REU) made of fiberglass impregnated with sand and calcium carbonate was used, and deployed at a depth of 3 m. The results of this study showed that fiberglass is a viable alternative material for artificial reefs (Chou and Lim, 1986).

Thailand

The rapid development of commercial gears such as trawl net and purse seine operated close to the coastline and the use of destructive fishing gears such as push nets and fine mesh cod-end trawlers seriously affected the livelihood of small-scale fishers in Thailand. A large area of mangrove swamps had also been cleared for other purposes such as aquaculture and human settlement. The Government therefore had to undertake various management measures to rehabilitate the coastal resources such as installation of ARs, introduction of stationary gears, and proclamation of marine protected areas.

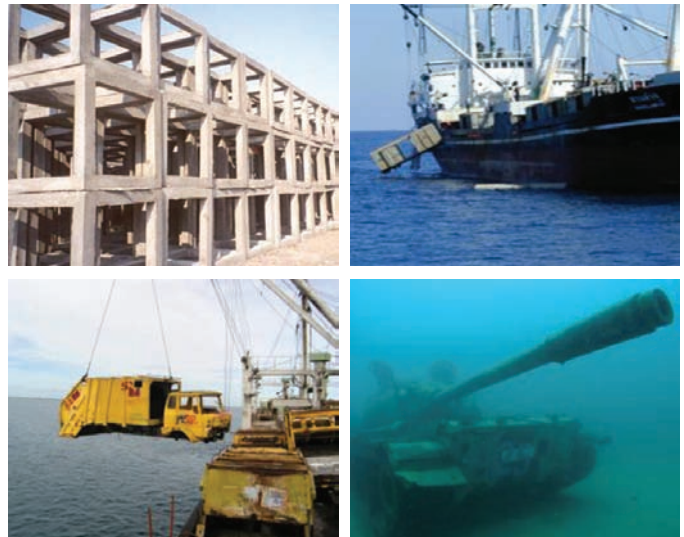
The country's AR program started in 1978 using tires, concrete (cylinder, pyramid and cube), rocks, wood, unused train wagon, garbage trucks, and army tank with the main objectives of rehabilitating the coastal fishing grounds, providing habitats and shelters for juveniles, increasing the small-scale fishers' incomes, providing substrates for primary and secondary production, deterring trawlers from encroaching into nursery grounds, and reducing conflicts among fishers and resource users. The ARs were deployed at the depth of 4-18 m along the coast of the Gulf of Thailand and Andaman Sea. During the initial stage, most of the ARs were deployed and scattered in wide areas

which proved to be less effective as most structures were buried especially on muddy sea bottom, damaged by pair trawlers, and entangled with gill nets.

Three main agencies are responsible for the country's ARs program, namely: the Department of Fisheries of Thailand (DOF), Department of Marine and Coastal Resources, and the Royal Thai Navy. During the research and development period (1979-1985), the ARs program of Thailand focused on research and experiment to identify the suitable materials, design, deployment techniques, and durability of the structures. Monitoring the status around the ARs showed significantly high diversity of fish with more than 50 species recorded. Moreover, the most suitable and durable ARs are the square concrete cubes, although there were no differences in terms of species diversity and catch in all the AR designs.

Under the country's National Social and Economic Development Plan IV (1988-1992), the Small-scale Fisheries Development Project was launched by the DOF, which included coastal small-scale fisheries development, installation of ARs, and fishery resource rehabilitation. The project was implemented from 1988 until 2003 in order to conserve the marine and environmental resources. Moreover, at least 50 km² from each province was designated as fishing grounds for traditional fishers in order to reduce conflicts.

The construction and installation of ARs began at large scale in 1985 when the Government started allocating annual budget for the ARs project. In 1985-2010, the DOF installed small-scale ARs in 334 sites covering an area of 478 km² and large-scale ARs in 33 sites covering 1,435 km² at the cost of Baht 673 and 568 million, respectively. In the southern part of the Gulf of Thailand, the ARs project started since 1983 and initiated by National Institute of



Artificial reefs in Thailand, made of concrete, Train goods wagon, garbage truck, and war tank

Coastal Aquaculture of Songkhla Province for experimental purposes. Between 1983 and 2004, a total of 64 new AR sites had been established at a total cost of Baht 206 million. Starting in 2002, most of the ARs and coastal resources rehabilitation projects in Pattani and Narathiwat Provinces were placed under the Royal Initiation of Her Majesty the Queen. The materials used for the ARs were tires, concrete pipes, dice blocks, and goods wagon, and placed between 9.5-12 km from the coastline of Pattani and Narathiwat Provinces. Later in 2002-2004, another 32 new sites of ARs were established at a cost of Baht 41 million.

In terms of fisheries management, near-shore areas within 3 km from shorelines had been identified as protected areas since 1972 from commercial gears such as trawlers and push nets under the Fisheries Act. Closed season from 15 February to 15 May was also imposed in 1984 covering an area of 26,400 km² in the Gulf of Thailand, which had been identified as spawning ground for important demersal and pelagic species. Such regulation prohibited fishing operations by all types and size of trawlers (with the exception of beam trawlers), all types of purse seines (except for anchovy purse seine operating in day time), and gill nets with mesh size less than 4.7 cm.

Vietnam

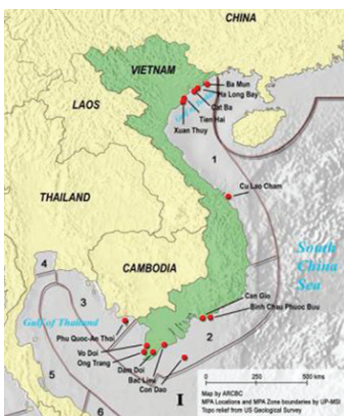
ARs were not widely used for habitat rehabilitation in Vietnam due to the high costs involved. A few studies were however, conducted by the Research Institute for Marine Fisheries in 2003-2004 in Ha Long Bay to rehabilitate the natural reefs and experiment on the proper methods to construct and deploy ARs in highly turbid areas. Nonetheless, the National Plan on Environment and Sustainable Development (NPESD) and the Biodiversity Action Plan (BAP) of Vietnam promote the establishment and management of marine protected areas (MPAs). Thus, the first MPA was established in 2000 in Central Vietnam funded by World Bank, IUCN and the Asian Development Bank (ADB).

After two years, the MPAs had demonstrated as means of recovering fish population. The MPAs then expanded

to other areas of the country with support from the Danish International Development Agency (DANIDA) in collaboration with the local government units and NGOs. The project “Support to the Marine Protected Area Network in Vietnam” started in 2003 consisting of two sub-projects in order to address priority needs at both national and provincial levels. The project at national level developed the existing network of MPA sites through capacity development as well as strengthened policy and legal frameworks. At the provincial level, one site was selected as second MPA site. Results of the assessment showed that the management system through the MPA enhanced local awareness of resource protection and management, reduced pressures on the ecological systems, and raised awareness and understanding of the local people of the link between natural resources management and improved local livelihood system.

Conclusion

Inadequate funding and absence of policies created many problems on ARs, fish sanctuaries, MPAs, marine reserves, and other enhancement and rehabilitation programs in the region. Most of the common issues were on weak law enforcement, inadequate coordination among government agencies, less manpower and technical knowledge, and lack of monitoring and evaluation. There was a general lack of understanding of the purposes of ARs, whether for fishing or enhancing the coastal resources. Personnel involved also lack technical experience and knowledge especially in marine engineering and oceanography, resulting in faulty installations and poor quality of the ARs. Very few AR sites had been studied and most countries lack good data on fish recruitment, survival of juveniles, engineering, physical performance, standing stocks, bio-fouling, and socio-economics. As for marine stock enhancement, such activities are generally costly while experiences in tropical countries like in Southeast Asia where fisheries are multi-species had been mostly unsuccessful. Thus, there is a need for techniques on stock enhancement applicable for tropical fisheries in this region. Successful resource enhancement activities (*e.g.* ARs, MPAs, stock enhancement) require decentralization of management functions and responsibilities as well as rights-based fisheries which should be in place and functioning with due consideration of the involvement and participation of communities and fishers. MPAs and ARs can be complementary tools for conservation, management and enhancement of fisheries resources. A combination of integrated programs using ARs, closed season, limited entry, habitat protection and restoration, fish sanctuaries, mangrove reforestation; and increased community awareness of the need to conserve the resources could be promoted for the purpose of resource enhancement.



Marine protected areas in Vietnam

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Optimizing Energy Use in Fisheries in Southeast Asia

Bundit Chokesanguan

In terms of geographical features, the total length of the coastlines of Southeast Asia is estimated to be about 112,699 km while the total EEZs is about 9,407,999 km². The continental shelf which is the stretch of sea beds adjacent to each country also known as territorial waters is 3,523,398 km². This scenario makes fishing an important activity especially in the coastal areas of Southeast Asia except Lao PDR being land-locked which is solely engaged in inland capture fisheries and aquaculture. In the region, fossil fuels are used not only for commercial fishing boats such as the super-trawlers, but also for powered small-scale boats especially those that operate beyond the countries' EEZs. This specifically means that fossil fuel inputs are now increasingly being used to harvest the fishery resources in order to increase fishery production. The increasing use of fossil fuels by fishing boats led to increased emission of CO₂ which is the carbon footprint of fishing boats. Since the boat's carbon footprint is directly proportional to the amount of fuel burned, it is therefore necessary to reduce the use of fossil fuel to minimize the fishing boat's carbon footprint and subsequently reduce the emission of CO₂ a major greenhouse gas (GHG) that contributes heavily to global warming.



hand, Lao PDR is the only country in the Southeast Asian region which is land-locked but is endowed with enormous internal water areas from the Mekong River which forms a large part of its western boundary with Thailand.

The seas of Southeast Asia form part of the South China Sea, constituting about 2.5% of the world's oceans, and bordered by Brunei Darussalam, Cambodia, China, Hong Kong, Indonesia, Malaysia, Philippines, Singapore, Taiwan, Thailand and Vietnam. The seawaters which surround the Southeast Asian countries include the Andaman Sea, Gulf of Thailand, Strait of Malacca, Indian Ocean (eastern part), South China Sea, Philippine Sea, Celebes Sea, Java Sea, Arafura Sea, Makassar Strait, and Timor Sea. On the other

The region's EEZ and internal waters (**Table 1**) offer great potentials for exploitation by the fisheries sector, which plays an important role in supplying protein to the populations, generating income and employment, and stimulating economic growth. In 2007, the total fishery production of the Southeast Asian countries was 25,211,212 mt valued at US\$ 23,938 million. The quantity exported by the countries was 7,369,862 mt valued at US\$ 14,395 million (**Table 2**).

Table 1. Geographical features of the Southeast Asian countries

Countries	Length of coastline ^a (km)	Exclusive Economic Zone (EEZ) ^b (km ²)	Continental shelf ^b (km ²)	EEZ + internal waters ^b (km ²)
Brunei Darussalam	161	10,090	8,509	15,855
Cambodia	443	62,515	62,515	243,550
Indonesia	81,000	6,159,032	2,039,381	8,019,392
Lao PDR	-	-	-	236,800
Malaysia	4,675	334,671	323,412	665,474
Myanmar	2,832	532,775	220,332	1,209,353
Philippines	17,460	1,590,780	272,921	1,890,780
Singapore	224	1,067	1,067	1,772
Thailand	2,614	299,397	230,063	812,517
Vietnam	3,260	417,663	365,198	748,875
TOTAL	112,669	9,407,990	3,523,398	13,844,368

Sources:

^a SEAFDEC Fishery Statistical Bulletin for the South China Sea Area: 2007

^b United Nations Law of the Sea (1982)

Creel (2003) established that about 50% of the world's population lived within 200 km from the coastline, a figure which could double by 2025. In 2007, the population of Southeast Asia was reported at 560 million (SEAFDEC, 2010) which means that about 280 million people are living in the region's coastal areas. From the point of view of sustainability, the concentration of peoples in coastal areas could put the ecosystem which provides the much needed economic benefits, at risk. The concentration of peoples in the region's coastal areas also led to the increasing number of fishers. Records have shown that there were more than 4,193,000 fishers in the region of which more than 3,052,000 were full-time; 805,000 were part-time mainly engaged in fisheries; while more than 336,000 were part-time partly engaged in fisheries (SEAFDEC, 2010).

Correspondingly, the number of fishing boats is also large as reported in SEAFDEC (2010). Specifically, the report indicated that in 2007, the Philippines reported the highest number of boats at 788,526, followed by Indonesia with 590,314 boats of which 241,889 were non-powered boats and 348,040 were powered comprising 185,509 out-board powered and 162,531 in-board powered boats less than 5 gross tons. In total, the number of fishing boats in Southeast Asia, both powered and non-powered could be about 1,500,000 (**Table 3**).

Contribution of Fisheries to Greenhouse Gas Emission

The fishing sector is an important but rapidly growing source of greenhouse gas emission and thus, should be

Table 2. Southeast Asian fisheries production and trade of fishery commodities: 2007

Countries	Total Fisheries Production		Export of Fishery Commodities		Imports of Fishery Commodities	
	Qty (mt)	Value ('000 US\$)	Qty (mt)	Value ('000 US\$)	Qty (mt)	Value ('000 US\$)
Brunei Darussalam	3,227	11,464	93	5	14,043	13,355
Cambodia	525,100	58,038	55,812	32,566	4,200	8,222
Indonesia	7,510,767	7,683,427	854,601	2,258,919	145,230	142,750
Lao PDR	143,847	296,962	-	-	-	-
Malaysia	1,654,221	1,855,326	286,404	752,393	453,197	633,667
Myanmar	2,808,037	1,862,403	343,874	549,120	2,428	466,159
Philippines	4,710,952	3,912,137	173,076	569,790	200,136	149,483
Singapore	8,026	23,319	^a 2,855,492	482,435	^b 2,763,427	862,554
Thailand	3,675,382	3,986,931	1,964,685	5,965,978	1,379,598	1,743,482
Vietnam	4,315,500	4,544,750	835,826	3,783,834	50,435	364,018
TOTAL	25,211,212	23,937,795	7,369,862	14,395,040	5,012,694	4,383,690

Source: SEAFDEC Fishery Statistical Bulletin for the South China Sea Area 2007

Notes:

^a More than 96% of the export quantity of Singapore comprised the ornamental or aquarium fishes

^b More than 91% of the import quantity of Singapore comprised the ornamental or aquarium fishes

- means no data available

Table 3. Number of fishing boats in the Southeast Asian region

Countries	Non-powered boats	Out-board powered boats	In-board powered boats	Total
Brunei Darussalam ¹	305	2,841	38	3,184
Indonesia	241,889	185,509	162,531	590,314
Malaysia	2,645	18,458	18,118	34,221
Myanmar ¹	15,219	14,289	1,863	31,371
Philippines	-	-	-	788,526
Singapore ¹	0	130	12	142
Thailand	-	-	-	13,056
Vietnam ¹	-	-	-	12,920
TOTAL	260,058	221,227	182,562	1,473,734

Sources:

SEAFDEC Fishery Statistical Bulletin for the South China Sea Area 2007

SEAFDEC Fishery Statistical Bulletin of Southeast Asia 2008

Notes:

¹ Data were reported for 2008, while the rest of the data were reported for 2007

- means no data available

made part of the international climate change mitigation framework. Some 2.5 million out of 4.3 million vessels used in fisheries are powered by fossil fuel burning engines that consume some 42-45 million tons of fuel per year. Considering the current volatility of fuel prices, this concern is very significant for the future viability of small-scale fisheries and related livelihoods. Together with labor, fuel is the most important cost in capture fisheries and a major constraint to the economic sustainability of fisheries.

This scenario is especially present in developing countries where access to and promotion of fuel reducing technologies are extremely limited. The link between energy use, costs and greenhouse gas (GHG) emission suggests that fisheries can make an important contribution to GHG reduction through the adoption of energy savings technologies and practices that reduce reliance on fossil fuel and eventually achieve improved national financial economy. It should be considered that fossil fuels are now widely used from the powered small-scale boats to the commercial fishing boats such as the super-trawlers. This specifically means that fossil fuel inputs are now increasingly being used by many countries in the region for intensifying fishing operations to attain increased fishery production. The increasing use of fossil fuels by fishing boats has led to the increased emission of CO₂ which is the carbon footprint of fishing boats per unit of output. The emission comes primarily from burning the fuel by the boat engine and also from other fishing activities such as towing and hauling the fishing gear, refrigeration of the catch and other related activities.

It has been established that the boat's carbon footprint is directly proportional to the amount of fuel burned, *i.e.* one gallon of gasoline (\approx 3.79 liters) could generate a carbon footprint of footprint of about 9.0 kg CO₂ (IPCC, 2009). It is therefore necessary to minimize the fishing boat's carbon footprint in order to reduce the emission of CO₂ which is a major greenhouse gas (GHG) that contributes heavily to global warming. Two ways to reduce the boat's

carbon footprint had been identified: reduce fossil fuel consumption, and offset boat's carbon footprint by reducing carbon footprint in other fishing activities onboard as well as onshore, which could include changing fishers' lifestyles onboard. Reducing the over-all boat's carbon footprint would therefore lead to reducing the impact of fisheries on the environment. Moreover, CO₂ emission could also be managed through good engine maintenance, responsible fishing operations, and proper handling of fuel through the practice of safe fueling procedures.

Therefore, reducing dependence on fossil fuels requires a combination of measures to be taken by fisheries stakeholders. This includes developing an appropriate baseline of energy use and energy practices, creating an appropriate policy framework for energy use, investing in research and development of Low Impact Fuel Efficient (LIFE) capture technologies, and promoting and raising awareness of proven, cost effective technologies available to the fishers.

Management Direction of Energy Use in Fisheries in Southeast Asia

Capture fisheries

Fishing activities using powered boats and with engines whether inboard or outboard had been conducted in the region's coastal waters as well as in the respective countries' EEZ and internal waters. Considering the big number of powered fishing boats in operation in the region's seawaters, it has become imperative to reduce fuel consumption in order to contribute to savings on operations costs as well as reducing the CO₂ being released to the environment. Reduction in fuel consumption of fishing boats engaged in capture fisheries can be managed through the improvement of fishing methods, control of the lights used in fishing or light intensity, as well as the reduction of fishing capacity or number of fishery vessels based on respective appropriate policies of the Southeast Asia countries. However, in order that such measures become effective in reducing energy use in fisheries, these should be accompanied with good engine maintenance including regular or annual maintenance to improve the performance of engines, and use of alternative energy source for example the use of sails for small fishing vessels, natural gas such as the liquefied petroleum gas (LPG) or compressed natural gas (CNG) or the liquefied natural gas (LNG) commonly used in natural gas vehicle (NGV) as alternative fuel for engines to reduce pollution and CO₂ released from vessel's engine, and smart design of fishing gears and fishing vessels to reduce resistance during fishing operations or reduce travel time from shore to fishing grounds.



Fish handling and post-harvest technology onboard fishing boats

The development of sustainable fisheries post-harvest technology is vital for advancing the production of fish and fishery products in the region in terms of safe and good quality standards, to help place ASEAN fish and fishery products in the world market, and eventually boost the flow of foreign currency into the region's economies, as well as increasing the availability of fish and fish products for human consumption.

Sustainable development in fisheries post-harvest technology can therefore, be achieved through minimizing the fuel consumption for refrigeration or that of the boat's auxiliary engine through good fish handling processes and preservation, and proper use of ice and chilled sea water which SEAFDEC has already promoted in the Southeast Asian countries. Furthermore, the traditional method for fish processing such as the use of solar energy should also be advanced to reduce the use of charcoal and fuel in processing.

Aquaculture

Intensive aquaculture, which is mostly done as national operation and well within national policy frameworks in the region, is also confronted with many constraints that impede its sustainable development. Widely fluctuating oil prices led to increased costs of inputs and other operating costs such as feeds and transportation, making it difficult for fish farmers to continue their operations. Although aquaculture production has increased, farm gate prices of aquaculture products continue to decrease. This situation results in less profits for fish farmers and the whole aquaculture operation is becoming more risky. In order to cope up with the situation, approaches following environment friendly aquaculture should be applied in extensive and semi-intensive aquaculture systems which should also be enhanced and applied more in intensive culture systems that consume a lot of energy. Specifically, research on suitable and cost-effective substitutes for fish meal by using low-cost agricultural products should be pursued and/or intensified. This will reduce pressure on capture fisheries and reduce carbon footprint not only from aquaculture operations but in capture fisheries as well.

Reducing the Use of Fossil Fuel in Fisheries

There are many ways of reducing the use of fossil fuel in fisheries and fishing operations. These could include changing the hull design, range of engine power and operation, and engine design, engine operation and maintenance, and modification of fishing gear and methods,

as shown in **Box 1**. Engines used in fishing boats are classified as heavy duty, and thus are meant to operate in loaded condition for long periods. Automatic engines are generally classified as light duty, and their fuel options such as the use of unmodified vegetable oils, may not be applicable for heavy duty engines. In marine context, engines reliability has significant implication for safety, therefore, fuel/engines strategy must carry less risks of failure.

Natural gas is an interesting option for a reduction of fuel cost and its use can reduce greenhouse gas emissions (CO₂) due to lower carbon to hydrogen ratio than diesel fuel. LPG is a generic name for hydrocarbons mainly propane and butane, and when these mixtures are lightly compressed and cooled they change from a gaseous state to liquid. This is an advantage for the utilization of LPG because the liquid fuel, having an acceptably similar volumetric energy-density to diesel can be comfortably stored at ambient temperature in conventional pressure vessels. Natural gas can be stored as liquid (LNG) or in compressed form (CNG), although such storage and associated refueling facilities are not widely available. The cost of converting low pressure natural

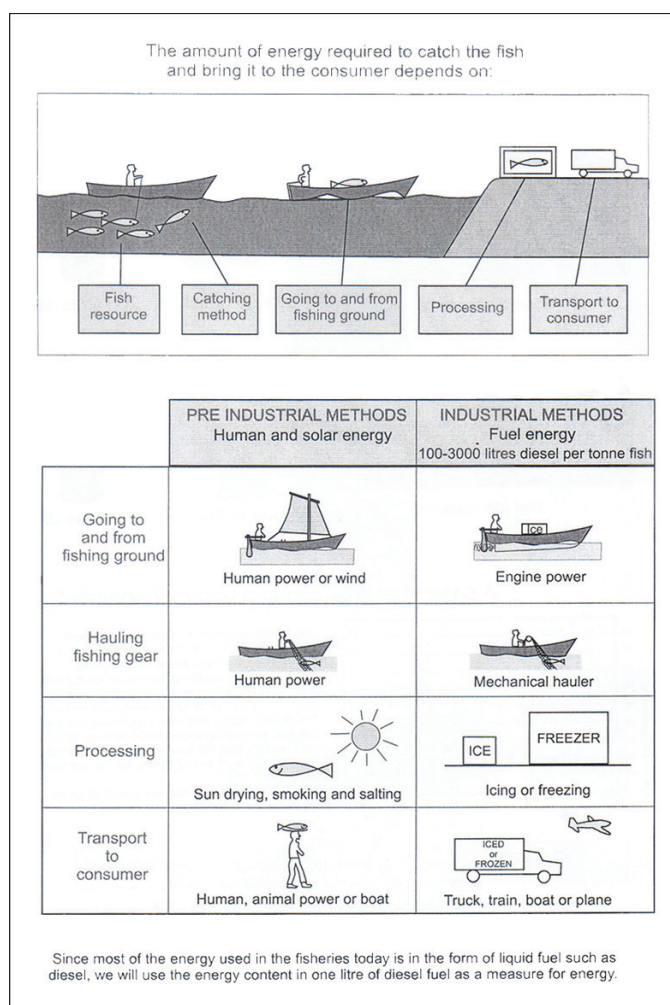


Fig. 1. Energy use in fisheries

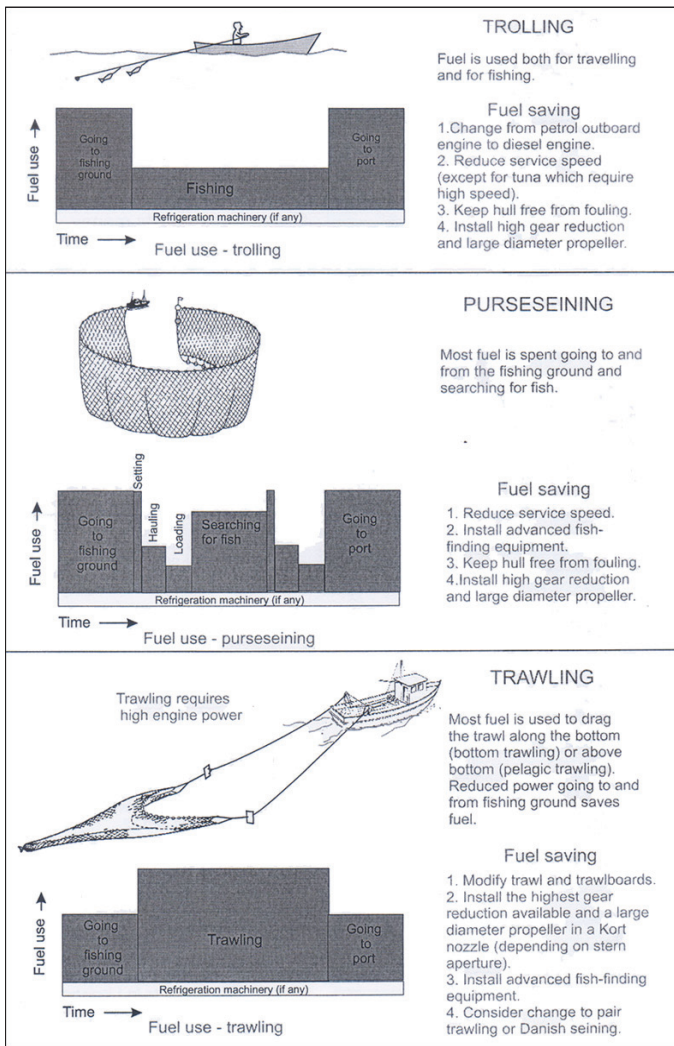


Fig. 2. Active Fishing Methods

gas to CNG and LNG is significant. Particularly, LNG and on-board storage tanks for fuels are far from straight forward, and for CNG storage at 200 bar is well-established technology which is already applied worldwide.

Hydrogen is a clean fuel that can be produced from fossil fuels, biomass or electricity, but the potential for reduced greenhouse gas emissions depends on the production method used. Production from fossil fuels could involve capture and sequestration of the fossil carbon, but the cost of production, storage and utilization on board are relatively high at present. Ethanol is an alcohol and an oxygenated organic carbon compound. It is the intoxicating component of alcoholic beverages and is also used as solvent (methylated spirits). Ethanol as a renewable fuel that produces less fossil CO₂ than conventional fuels and could easily blend with gasoline but not with diesel. Although alcohols can be used in diesel engines, the process would however require engine modification for extensive engine adaptation.

SEAFDEC Projects on Energy Use in Fisheries in Southeast Asia

SEAFDEC had implemented since 1998 the Project on Responsible Fishing Technologies and Practices (Fishing in harmony with nature) in collaboration with the SEAFDEC Member Countries. One of activities under this project is the promotion alternative sources of energy for fishing in coastal areas in Southeast Asia, which include experiments and trials on the use of sails for small fishing boats. In addition, a formula to determine the size of a sail with respect to the size of the boat was established.

In Thailand, results of the experiments indicated that the average speed of a boat must be about 15-20 km/hr. Experiments were also conducted in Myanmar in late 2008 after the Cyclone Nagris hit the country's Irrawaddy Delta. Evaluation and assessment of the experiences in these countries were conducted while promoting the use of wind energy was continued in the other Southeast Asian countries. Furthermore, the SEAFDEC Training Department also proposed to conduct a project on optimizing energy use in capture fisheries in Southeast

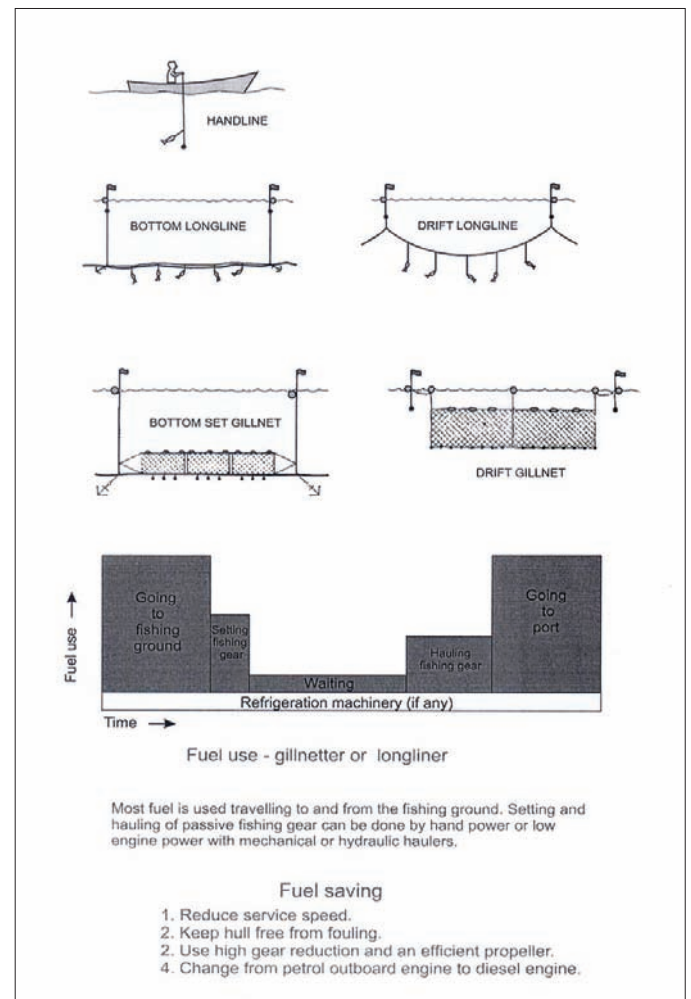


Fig. 3. Passive Fishing Methods Adapted from Gulbrandsen, 2010

Asia, which is aimed at reducing the use of fossil fuels and developing appropriate baseline energy use, creating appropriate policy framework for energy use to determine and estimate the amount of fuel consumption and CO₂ emission in fishing boats in Southeast Asia, and mitigating

fuel consumption and energy use in capture fisheries. The promotion of the appropriate energy saving technologies and low impact fuel efficiency fishing (LIFE Fishing) in Southeast Asia will be implemented together with raising awareness and building human capacity in the region

Box 1. Ways and means of reducing the use of fossil fuel in fisheries

Hull design

The reduction in engine power can be achieved by increasing the length of the waterline (LWL), making it possible to obtain a sharper bow and thereby reduce the resistance when other dimensions are kept the same. Although the weight of a boat itself is increased by the prolonged length, the overall effect on the hull resistance is beneficial. A limiting factor is the increased cost of the hull, which must be balanced against the fuel saving. Finally, the reduction of boat weight and utilization of sustain boat displacement should be considered.

Engine power and operation range

By engine power, means the way power delivery is measured, since for fishing boats only the rating power is continuously measured. An internal combustion engine does not operate at its peak throughout the whole range of rev/min of output. From a specific fuel consumption curve, the specific fuel consumption in the range 70 - 80 % of maximum rev/min shows that an engine burns fuel most efficiently.

Engine design

- Economical engine power and optimized fuel consumption**
 The accepted guidelines for trawlers on economical engine power to reduce fuel consumption for small fishing vessels, suggested that a vessel should not be equipped with engines larger than 5 Hp/ton displacement (continuous duty DIN 6270 “A”) and that it should be operated in service condition at about 3 Hp/ton actual output at maximum of about 80% revolutions/min.
- Power margin definition**
 Power margin is the excess capacity of a propulsion engine for sailing a boat at designed service speed. Therefore, it is necessary, but the question is how big such power margin should be. The recommended optimized margin requires about 1.6 to 1.7 of continuous rating power.
- Definition of engine size**
 Engine power used for fishing boats is defined as the ship’s displacement at service condition speed multiplied by economic service rate power per ton and margin power.
- Reduction gear and propeller**
 It is clear that a large reduction gear ratio can contribute to considerable fuel saving while the boat speed is kept constant. Higher thrust is available by adopting larger reduction ratios while fuel saving is in the inverse proportion to speed. In this case, higher reduction gear ratio means larger propeller diameter and increased draught. In shallow harbor entrances, this might be a limiting factor unless a certain type of limiting propeller is used. As a general rule, the maximum available reduction gear ratio should be chosen.

Engine operation and maintenance

When an engine is badly operated or not well maintained, the loss in efficiency will be as high as 30 to 40 %. Thus, it is necessary to operate the engine at properly maintained condition, such as maintaining the engine at ambient temperature through the use of cooling systems and ventilations. Cleaning operation of the engine must be carried out by replacing injectors/filters, strainers regularly, and performing engine periodical check maintenance and inspection of the transmission system. Most especially, lubrication oil must be changed at certain grades and at intervals recommended by the engine manufacturer. To avoid dirt and water contaminating the fuel, an extra fuel oil filter and a water separator should be installed between the daily fuel tank and the engine.

Modification of fishing gear and methods

The amount of fuel used to catch and land a ton of fish varies greatly with the type of fishing gear and methods as well as the fish resource including the distance to fishing grounds. The strength of the fish source (good fishing grounds) is of major importance in terms of fuel use. A poor resource or poor fishing ground means more fuel used per ton of fish landed.

Alternative fuel use

Alternative fuels to petro-diesel include bio-diesel, LPG, LNG, CNG, ethanol, and hydrogen. A right choice of fuel may reduce fuel costs and improve business liability, as well as reduce greenhouse gas emission. This issue could have a bearing on the net cost of converting an alternative fuel (Sterling and Goldsworthy, 2006).

Alternative energy use

Utilization of alternative energy relates to moving away from the use of chemical energy in the form of fuel and the conversion of the heat of combustion into mechanical work using a heat engine. Among the alternatives that have practical possibilities are wind, solar and wave energies. However, there are two issues related to harnessing such energy, namely: collection and conversion of the energy to more usable form and storing the energy until it is required in fishing operations. For all these forms of energy, it seems unlikely that either or all of them combined would be able to satisfy the total energy demand of a typical fishery operation at least in the foreseeable future. Nonetheless, utilization of both wind and solar energy in fishing could be easily conceptualized based on the already proven and well-known technologies, although the practicalities and performance of such systems on fishing boats would depend on the exact application of the correct or emerging technologies used. Nevertheless, the utilization of wave energy could not yet be easily conceptualized as of the moment.

(Suthipong *et al.*, 2010). As envisaged, the proposed project could contribute to the reduction of the use of fossil fuel in fisheries and fishing operations, and eventually reduce CO₂ and greenhouse gas emissions. Finally, the ultimate goal of reducing the cost of fishing would directly benefit the fishers.

ASEAN Plan of Action in Regional Energy Policy and Planning (APAREPP):2010 - 2015

Regional energy policy and planning are crucial to attaining shared goals of enhancing greater energy security and environmental sustainability in the context of open market competition and sustainable development in the ASEAN region. In the ASEAN countries, the issue on energy use in fisheries has become one of the most critical areas that would need government policy interventions. Overall, energy policies should critically address key areas of energy supply development, energy demand, oil operational reserves, transformation, transport and distribution sectors, and environmental protection. These areas need to be planned properly to evolve a dynamic and responsive energy policy to ensure a secure, affordable, reliable and competitive energy supply in the context of sustainable development in the ASEAN region.

As new energy landscapes and challenges arise, ASEAN views the need for ASEAN countries to move beyond independent energy policies and planning to an inter-dependent, inter-country and outward looking policies for greater economic integration and narrowing the development gap. Thus, ASEAN energy security policy and planning should ensure the consolidated and harmonized standards of policy and planning activities on energy security in the Member Countries. An end goal is to enhance the individual national energy policy and planning activities of the ASEAN countries for integration and mainstreaming into a cohesive and effective regional energy policy analysis and planning towards sustainable development (**Box 2**). The objective of the plan of action is to enhance cooperation on regional energy policy analysis and planning towards sustainable development and to effectively manage the implementation of APAREPP.

Box 2. Strategic goals of APAREPP

- To effectively manage the implementation, monitoring and evaluation of the progress of APAREPP programs;
- To develop tools and instruments for monitoring the APAREPP;
- To strengthen collaborative efforts towards regional energy policy and planning for sustainable development; and
- To strengthen capacity building by formulating sound regional energy policies and coordinated courses of action to meet the overall goal of the APAREPP.



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Deep-Sea Resource Explorations: Challenges of the Southeast Asian Countries

Natinee Sukramongkol

This article attempts to summarize the available information on “Deep Sea Explorations” in the Southeast Asian region and adjacent waters, and synthesize the reports from the SEAFDEC Member Countries during meetings, training sessions and workshops supported by the Japanese Trust Fund under the Project on “Development of Demersal Fishery Resources Living in Un-trawlable Fishing Grounds in the Southeast Asian Region: Deep-Sea Fisheries Exploration in Southeast Asia” which was implemented from 2007 until 2010.

The SEAFDEC Project on “Development of Demersal Fishery Resources Living in Un-trawlable Fishing Grounds in the Southeast Asian Region: Deep-Sea Fisheries Exploration in the Southeast Asia” covers the seawaters that surround the Southeast Asian countries, mainly the South China Sea, Andaman Sea, and Gulf of Thailand. The South China Sea is a marginal sea which is part of the Pacific Ocean, encompassing an area of around 3,500,000 km² from Singapore and Malacca Strait to the Strait of Taiwan. It is located south of mainland China and Taiwan, west of the Philippines, northwest of Sabah and Sarawak in East Malaysia and Brunei Darussalam, north of Indonesia, northeast of Peninsular Malaysia and Singapore, and east of Vietnam. The process of extension culminated in seafloor spreading around 30 million years ago resulted in the V-shaped basin at present. More than 200 islands and reefs had been identified in the South China Sea area, most of which are within the Spratly Islands. The largest singular feature in the Spratly Islands is a 100 km wide seamount called Reed Table mount also known as Reed Bank, in the northeastern part of the Islands which is separated from Palawan Island of the Philippines by the Palawan Trench (Tonnesson, 2005). The Reed Bank was an island until it sunk about 7000 years ago and completely submerged at a depth of 20 m. With an area of 8,866 km², it is one of the largest submerged atoll structures of the world (Tonnesson, 2005).

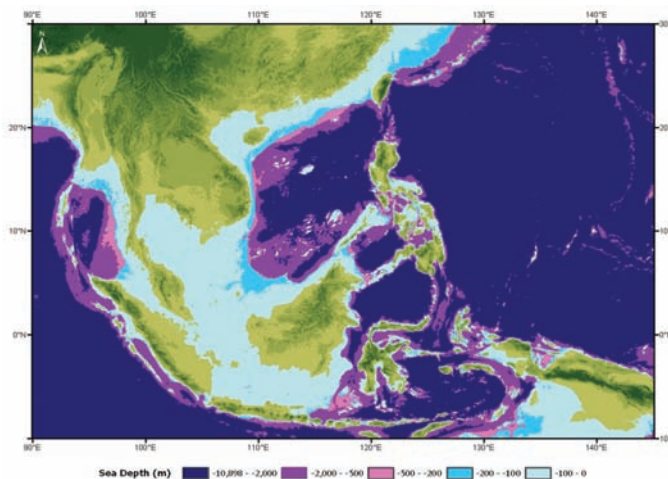
The Gulf of Thailand is bordered by Cambodia, Thailand, and Vietnam (south of the mouth of the Mekong River) up to Malaysian coast (city of Kota Baru), covering an area of roughly 320,000 km². The southwestern part of the sea from the Gulf of Thailand to the Java Sea is the great continental shelf called “Sunda Platform” occupying 50.2% of the whole area where the water is generally shallow at less than 61 m depth (Tang, 2001; Tonnesson, 2005). In the northern part of the sea, a deep basin or sea valley lying

off Palawan Islands which reaches 5,016 m and this zone also has an abyssal plain with a depth of about 4,300 m (Wyrcki, 1961).

With an area of 798,000 km², the Andaman Sea is a marginal sea of the northeastern Indian Ocean bounded to the north by the Irrawaddy River delta of Myanmar; to the east by peninsular Myanmar, Thailand, and Malaysia; to the south by Sumatra Island of Indonesia and by the Strait of Malacca; and to the west by the Andaman and Nicobar Islands which are part of the union territory of India. At the southwestern reaches, the Andaman Sea narrows to form the Strait of Malacca, which separates the Malay Peninsula from Sumatra Island. Andaman Sea is a part to the southeast of the Bay of Bengal, south of Myanmar, west of Thailand and east of the Indian Ocean. The coastline is roughly 1,200 kilometers long (north-south) and 650 kilometers wide (east-west). Its average depth is 870 meters and the maximum depth is 3,777 meters.

What is a “Deep Sea”?

“Deep sea” can be classified into four zones, namely: the **mesopelagic** as the uppermost zone which ranges from 200 to 1,000 m below sea level; the **bathypelagic** occupying the 1,000-4,000 m depth zone; the **abyssopelagic** from 4,000 to 6,000 m; and the **hadopelagic** as the zone with deep-ocean trenches (FAO, 2005). Various considerations had been made to define a deep sea, where some works used the depth-based zonation of the mesopelagic as the start of the deepwater habitat.



Deep sea areas in Southeast Asia (Laongmanee, 2009)
ETOPO1 Data, 1 minute resolution from: <http://www.ngdc.noaa.gov/mgg/bathymetry/relief.html>

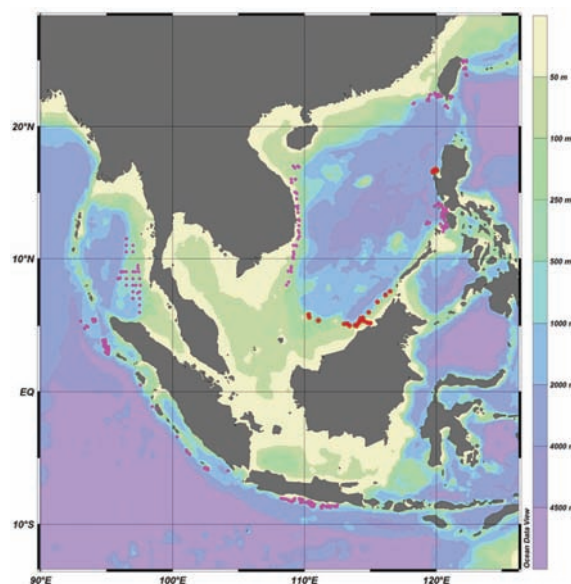
During the recent FAO Workshop on the Vulnerable Ecosystems and Destructive Fishing in Deep-Sea Fisheries (FAO, 2008), it was clarified that a “deep sea” is “the marine environment that extends downwards from the continental shelf break, i.e. waters deeper than 200 m to its maximum depth”. It was also emphasized during the 2008 Workshop that deep sea fisheries currently operate only at depths of less than about 2,000 m although the deep sea environment extends to the maximum depths of the ocean and future prospective exploitations could include the deeper waters.

Fishing Practices and Explorations in Deep Sea Areas of Southeast Asia

Although a great continental shelf occupies almost 50% of the South China Sea, the continental slope and the deep basin down to nearly 1,000 to 5,000 m are the largest habitat around the Philippines, Taiwan, Indonesia, and part of the Andaman Sea areas. Within the 100 m depth, the fishery resources have been intensively exploited by trawling and while the shallow-water fishes in the region have been well documented, the deep sea fauna have not yet been fully investigated (Yeh *et al.*, 2003). The known deep sea pelagic resources are those of tunas, billfishes, and sharks, which are already being utilized. However, little or no information are available on the resources in the Exclusive Economic Zone (EEZs) of the countries in Southeast Asia especially the demersal resources beyond 100 m on the continental shelf and slopes, which could be due to the fact that no surveys have been specifically directed at the deep sea demersal and mesopelagic resources in the region.

In the late 70s, an investigation of the deep sea fishery resources in the Asian region was conducted during the FAO assisted survey of the marine fishery resources of countries bordering the Indian Ocean using the Norwegian research vessel, the R.V. Fridtjof Nansen. The survey covered the waters of Indonesia, Malaysia, Myanmar, and Thailand (Nishida and Sivasubramaniam, 1986). In 1979-1980, the R.V. Fridtjof Nansen which was well equipped for acoustic and fishery resource surveys carried out 49 bottom trawl operations in Myanmar waters, 7 operations in the waters of Thailand, and 4 operations in Indonesian waters (Nishida and Sivasubramaniam, 1986). Results from the acoustic survey and experimental trawling operations of the R.V. Fridtjof Nansen indicated substantial resources of deep sea shrimps and lobsters in the unexploited zone that ranges from 200 to 350 m of the EEZs of Myanmar and Thailand (Nishida and Sivasubramaniam, 1986).

Early expeditions in the deep sea of the South China Sea were started in Philippine waters in 1843 (Ramiscal, 2009). At the beginning of the 20th century, the US



Demersal resources survey conducted on the continental shelf and slope (100-1,000 m) in the South China Sea and Andaman Sea from 1983 to 2010

Pink= survey by national research vessels;
Dark red=survey under the collaboration with SEAFDEC Member Countries

Bureau of Fisheries organized long series of deep sea sampling expeditions in the Pacific and Hawaiian Islands, Philippines and Indonesia using the vessel “Albatross”. The “Albatross” stayed in the Philippines from February 1908 to January 1910 and conducted dredging and trawling survey of about 292 stations at sea depths of more than 185 m (Ramiscal, 2009). From those Albatross expeditions, numerous taxonomic works were produced and many new crustacean species in Philippine waters had been described including a living fossil of the glypheoid, *Neoglyphea inopinata* (Ramiscal, 2009).

Another major series of deep sea explorations in Philippine waters was carried out by the French National Museum of Natural History (“MUSORSTOM”), using the R.V. Vauban and the R.V. Coriolis in 1976, 1981, and 1985 at the southwest waters off Luzon, Mindoro, and Marinduque, respectively. The survey was focused on the recapture of *Neoglyphea* (glypheoid lobsters) specimens.

Significant deep sea resource surveys in Philippine waters were conducted under the project “Census of Marine Life” (2005 to 2008) which focused on the taxonomy and morphology of deep sea benthic fauna (Ramiscal, 2009), considering that 88% of the Philippine territorial waters are deep water zones. The surveys covered the areas at Panglao Island (in 2004), Western Pacific off Luzon Island (in 2007), and off Lubang and Mindoro (in 2008) with sea depths that range from 100 to 2,250 m.

The explorations in many areas off Philippine waters since 2004 reported significant catches of the pandalid shrimps



Above: Deep-sea exploration at Lingayen Gulf of Philippines onboard the M.V. DA-BFAR in 2008; and Left: data recording during the survey

(*Heterocarpus woodmasoni*, *H. hayashii*, *H. dorsalis*) which were abundant at sea depths between 200 and 600 m. SEAFDEC/TD in collaboration with the Philippine Bureau of Fisheries and Aquatic Resources (BFAR) conducted deep sea fishery resources survey in 2008 on the continental shelf-slopes with depths ranging from 200 to 1000 m at Lingayen Gulf located on the northwest of Luzon in the Philippines (SEAFDEC, 2008). The catch composition of the deep sea demersal fishes caught using the beam-trawl in Lingayen Gulf comprised more than 50% belonging to the family Macrouridae, Colocongridae, and Sternoptychidae (SEAFDEC, 2008). The catch per unit area (CPUA) according to depth range indicated an interesting distribution of the potential deep sea fishery resources in Lingayen Gulf. An average CPUA for all crustaceans and fish caught from beam trawl was reported at 207 kg/km² with the highest at depth between 200 and 400 m at 348 kg/km² (SEAFDEC, 2008).

In the waters of Thailand, attempts were made to assess the state of the demersal resources in the Andaman Sea at sea depths between 16 and 85 m during the 5th Thai-Danish Expedition (FTDE) in 1966 using the national research vessel, the R.V. Thanarat (Seidenfaden *et al.*, 1968). The fishes collected during the FTDE included 80 species from 41 families and the specimens comprising 64 species were

deposited at Phuket Marine Biological Center (Hylleberg and Boonyanate, 1993). Three major surveys of the deep sea demersal resources in the Andaman Sea at the sea depths of more than 200 m were conducted in 1975, 1981, and 1987 (DOF Thailand, 1983; SEAFDEC, 1982; Nishida and Sivasubramaniam, 1986; Ananpongsuk, 1989). The survey covered the continental slope at depth from 200 m to 550 m off Marid coast (Myanmar), and off southwest of Phuket to Adang Island (Thailand).

In 1981, during the joint survey of Thai-Japanese-SEAFDEC using the R.V. NAGASAKI MARU, the predominant groups of deep sea shrimps and lobsters, cephalopods, Nemipteridae, Synodontidae, and Elasmobranchii were recorded at depths that range from 200 to 400 m around the continental slope off Myanmar and Thai waters (SEAFDEC, 1982; Nishida and Sivasubramaniam, 1986). At least 35 families of fish were identified after the deep sea trawl survey in the Andaman Sea of Thailand in 1981-1987 (DOF Thailand, 1983; Ananpongsuk, 1989; Nishida and Sivasubramaniam, 1986).

SEAFDEC (1982) and Ananpongsuk (1989) reported that the species found in waters with depths more than 200 m were the Nomeidae (*Cubiceps squamicep*), Polymixiidae (*Polymixia japonicus*; *Polymixia berndti*), and Macrouridae (*Coelorhynchus* sp.; *Hymetnocephalus* sp.; *Nezumia* sp.; *Malacocephalus laevis*). Moreover, decapod and cephalopod groups such as deep sea shrimps, spiny lobster, and crabs were also caught where the CPUE of deep sea shrimps was from 3.7 kg/hr and 14.1 kg/hr (Ananpongsuk, 1989). In 1987, a survey was conducted at sea depths between 400 and 421 m in the southwestern waters off Phuket Island using the M.V. Paknam. The maximum CPUE was 181.8 kg/hr of which the CPUE of useful species was 20.3 kg/hr, 11.5 kg/hr for crustaceans, and 150.0 kg/hr for trash fish (Ananpongsuk, 1989).

Recently, a comprehensive survey under the project “Biodiversity of the Andaman Sea Shelf (BIOSHSELF)” by the scientific collaborative program between Denmark and the Phuket Marine Biological Center (PMBC) of Thailand was conducted in 1996-2000 (Aungtonya *et al.*, 2000). The survey covered the areas from the border of Myanmar in the north to the Malaysian border in the south of the waters of Thailand using the R.V. Chakratong Tongyai (Aungtonya



Species of pandalid shrimps caught during the deep sea surveys in the Philippines (Ramiscal, 2009)



Spiny lobster caught during the survey in Thai waters (Siripitrakool, 2009)

et al., 2000). Deep sea fauna that included the polychaetes, crustaceans, mollusks, and fishes collected from the survey were used as inputs during the series of PMBC-DANIDA International Workshops at PMBC, Thailand in 1997-1998 (Bussarawit *et al.*, 2008).

Records showed that deep sea surveys had been conducted in Myanmar since 1968 (SEAFDEC, 2009). However, the most significant survey was conducted in 1979-1980 by FAO/UNDP using the R.V. Fridtjof Nansen. The survey reports indicated that the estimated biomass of demersal fishes in Myanmar waters was between 750,000 and 800,000 tons (Sætersda *et al.*, 1999). Off the waters of Myanmar, the average trawl catch rate was reported at 259 kg/hr at depths that range from 90 to 100 m (Sivasubramaniam, 1985). The fish species *Priacanthus macrocanthus* and *Peristedion weberi* were reported to be the most significant catch at the depths between 100 and 150 m, although *Nemipterus japonicus* was the most frequent species caught at greater depths (151-350 m).

Moreover, sea robins (*Peristedion weberi*) and deep sea lobsters (*Puerulus* sp.) were also noticeably significant (Rijavec and Htun, 1984). In 1985, the Department of Fisheries (DOF) of Myanmar collected data from 533 shrimp trawls and reported catch rates of about 31.2 kg/hr which confirmed the results from the Thai-Myanmar joint survey at 31.6 kg/hr (Htay Oo, 2009). Although there was no information on the deep sea fishery resources at depths more than 200 m based on trawl survey on the continental shelves and slopes off Myanmar waters, but the collaborative survey of the un-trawlable areas between Thailand and Myanmar in 1990 using the R.V. Chulabhorn reported that the commercial fish species at the continental slope areas comprised the yellow snapper at average catch rate of 1.7 kg/100 hooks and the banded grouper at average catch rate of 0.9 kg/100 hooks. In 2007, the M.V. SEAFDEC 2 conducted the bottom trawl survey on the continental shelf at the eastern central part off Myanmar waters up to 100 m depth and reported that the highest catch

was the lizard fish (*Saurida undosquamis*) which comprised about 20% of the total catch at 91 kg/hr (Han Win, 2010).

Deep sea trawl surveys in the waters of Indonesia were first initiated at the Indian Ocean south off Java in 1972 and 1975 with assistance from the Fisheries Research Agency of South Korea under a bilateral agreement (Sumiono, 2009). From 1979 to 1981, joint explorations of the fisheries and stock assessment of demersal fish resources were carried out under the collaborative Jetindofish Project among the Government of Indonesia, the Federal Republic of Germany, the Commonwealth of Australia, and the FAO/UNDP as coordinating agency, in the Indian Ocean subareas (Sumiono, 2009). The surveys were conducted at the south off Lombok Island to Eastern off Timor from sea depth of 50 m to 200 m (Lohmeyer, 1982).

Moreover, in 1980 the R.V. Fridtjof Nansen conducted bottom trawl surveys at the west coast of Sumatra under the agreement between the Government of Indonesia and the FAO/SCSDEVPRO, where the estimated standing stock of demersal fishes was reported at 65,000 tons although the survey was conducted with insufficient time and thus, more research would be needed (Aglen *et al.*, 1981). An extensive deep sea fishery resources survey in Indonesian waters was conducted in Banda Sea, Arafura Sea, and Timor Sea in 1992 and 1993 using the R.V. Baruna Jaya-I (Badrudin *et al.*, 2004; Badrudin *et al.*, 2005), at the continental shelf and slope with depths ranging from 200 m to 1,000 m (Sumiono and Iskandar, 1993; Soselisa *et al.*, 1993; Wudianto and Barus, 1993). Recently, a joint survey of the country's fishery resources was implemented between the Government of Indonesia and Overseas Fishery Cooperation Foundation (OFCF) of Japan, using the R.V. Baruna Jaya IV on the west coast of Sumatra and Java of Indonesia between 2004 and 2005. The results from the survey in 2004 provided general knowledge about the diversity and abundance of fauna indicating high diversity in the area (OFCF and AMFR, 2006). A total of 456 fish species, 52 crustacean species, and 42 cephalopod species were recorded from the results of 138 trawling operations in 2004-2005. The survey also revealed that the area serves as a habitat for the commercially useful species such as the red roughy *Haplostethus crassispinus*, black roughy *Haplostethus rubelloterus*, Alfonsino *Beryx splendens*, and blackthroat seaperch *Deoderlrieinia berycoides* (OFCF and AMFR, 2006).

The results of the surveys conducted in the various parts of west off Sumatra, south off Java, and south off Lombok Island to eastern off Timor, indicated that the fishery resources in the deep water areas of the Indian Ocean are still less exploited (Aglen *et al.*, 1981; Lohmeyer, 1982; OFCF and AMFR, 2006). However, the density of the

demersal stocks in the Indian Ocean was lower than those of Java Sea and the fish density had the tendency to increase towards the coast (Sumiono, 2009). High density of the deep sea shrimps was found at depth between 200 and 300 m (Lohmeyer, 1982). In the Arafura Sea and Timor Sea, the stock density of deep sea prawn seemed to fluctuate between 280 kg/km² and 1970 kg/km² at sea depths ranging from 400 m to 800 m (Sumiono and Iskandar, 1993). The catch rates of the caridean prawn (*Aristeus virilis*, *Heterocarpus woodmasoni*) and marine lobsters (*Metanephrops sibogae*) decreased from Arafura Sea to Timor Sea but giant red shrimp (*Aristeomorpha foliacea*) tends to increase (Sumiono and Iskandar, 1993).

The estimated stock density of the demersal fishes at sea depths ranging from 200 m to 1,000 m in Arafura Sea (sub area of Tanimbar) and Timor Sea were 475 kg/km² and 294 kg/km², respectively. The demersal fish stock in the sub-areas of Western Sumatra however, fluctuated between 829 kg/km² and 1,773 kg/km² at sea depths from 500 m to 1,000 m (Badrudin, 2006). The highest demersal fish stock density was observed at sea depths between 500 m and 750 m in the western part of Banda Aceh (Badrudin *et al.*, 2006).

The dominant demersal fish families found in the deep water areas of Indian Ocean and other parts of Indonesia were



Important shrimp species caught during the surveys in Indonesian waters: left - *Aristeus virilis* at 703 m deep and right - *Heterocarpus* spp. at 882 m deep (Sumiono, 2009)



Sorting of marine species caught during the deep sea survey of Indonesian waters (Sumiono, 2009)

Ophidiidae, Macrouridae, Myctophidae, Alepocephalidae, Plesiobatidae, Acropomatidae, and Trichiuridae. The major species in terms of number and highest relative abundance (CPUE) were *Lamprogrammus niger*, *Trichiurus lepturus*, the lantern fish *Diaphus* sp., the rat-tails macrouridae *Caelorinchus divergens*, the neoscopelids *Neoscopelus macrolepidotus*, the spinyfins *Dirtemoides pauciradiatus*, the alepocephalid *Bajacalifornia erimorensis*, and the trachichthyds *Haplostetus crassispinus* (Badrudin *et al.*, 2006; Sumiono, 2009).

Deep sea resource surveys in Vietnam were conducted under the two major projects, namely: Viet-Xo Joint Survey in 1978-1988, and the ALMRV I and II in 1996-1997 and 2000-2005, respectively (Nghia, 2009). The Viet-Xo joint surveys were conducted using the otter trawl in about 1,312 stations (at sea depths of more than 200 m) where the catch rates fluctuated from 30 kg/hr to 460 kg/hr (Nghia, 2009). The Assessment of the Living Marine Resources in Vietnam (ALMRV) surveys off Vietnam waters which were supported by DANIDA comprised the ALMRV Phase I using the otter trawl in the deep sea areas of 63 stations and the ALMRV Phase II using the otter trawl, trap, and bottom longline on the continental slope of 28 stations.

The first attempted marine resources survey in Malaysia using its national research vessels was in the EEZ of Malaysia in 1985-1987 using the R.V. Rastrelliger, and in 1996-1997 using the K.K. Manchong (Sallehudin, 2009). However, access to the deep sea resources at the area more than 30 nm offshore was made in 2004 to 2005 onboard the K.K. Manchong (Sallehudin, 2009). Considering the limited EEZ area of the coast of Peninsular Malaysia, trawl fishing in the deeper end of its EEZ had been limited at sea depth of about 185 m in the east and 100 m in the west coast of Peninsular Malaysia (FAO, 1999). The R.V. Fridtjof Nansen also visited the west coast of Peninsular Malaysia in 1980 and reported that the catch rate from trawling was about 395 kg/hr at 90 m depth (Sivasubramaniam, 1985). The survey in the Malaysian EEZ off Sarawak waters in 2004-2005 indicated that the average catch rates of demersal fish at depths between 92 m and 185 m were 44.8 kg/hr in 1987, 109.7 kg/hr in 1998, and 82.4 kg/hr (Sallehudin, 2009).

The dominant species were *Priacanthus macrocanthus*, *Saurida tumbil*, *S. longimanus*, *Decapterus kurroides* while the deep sea species found during the survey in 2004-2005 were *Lophiomus* spp. (ghost shark) and *Malakichthys elegans* (Sallehudin, 2009). At the un-trawlable areas in Sarawak waters, the catch by bottom vertical longline (BVL) comprised the Ariidae, Lutjanidae, Squalidae, Lethrinidae, Nemipteridae, Potunidae, and Muraenidae (Sallehudin, 2009).



Catch from the deep sea survey in Sabah and Sarawak waters onboard the M.V. SEAFDEC 2 in 2010. Photo by: Abdul Aziz Yusof

The relatively short history of the fishery research survey at offshore areas of Brunei Darussalam started in 2004. Information on the fishery resources at the continental shelves and slopes (sea depths between 100 and 400 m) off Brunei Darussalam waters were derived from the results of the collaborative survey between Brunei Darussalam and SEAFDEC using the M.V. SEAFDEC 2 starting in 2008. The survey indicated that the fish density along the continental slope ranged from 0.63 to 1.53 mt/km², ave: 1.2 mt/km² (Matzaini, 2009). The species composition from the demersal trawl on the continental shelf and upper slope (100-200 m) was dominated by the lizard fish (*Saurida tumbil*) and nemipterids (*Nemipterus* sp.). At the lower continental slope (200-400 m) the catch comprised the silver belly sea perch followed by lantern fishes and beard fish. Moreover, a significant amount of deep sea shrimps (*Heterocarpus* sp., *Plesionika* sp.) were caught by beam trawl at the sea depth between 215 and 374 m (Matzaini, 2009).



Deep sea resources survey onboard the M.V. SEAFDEC 2 in the waters of Brunei Darussalam in 2009.



Isopod caught during the deep sea survey in Malaysia (2010). Photo by: Abdul Aziz Yusof



Above: *Heterocarpus* sp. and Below: *Plesionika* sp. (Matzaini, 2009)

Deep Sea Fisheries Resource Explorations by SEAFDEC

SEAFDEC in close collaboration with the Member Countries has been supporting the investigations of the deep sea fishery resources in the Southeast Asian waters. Such assistance includes human resource development (HRD) activities in the form of training sessions, workshops, on-the-job training, to encourage the Member Countries to take initiatives in conducting deep sea resource explorations in their EEZs to investigate the status and potentials of the deep sea fishery resources.

From the point of view of the international concern on ecosystem approach for deep sea fisheries, collaboration and coordination with other relevant initiatives were also enhanced. The results of the surveys (**Table 1**) had been compiled in a form of the set of guidelines and standard operation procedures in the level of scientific surveys and operations while the initial set of collection fishes collected from the survey had been catalogued.

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Table 1. Explorations made by Member Countries with assistance from SEAFDEC

Activity	2007	2008	2009	2010
Supporting Deep Sea Fishery Resources Survey		<ul style="list-style-type: none"> Lingayen Gulf, Philippines (May) Brunei Darussalam waters (June) 	<ul style="list-style-type: none"> Brunei Darussalam waters (March) 	<ul style="list-style-type: none"> Brunei Darussalam waters (Sep-Oct) Malaysia, off Sabah and Sarawak (July-Aug)
Development/improvement of deep sea sampling gears and technology	<ul style="list-style-type: none"> Fishing trial of deep-sea beam trawl and Isac-Kid Mid-Water Trawl (IKMT) 	<ul style="list-style-type: none"> Beam trawl sampling gear development 	<ul style="list-style-type: none"> Workshop: SOP and development/improvement of sampling gears for the deep sea resource exploration (May) 	<ul style="list-style-type: none"> Agassiz trawl development
Human resources development (HRD)		<ul style="list-style-type: none"> Shipboard training: Survey methodology using deep sea beam trawl, bottom trawl, and deep-sea trap onboard M.V. DA-BFAR (May) 	<ul style="list-style-type: none"> Training workshop: Deep-sea fish identification (Jan.) 	<ul style="list-style-type: none"> Training Workshop: Research Methodologies for the Study on Impact of Fishing to Deep Sea Ecosystem (Oct)
Deep sea ecosystem and impact from fishery				<ul style="list-style-type: none"> Expert Meeting: Deep sea fishing and its impact to ecosystem deep sea resource exploration (Sep)
Information dissemination	<p>SOP Publications:</p> <ul style="list-style-type: none"> IKMT (TD/RES112) Deep-Sea Beam trawl (TD/RES113) Collapsible Fish Trap (TD/RES114) Check List of Deep Sea Fishes in the Southeast Asian Waters (TD/RES115) 	<ul style="list-style-type: none"> Preliminary report on the fishery resources exploration on the continental slopes in Lingayen Gulf, the Philippines (TD/RES127) Report of the training workshop on the deep sea fishery resources exploration on the continental slopes in Southeast Asian waters (TD/RP124) 	<ul style="list-style-type: none"> Set of posters of fishes and the initial set of collection and catalogue of fishes collected from the survey Report of the training workshop deep-sea fish identification (TD/RP/137) Report of the workshop on SOP and development/improvement of sampling gears for the deep sea resource exploration (TD/RP143) 	<ul style="list-style-type: none"> Report of the expert meeting deep sea fishing and its impact to ecosystem deep sea resource exploration (TD/RP/140) Report of the training workshop on research methodologies for the study on impact of fishing to deep sea ecosystem (TD/RP/141) Establishment of regional and national network to share information

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SEAFDEC Initiatives on Cetacean Sighting in the Waters of Southeast Asia

Sayan Promjinda, Somboon Siriraksophon, Worawit Wanchana, and Nawinee Khumthong

Many questions have always been raised on whether the waters of Southeast Asia really have large cetaceans such as whales in addition to dolphins that are often seen in the region's coastal areas. As it is widely recognized, most large cetaceans are highly migratory species and thus, are not often found on the continental shelves or coastal areas. Recently however, large cetaceans such as the blue whale, fake killer whale, Bryde's whale, and humpback whale calf, among others, have been frequently found stranded in the coastal areas in the region. The interaction of large cetaceans to the coastal habitats was therefore one of the questions raised during the various meetings of the SEAFDEC Council considering the present declining of cetacean stocks in the waters of Southeast Asia. In order to address such concern, SEAFDEC has continued to gather information on the distribution and composition of cetacean species in the region through a cetacean research program focusing on cetacean sighting in Southeast Asian waters.

Current Status of Cetaceans in Southeast Asia

The Convention on Migratory Species (CMS) has been assessing the standing commitments of the Southeast Asian countries for the conservation of marine mammals such as cetaceans and dugongs that have been exposed to a number of threats (Perrin *et al.*, 2002). The CMS as an intergovernmental treaty under the auspices of the United Nations Environment Programme (UNEP) which is concerned with the conservation of terrestrial, marine and avian migratory species. In the course of their assessment, the CMS had noted that by-catch and non-targeted catch by both legal and IUU fisheries had been the culprits for the dwindling populations of cetaceans and dugongs in Southeast Asian waters.

In an attempt to evaluate the efforts of the countries in the region towards conserving the cetaceans and dugongs, two important conferences had been conducted. The First International Conference on Marine Mammals of Southeast Asia was conducted in the Philippines in 1995 where recommendations were raised for the conduct of surveys to improve knowledge on the migratory behavior and distribution of marine mammals, and study on by-catch of cetaceans and dugongs in fisheries; development of marine mammal action plans; and raising awareness of various conservation threats on such mammals. The progress of the Southeast Asian countries on the implementation of such recommendations were reviewed during the Second International Conference on Marine Mammals of Southeast Asia also conducted in the Philippines in 2002, where the associated Workshop on the Biology and Conservation of Small Cetaceans and Dugongs of Southeast Asia discussed the various concerns and research needs of Southeast Asia, and the need to conduct stock assessment of cetaceans and dugongs in the region; study of the stock structure and abundance of the populations including their distribution; and investigation of the impact of by-catch on the cetaceans and dugongs.

SEAFDEC research on cetaceans in the waters of Southeast Asia

Recently, many large cetaceans have appeared close to coastal habitats in Southeast Asia presumably to feed, but very few works had been done on the interaction between

Although cetacean research activities are currently being carried out in the region, most of the research works are focused mainly on the conservation of cetaceans and are mostly conducted by environment agencies and NGOs working with the fisheries sector. Meanwhile, the fisheries sectors in many countries of Southeast Asia have developed their respective programs on dolphin conservation as well as on the assessment of the standing stock/population of dolphins in collaboration with the NGOs such as those conducted in the Philippines, Lao PDR, Myanmar, Malaysia, Thailand, Indonesia, Cambodia and Vietnam. However, only very few cetacean research studies are focused on the interaction of cetaceans with the fisheries resources and habitats.



Data collection of cetaceans onboard the M.V. SEAFDEC 2

the cetaceans and habitats as well as on the need to clarify the degree of impacts of large cetaceans to the coastal fishery resources. In addressing such concern and with support from the Fisheries Research Agency of Japan, SEAFDEC initiated in 2008 the “Cetacean Research in Southeast Asian Waters: Cetacean Sighting Program” which aims to make an inventory of cetacean species found in the Southeast Asian waters through sighting survey using the SEAFDEC research vessels and respective national research vessels of participating countries (**Fig. 1**); gather information on accidental deaths of cetaceans on the coastal areas of the region; enhance human resources capacity; investigate the interaction of migrating large cetaceans to the marine coastal ecosystems and habitats; and disseminate information on cetacean species distribution in relation to their habitats/coastal ecosystems in the Southeast Asian waters. The identification of cetaceans and dolphin species were recorded using single lens camera and binocular camera as shown in **Fig. 2**.

Although SEAFDEC has insufficient knowledge and skills on cetacean research, but with the technical assistance of cetacean experts from Japan and other national institutions, SEAFDEC was able to conduct cetacean sighting surveys in the region as well as enhanced the human resource capacity of the SEAFDEC Member Countries on cetacean research through various hands-on activities during shipboard training and workshops. **Box 1** shows the information on the cetacean sighting surveys conducted by SEAFDEC in collaboration with the Member Countries since 2008.

During such sighting surveys, the number of dolphins and whales found along the cruise path was estimated and recorded, to determine the existing density of dolphins and whale populations in the sea waters before future works would be made on the cetacean identification and estimation of the cetacean populations.

SEAFDEC also conducted actual sighting surveys using the research vessels of SEAFDEC Member Countries. When the Philippine Bureau of Fisheries and Aquatic Resources (BFAR) conducted a marine research survey in Philippine waters using its research vessel, the M.V. DA-BFAR on 16-26 August 2009, two SEAFDEC/TD



Fig. 1. Research vessels involved in the cetacean sighting surveys

scientists joined the survey onboard the research vessel. Such SEAFDEC initiative was meant to collaborate with the staff of BFAR for the cetacean sighting research survey; and to disseminate and exchange information on cetacean sighting methodology adopted by the BFAR scientists onboard the M.V. DA-BFAR.

The distribution of cetaceans and dolphins recorded during the cetacean sighting surveys conducted by SEAFDEC in the waters of Southeast Asia from 2008-2010 is shown in **Fig. 3**. While **Fig. 4** shows the species of cetaceans



Fig. 2. Equipments used for cetacean sighting surveys

and dolphins identified through the photographs taken by scientists during the cetacean sighting surveys in the waters of Southeast Asia.

Furthermore, for the analysis of the status of cetacean works in the region, the Regional Workshop on Information Gathering and Cetacean Research in the Southeast Asian Waters was conducted by SEAFDEC on 30-31 July 2009. The Workshop was aimed at providing a forum for the SEAFDEC Member Countries to share and exchange information related to their conservation efforts on cetaceans, and national issues related to cetacean research. Specifically, the Workshop aimed to: review and discuss the cetacean research programs in Southeast Asia; gather cetacean data/information as inputs for the check list on cetacean species existing in the Southeast Asia waters based on results of sighting surveys by the countries and SEAFDEC; identify the whale/dolphin watching spots existing in the Southeast Asian waters, share/exchange information on the stranding of large cetaceans in the coastal areas and seashores of the countries in the region; and discuss the interaction of large cetaceans to the coastal resources/habitats.

In order to develop the human resource capacities of the ASEAN countries on cetacean stock assessment methodology, SEAFDEC/TD with the collaboration of Department of Marine and Coastal Resources (DMCR) and the Ministry of Natural Resources and Environment of Thailand, and Fisheries Research Agency of Japan, the Regional Training Program on Cetacean Information Gathering and Research Methodology on Cetacean



Fig. 3. Distribution of cetaceans and dolphins in Southeast Asian waters (based on the results of the sighting surveys conducted by SEAFDEC)

Box 1. Data recorded from the sighting surveys conducted by SEAFDEC

Cruise No.	Destination	Survey Route	Lat/Long	No Observed	Species
28-1/2008 3 Mar-4 Apr	Andaman Sea Thailand	Gulf of Thailand- Singapore Strait- Malacca Strait- Andaman Sea	Lat 3.25-8.50 Long 096.22-103.77	213 12	Unidentified dolphins Unidentified whales
29-2/2008 4 Jun-5 Jul	Brunei Darussalam	Gulf of Thailand-South China Sea-Brunei waters	Lat 5.01-10.96 Long 102.08-114.43	56 60	Unidentified dolphins Long-beaked common dolphins
30-3/2008 24 Nov-25 Dec	Andaman Sea, Thailand	Gulf of Thailand- Singapore Strait- Malacca Strait- Andaman Sea	Lat 3.23-9.20 Long 095.71-100.73	17 2 4 40	Unidentified dolphins Indo-Pacific hump-backed dolphins Bottle nose dolphins Long-beaked common dolphins
32-2/2009 23 Apr-22 May	Sulawesi Sea, Indonesia	Gulf of Thailand-South China Sea-Sulu Sea- Celebes Sea-Sulawesi Sea	Lat 2.26-3.23 Long 125.50-125.80	36 15	Unidentified dolphins Short-finned pilot whales
DA-BFAR 16-26 Aug 2009	Philippine waters	Mindanao Sea-Camotes Sea-Visayan Sea- Sibuyan Sea-Manila Bay	Lat 9.74-12.60 Long 122.20-126.18	22 5 1 60 10	Unidentified dolphins Common bottle nose dolphins Sperm whale Spinner dolphins Melon head whales
FRV Chulabhorn 5 May-7 June 2010	Andaman Sea, Thailand	Andaman Sea	Lat 8.07-8.18 Long 095.47-095.50	30 4	Short-finned pilot whale False killer whale
35-3/2010 26 Jun-11 Aug	Sabah and Sarawak waters	Gulf of Thailand-South China Sea-Sabah- Sarawak Seas	Lat 3.49-7.18 Long 111.01-116.17	70 50	Common bottle nose dolphins Spinner dolphins
36-4/2010 15 Sep-25 Oct	Brunei Darussalam waters	Gulf of Thailand-South China Sea-Brunei waters	Lat 5.07-5.37 Long 113.50-114.19	4 5 10	Unidentified whales Unidentified dolphins Bottle nose dolphins

Stock Assessment was organized in November 2010 at Chachoengsao Province, Thailand. Representatives from the SEAFDEC Member Countries including staff from universities in Thailand and from SEAFDEC participated in the workshop, which specifically focused on cetacean stock assessment and abundance estimation techniques, *i.e.* photo identification and sighting data as well as on relevant topics, *e.g.* forensic identification for whales and dolphins, linkages between cetacean abundance and environmental features, among others. In addition, the proposed Regional Handbook on Estuarine/Riverine Cetacean Stock Assessment Methodology by Photo Identification is now being produced in collaboration with the DMCR for possible release before the end of 2011.

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Fig. 4. Cetacean species in Southeast Asian waters identified from photographs taken during the cetacean sighting surveys

Recognizing Gender Capability in Promoting Sustainable Fisheries Development and Poverty Alleviation in Fishery Communities

Sumitra Ruangsvakul

Gender is a concept that deals with the roles and relationships between women and men that are determined by social, political, cultural and economic contexts - not through biological aspects. Unequal power relationship between women and men in many cultures mean that women are disadvantaged in terms of their control over resources, access to services as well as in their ability to take advantage of new opportunities and in dealing with ongoing changes affecting their lives.

In the development of small-scale fisheries, policies have traditionally targeted women as mainly fish processors. As a matter of fact, in many cases women's groups in fishery communities typically receive inputs such as improved ovens and credit to enable them to pursue their fish processing functions. It is inherent in human nature that fisheries-related development activities target the men to be engaged in the exploitation and sometimes in managing the resources, whereas women have usually been excluded from planning and "mainstreaming" of fisheries activities. It is pathetic to note that until to date, the implications of women having unequal status to men for achieving positive and sustainable change have not been investigated in policy-making processes, although the repercussions on the social and economic outcomes of such policies should have been significant.

Fish and fisheries products are integral parts of the diet of many cultures and their production has been an important economic enterprise in the fishery communities especially in the Southeast Asian region. It is along this aspect that women have played active role in securing the supply of fish and fisheries products both from the small-scale and commercial fisheries sectors. Nevertheless, women have always been engaged in an assortment of livelihood activities that range from shallow water fishing in artisan fisheries to waged labor in the commercial fishery sector.

In such a wide range of activities, the "invisible" women become important contributors to both national and household food security while their incomes from waged labor are partly responsible for the foreign earnings of the countries (Needham, 2011). The Best Practices for Mainstreaming Gender into Small-scale Fisheries Policies had been developed and being promoted to serve as guide

for policy makers in the formulation of relevant policies (RFLP, 2010). The Best practices had been envisaged to ensure that gender issues are mainstreamed into the respective countries' policies for the development of sustainable fisheries especially in the Southeast Asian region.

Importance of Gender Issues in Small-scale Fisheries Development

Even though women may not be usually involved in active fishery operations except in inland and lagoon fisheries or aquaculture, they participate substantially in the pre- and post-harvest operations. The diverse array of women's roles in fisheries apart from their activities as housewives, mothers and homemakers that usually engaged them from dawn to dusk includes their tasks as fisherwomen, fish sellers, fish auctioneers' agents or merchants, as well as in repairing nets, drying and salting fish, and working as laborers for fish processing industries and in aquaculture facilities.

Therefore, in addition to the obvious concerns about fairness, equal opportunity and discrimination, there are good reasons why the role of women should be taken into account in the effective and efficient development of fisheries in Southeast Asia. These are as shown in **Box 1**.

Box 1. Relevance of gender issues in the effective and efficient development of fisheries in Southeast Asia

1. Women make significant contributions to fishery-related activities other than fishing. They play the major role in processing fish and fisheries products as well as in marketing. Although these roles are often very different than those of men, the women have been "invisibly" integral parts of the industry and ignoring these aspects in policy formulation means ignoring also a large portion of the productive labor force in fisheries.
2. The various works done by women generate different kinds of knowledge. For example, while men may know which grounds could be best for fishing operations, the women would know the price that certain fishes would fetch in the markets. Such sources of knowledge are often complementary, as indicated in the example which suggests the need to know where to catch the high-value fishes. Only with the knowledge of both women's and men's opinions and expertise can we understand the fishery sector better and manage its development appropriately.
3. The under-representation of women in decision making takes away a large portion of the available pool of expertise - from both the government and the community.

Gender Capacity in Promoting Sustainable Fisheries Development in Fishery Communities

The SEAFDEC Project on Integrated Coastal Resources Management (ICRM) conducted from 2005 to 2009 in Sihanoukville, Cambodia (ICRM-SV) in collaboration with Fisheries Administration (FiA) of Cambodia included one feature activity that aimed to encourage and extend locally-based fishery resources management to the communities in the project site (Ruangsivakul *et al.*, 2011). Based on the recommendations of the fishers in the project site, a fish *refugia* system for blood cockles was established considering that blood cockles are the most economically important and dominant commodity in Prey Nop II of Sihanoukville.

However, since the area's blood cockle resources had been under the threat due to destruction of the fisheries habitats from rampant illegal fishing by dredgers and also from over-exploitation, the establishment of the *refugia* system was a welcome development as the fishers recognized it as means of conserving the said resource. The establishment of the *refugia* system entailed a series of processes where the fishers were actively involved with. Firstly, the fishers identified the most appropriate species for the *refugia* system based on the criteria that they had agreed upon during a series of consultations. Secondly, the blood cockle fishers group (BCFG) was organized, where 90% of the members are women, and the third step involved the development of self regulatory measures for the *refugia*



area. The direct beneficiary group of the *refugia* system comprises those who are engaged in blood cockle fishing. As a result, the processes undertaken by the fishers during the establishment of the *refugia* system had enhanced the capability of the women leaders in the fishing communities in management aspects.

The processes also increased the awareness of women in fisheries especially on the significance of conserving the important habitat and resources in accordance with their established regulatory measures, and raised the working morale among the members in a harmonized way. Such factors led to the development of a very favorable social scenario in the project site as well as to the decreasing level of illegal fishing in the *refugia* area. Meanwhile, the project has envisaged that the blood cockle resource in the area would be increased year by year thereby improving the livelihood of the fishers in the community.

Gender Capacity in Promoting Poverty Alleviation Strategies in Fishery Communities

From the results of the case studies conducted through the various activities of SEAFDEC related to gender and fisheries development, one of the most significant impacts was the enhancement of the women's good sense and potentials to manage their business ventures and finances (Ruangsivakul *et al.*, 2011). Moreover and as a result, many women's groups have now recognized the need to improve their savings and credit systems in order to reduce dependence from middlemen during the marketing of fish and fisheries products, thus increasing their incomes. In this regard, women could be tapped for the sustainable economic development in fishery communities.

Microfinance services

Informal savings schemes and credit markets are widely developed in many countries and had positively contributed to providing and facilitating access to capital or assets. Being accessible for the users, such schemes have been conducted in more flexible manner and user-friendly in terms of the processes and procedures. Moreover, the schemes have been developed to be more adapted to the clients' microcredit needs. In small-scale fisheries in Southeast Asia, the fisherfolks have always been very poor and among the most marginalized members of the communities. However, their low social status is a result of poverty as well as exploitation by middlemen and unscrupulous merchants.

More often than not, middlemen have the tendency to control over credit and fish marketing systems, which drain away whatever surplus incomes that could be generated by

the fish workers. This situation often places the fishers at the mercy of the middlemen and makes the fishers forever indebted to them without any possible way out. Kato (2008) pointed out the many factors that should be considered for the sustainable development of small-scale fisheries in Southeast Asia. He aptly demonstrated such concerns in a vicious cycle (Fig. 1) where fishers have no way out from extreme poverty, and offered suggestions to address those concerns.

One approach that could provide the fishers a way out from extreme poverty would be through the introduction of micro-financing services. Globally, women constitute the majority of microfinance clients, primarily because of their excellent track records in terms of loans repayment and in sustaining micro-savings. It is a common knowledge that women play important roles in fishing communities that encompass social and economic responsibilities and duties within and outside their households. Women are particularly involved in the productive activities directly related to fisheries production, processing and marketing as well as in non-fisheries income-generating activities where capital would be needed.



Members of women's group in the ICRM-PL project value adding fishery products as alternative livelihood to improve their households' incomes

More importantly, women should be given the opportunities to improve their knowledge and skills not only in fish processing and products development but also in micro-financing. It should be considered that in many cases, the loan requirements of women for their business ventures in fisheries are small but they have the habit of frequently borrowing money to be used as capital. This situation makes women the most appropriate clients of any micro-financing schemes and services.

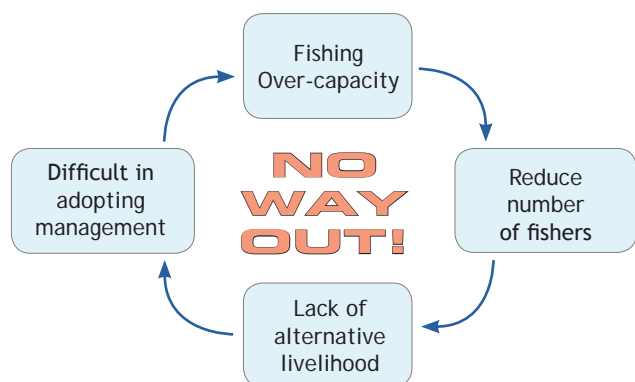


Fig 1. Vicious cycle which continues to trap small-scale fishers in extreme poverty (Kato, 2008)

Fish processing

The SEAFDEC Project on Integrated Coastal Resources Management (ICRM) in Pathew District, Chumphon Province (ICRM-PD) in Thailand, and Puala Langkawi (ICRM-PL) in Malaysia, included activities on the development of local business aimed at increasing the fishers' income and creating job opportunities that could compensate for the fishers' decreasing income from being dependent on the degraded fishery resources. The development of value-added fishery products was therefore considered as means of increasing the fishers' income and where the women played the major role. Considering that the women in the ICRM-PD and ICRM-PL projects had been active members of community-based savings and financing groups, therefore they can have easy access to some sources of micro-financing (SEAFDEC, 2007) for their business ventures.

Thus, the strategies towards alleviating poverty in fishery communities could focus on improving the skills and knowledge of the women's groups in fish processing, product development, and micro-financing. Moreover, the women should also be provided the opportunities to enhance their knowledge and skills to be able to contribute to the economic development of their respective communities. In the case of the ICRM-PD and ICRM-PL, the women's groups were officially organized to take advantage of appropriate human resource development (HRD) activities that enabled them to develop their production and management skills in cottage industries with special



Members of the BCFG monitoring the status of the blood cockle *refugia* under the ICRM-SV project

emphasis on the standardization and improvement of the quality of their products including packaging materials and design, and enhancement of their marketing promotions. For the sustainability of their business ventures and for the transparency of their business transactions, the groups were trained in good book-keeping and accounting systems. Thus, the women's groups were able to learn not only the new techniques of improving their traditional products but also gained knowledge in management, accounting, planning and marketing, and eventually succeeded in increasing their households' incomes.

Way Forward

The 2001 Resolution and Plan of Action adopted during the ASEAN-SEAFDEC Millennium Conference in November 2001 did not specifically stipulate the need to mainstream gender in the small-scale fisheries policies. Considering the varying roles that women play in the sustainable development of small-scale fisheries and the contribution of women to the economic development in fishery communities, there is no other opportune time than now to promote the mainstreaming of gender in the national policies on small-scale fisheries.

This is therefore a call to policy makers to consider this suggestion especially that the new decade Resolution and Plan of Action would be developed and adopted during the ASEAN-SEAFDEC Fish for the People 2020 Conference in June 2011. In this way, gender capacity in fisheries development could then be formally recognized and enhanced.

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Promoting Sustainable Aquaculture Development to Increase Fish Supply and Improve Livelihoods of Rural People in Southeast Asia

Joebert D. Toledo, Belen O. Acosta, Relicardo M. Coloso and Evelyn Grace de Jesus-Ayson

The most crucial challenges for the countries of Southeast Asia today are combating poverty and improving food security in the rural sector. The World Bank reported that the problem is most acute and widespread in Southeast Asia where over three quarters live in rural areas (Shah, 2011). To address this challenge, the governments in many countries in the region have identified aquaculture as one of the sectors that could help support their drive towards addressing food security agenda and combating poverty. Edwards (2000) outlined the potential contributions of aquaculture to the livelihoods of the rural poor (**Box 1**). In terms of human nutrition, the contribution of aquaculture is significant, with fish being one of the main sources of animal protein, vitamins, minerals and fatty acids. Southeast Asia relies heavily on fish for food and for protein (Hishamunda *et al.*, 2009). Fish and other aquatic products are seen as good sources of animal protein and other nutrients for vulnerable groups, particularly those in the coastal areas. Apart from the importance of aquaculture in nutrition, it is also seen as a major agent for economic growth, especially in generating employment, trade and export earnings.

Aquaculture, especially commercial aquaculture, can provide employment not only through fish farming activities

per se, but also through the employment opportunities generated in the aquaculture support industries or those induced by aquaculture (FAO, 2008). For instance in Vietnam, more than a half million people are employed in aquaculture. For the country's policy makers, aquaculture is a tool for rural diversification – providing jobs and alternative to urban migration (Hishamunda *et al.*, 2009).

Promotion of Sustainable Aquaculture in the ASEAN Region

Recognizing the immense benefits that could be obtained from aquaculture in terms of addressing food security and in meeting the country's developmental goals, the Southeast Asian Fisheries Development Center (SEAFDEC) and the Association of Southeast Asian Nations (ASEAN) have joined hands to address in a concerted manner the important issues that would affect the sustainable development of aquaculture for food security, especially in the rural communities. During the ASEAN-SEAFDEC Millennium Conference in 2001, the concerned Ministers from the ASEAN and SEAFDEC countries adopted the Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region (SEAFDEC, 2001). This Resolution and Plan of Action which included a component

Box 1. Potential contribution of aquaculture to the livelihoods of the poor

Direct benefits

- Food of high nutritional value, especially for vulnerable groups such as pregnant and lactating women, infants and pre-school children
- Own enterprise' employment, including those for women and children
- Income through sale of relatively high value fish products

Indirect benefits

- Increased availability of fish in local rural and urban markets, which could bring prices down
- Employment on larger farms, in seed supply networks, market chains and manufacture/repair functions
- Benefit from common pool resources, particularly the landless, through cage culture, culture of mollusks and seaweeds, and enhanced fisheries in communal water bodies
- Increased farm sustainability through: (i) construction of ponds which also serve as small-scale, on-farm reservoirs; and (ii) rice/fish culture as a component of integrated pest management

Source: Edwards, 2000

on aquaculture served as policy framework that steer the ASEAN countries towards sustainable development and enhanced the contribution of fisheries to food security in the region (Pongsri, 2009).

The 2001 Resolution on aquaculture (SEAFDEC, 2001; Ekmaharaj, 2008) stipulated the need to: "Increase aquaculture production in a sustainable and environment-friendly manner by ensuring a stable supply of quality seeds and feeds, effectively controlling disease, promoting good farm management and transferring appropriate technology"; and "Promote aquaculture for rural development, which is compatible with the rational use of land and water resources, to increase fish supplies and improve the livelihoods of rural people". On the other hand, the provisions in the 2001 Plan of Action in relation to aquaculture are shown in (Box 2).

Implementation of the 2001 Plan of Action by Member Countries: Aquaculture

To assess the implementation of the progress of the Resolution and Plan of Action adopted in 2001 in various aspects (themes) of aquaculture and consequently to assist the Member Countries in defining the next decade's strategies for sustainable aquaculture, SEAFDEC/AQD convened the three-day Regional Technical Consultation (RTC) for Sustainable Aquaculture Development of Southeast Asia Towards 2020 in March 2010 in Bangkok, Thailand (Acosta *et al.*, in press). During the RTC, the representatives from the SEAFDEC-ASEAN Member Countries reported on the status of implementation of the 2001 Plan of Action on the various aspects of aquaculture in their respective countries, which is summarized below.

Supply of good quality seeds. Most countries still have problems in supply of good quality seeds as seeds for stocking are either gathered from the wild or imported from neighboring countries (for example, in the case of Brunei Darussalam and Cambodia). In Malaysia, while mass production of fishes and shrimps is being done, the country is still very much dependent on the wild for the supply of seeds especially for mollusks and mud crab.

For freshwater species, genetic improvement programs have progressed in some of the countries particularly on tilapias (Indonesia, Malaysia, Philippines, Thailand, and Vietnam) and carps (Indonesia, Malaysia, Thailand and Vietnam). Depending on the status of their breeding programs, improved strains of these commodities are already available and are being disseminated to the farmers through their respective government and private sector hatcheries. Reports also indicated that while some of these countries have established their own breeding programs, majority of the countries especially at the farmers' level, lack the capacity to maintain the good quality broodstock and seeds. There are also issues which need to be addressed in terms of dissemination of good quality seeds (especially the improved strains) and in making these accessible to a wide range of farmers.

Environment-friendly aquaculture. There is now an increased awareness and realization among the ASEAN countries on the importance of implementing environment-friendly aquaculture practices. Majority of the countries have initiated actions that will minimize the negative impacts of aquaculture activities on the environment. Policy guidelines (*i.e.* through responsible aquaculture) and various laws are being formulated and enacted to protect the fisheries habitats/aquatic environment and avoid degradation. However, weak enforcement of regulations and other constraints (for instance, lack of funding, institutional capacities and public awareness) are very much evident in most of the countries in the region and these restrict the successful implementation of the guidelines and regulations.

Getting out of the fish meal trap. Almost all of the country representatives reported that fish meal and fish oils are widely used as dietary component in feed formulations particularly for intensive fish and shrimp farming. The country reports also indicated that most of the countries are still dependent on imported ingredients for the manufacture of commercial feeds for farming of aquatic species.

There is also an increasing recognition of the need to reduce dependence on fish meal and other fish-based products; hence, efforts in majority of the countries are underway in terms searching for alternative protein source

Box 2. 2001 Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region - Aquaculture

- Ensure that national policies and regulatory frameworks on aquaculture development are directed towards sustainability and avoidance of conflicts
- Ensure production of high quality seeds on a consistent and sustainable basis
- Promote good management practices that reduce effluent pollution load and comply with relevant effluent standards
- Reduce the risks of negative environmental impacts, loss of biodiversity and disease transfer
- Improve the efficient use of aquatic feeds by regulating the quality of manufactured and feed ingredients
- Improved capabilities in the diagnosis and control of fish diseases
- Formulate guidelines on the use of chemicals in aquaculture, establish quality standards, and take measures to reduce or eliminate the use of harmful chemicals
- Build human resource capabilities for environment-friendly, healthy, wholesome and sustainable aquaculture
- Promote aquaculture as an integrated rural development activity

Source: SEAFDEC, 2001

as feed ingredient. Most of the countries have also begun implementing policies that will regulate the quality and use of manufactured feeds and feed ingredients.

Healthy and wholesome aquaculture. Efforts are being made by most of the countries to promote healthy and wholesome aquaculture. In Cambodia, although disease outbreak in aquaculture has never occurred and is not yet a problem of fish farmers, the Government has begun preparing guidelines and creating standards to promote environment-friendly aquaculture. In most of the countries, the strategies that are being implemented include: building the capacity of national staff on fish health and management; intensive information and communication campaign for good aquaculture practices (GAqP) for different species and aquaculture systems; implementation of HACCP at the farm level and other food safety programs; full traceability system for aquaculture production; registration and accreditation of hatcheries and farms; and establishment of early warning systems for diseases.

Biotechnology for aquaculture. Except in a few countries with more developed aquaculture, limited biotechnology R&D is being undertaken in most of the Member Countries due to lack of capacity (human and infrastructure). In Cambodia, Myanmar and Lao PDR, biotechnology application is mainly on the use of hormones in fish breeding. In Brunei, apart from hormone treatment of tilapia, the aquaculture industry undertakes research on propagation of Specific Pathogen-free (SPF) shrimp and later, on fish.

In countries with more developed aquaculture (*i.e.* Indonesia, Malaysia, Philippines, Thailand, and Vietnam),

biotechnological innovations include development of genetically superior strains of fishes, development of feed that provide balanced and nutritious diets, vaccines and immune-stimulants to improve diseases resistance, and molecular tools for fast and accurate disease diagnosis. Efforts are also being made on genetic marker development and research on probiotics for diseases prevention and control in aquaculture. Among the Member Countries, Thailand has achieved much progress in biotechnology research. The gap however, lies in enhancing education to develop new and more advanced biotechnology techniques to improve production, reduce costs and bring product quality to international standards. Moreover, further efforts should be made to bring the benefits of biotechnology research to aquaculturists and to a wide range of farmers.

Aquaculture for rural development. Promotion of aquaculture activities for rural development is an important priority of the Member Countries. In majority of the countries, cultivation of freshwater fish is mostly done, which includes small-scale backyard farming especially in rural communities. In some of these countries (for instance in Cambodia), local and international NGOs have been collaborating closely with the governments to develop rural aquaculture, especially in poor communities.

In rural communities where culture-based fisheries are being practiced (for instance, in Thailand), strong coordination/cooperation arrangements are still needed to effectively address the concerns of many farmers, particularly the marginalized groups. Moreover, the Government's strong support to rural aquaculture through development projects and extension programs is strongly needed to ensure that the rural people will also benefit from the technologies developed through aquaculture R&D.

Summary. Country reports indicated that while progress has been made in the ASEAN countries in terms of implementing the 2001 Resolution and Plan of Action on Aquaculture, there were constraints and issues which still need to be addressed (**Box 3**).



Fisherfolks learning to prepare marinated deboned fish (Guimaras, Philippines)

Box 3. Issues and constraints in the sustainable development of aquaculture in the region

Supply of good quality seeds

- Inadequate and unreliable supply of good quality seeds for stocking
- Seasonality and inconsistency of seed production
- Reliance on the wild and neighboring countries for source of seedstock; imported stocks are sometimes found weak and of poor quality
- Inconsistent supply of disease-free fingerlings; quality and health of fish seed need to be addressed
- Government fishery stations are bound to meeting seed production quotas; prioritization of quantity could compromise quality of seed
- Limited capacity and knowledge of farmers on broodstock management
- Breeding programs in some Member Countries are progressing; however, there is lack of mechanism and funding support for long-term maintenance of genetically improved strains

Environment-friendly aquaculture

- Increasing incidence of water pollution due to improper use of artificial feed
- Negative environmental impacts associated with intensification of aquaculture
- Poor implementation of policies, regulations (e.g. zoning, limits in number and size of farms) that will promote environment-friendly aquaculture at the local/community level

Getting out of fish meal trap

- Aquaculture sector relies heavily on imported commercial feed ingredients (fish oil, fish meal)
- By-catch from fishing vessels are continuously utilized for local consumption and fish meal; the practice contributes to stock depletion of fishery resources
- Mud crab and marine fish farming are heavily dependent on trash fish
- Lack of knowledge on effective feeding management (including feed formulations)

Biotechnology for aquaculture

- Lack of knowledge and capacity on biotechnology techniques
- Lack of funding support
- There is a need to enhance education and capacity building programs on advanced biotechnology techniques

Healthy and wholesome aquaculture

- Several farmers still import fingerlings for stocking; hence, increasing the chance of transfer of pathogens
- Reliance on prophylactic drugs; residues of chemicals in aquatic products pose food safety and health risks
- There is a need to establish and strictly implement standards, and guidelines to control the use of chemicals in aquaculture
- Incidence of diseases was reported in some countries due to intensification of farming and improper use of feeds (e.g. WSSV disease outbreaks reported in commercial shrimp farms)
- Lack of staff with expertise on aquatic animal health

Aquaculture for rural development

- Aquaculture development in rural areas remain at very low level
- Development programs on aquaculture in poor communities are affected by social problems (e.g. poaching)

Socio-economics

- Cost of production increasing due to widespread use of commercial feeds
- Investments in mariculture high and not affordable to several farmers
- Lack of training and extension programs for mariculture; lack of extension workers
- Difficulty of most farmers to meet the stringent requirements and standards for export of aquaculture products
- Weak institutional partnerships and linkages among government agencies, civil society and the private sector
- Poor link of small-holder farmers (small-scale producers) to the market chain

Initiatives of AQD

SEAFDEC/AQD has been at the forefront of promoting and harnessing the potential of aquaculture in the region to help address the looming scarcity in fish supply and alleviate poverty. AQD supports the member countries through its primary role in development of aquaculture technologies that are environment-friendly and are suitable to the needs of the region. To ensure that AQD addresses the areas of concern of responsible aquaculture development (i.e. technology feasibility, food safety, socio-economic viability, and environmental integrity), the Department has used the Resolution and Plan of Action on aquaculture as the overall framework for implementation of its programs (SEAFDEC/AQD, 2009). As such, AQD's R&D activities in the region have always been guided by the priorities, which focus on the: (1) Development of responsible

aquaculture technologies and practices; (2) Responsible use of aquatic genetic resources for the purpose of aquaculture; (3) Adoption of measures to avoid environmental degradation; and (4) Promotion of environmentally sound culture methods and commodities.

AQD supports the implementation of the Resolution and Plan of Action through research and development in the priority areas of broodstock development and seed production, farming systems and ecology, nutrition and feed development, fish health management, and socio-economics. Through these efforts, AQD has generated and transferred a number of aquaculture technologies as shown in **Box 4**.

To disseminate the above-mentioned aquaculture technologies developed by AQD, 391 international and

Box 4. Aquaculture technologies generated and transferred to the region

- Multi-species marine fish hatchery (to raise milkfish, sea bass, grouper, snapper and rabbitfish)
- Milkfish grow-out culture in modular ponds, pens, and cages
- Grow-out farming of marine fish
- Mud crab hatchery, nursery and grow-out in brackishwater ponds and mangrove pens
- Abalone hatchery, nursery, and grow-out in cages
- Environment-friendly shrimp farming in brackishwater ponds
- Tilapia and bighead carp hatchery and grow-out in ponds and/or cages
- Seaweed farming
- Feed formulations for several farmed aquatic species

local training courses had been conducted and 12,500 participants from various stakeholder groups from 50 countries had been trained. In terms of publications, from 2005 to 2010, AQD already published 161 scientific papers, 99 of which are in internationally peer reviewed scientific journals (ISI-CC covered journals). Through such research publications and achievements in developing a critical mass of experts, AQD has been widely recognized for its important contributions in the sustainable development of aquaculture in the Southeast Asian region.

Strategies for Sustainable Aquaculture Development in the Next Decade

Aquaculture has shown rapid growth and has continued contributing to national economic development. In Southeast Asia, Hishamunda *et al.* (2009) reported that from 2000 to 2006, the annual average growth rates in total aquaculture output (including aquatic plants) more than doubled those from 1990 to 2000. However, despite its good prospects, the aquaculture sector in the ASEAN countries is still facing new challenges as it moves towards the goal of sustainability.

During the March 2010 RTC on Aquaculture, the participants discussed the key issues on aquaculture in the next decade and formulated strategies on how to address such issues. The list of issues and recommendations focused on: (i) Meeting Social and Economic Challenges of Southeast Asian Aquaculture (**Box 5**); (ii) Quality Seed Production for Sustainable Aquaculture (**Box 6**); (iii) Healthy and Wholesome Aquaculture (**Box 7**); and (iv) Protecting the Environment and Adapting to Climate Change (Acosta *et al.*, 2010).

Success in sustainable production in aquaculture is largely dependent on the availability of good quality seed stock and optimal husbandry techniques. Quality of seeds is influenced by the broodstock, particularly its source, genetic quality and nutrition; methods used in maintenance of broodstock, and hatchery and nursery culture; and modes of harvesting, marketing and distribution.

Moreover, significant progress has been achieved in improving the quality of seed stocks, particularly on the tropical finfish, through breeding and genetics. However, issues related to sustaining the genetic gains from breeding research, maintenance and availability of and accessibility to quality seed still constrain the growth of the aquaculture industry.

The frequent occurrences of infectious diseases in aquatic animals and irresponsible culture practices have threatened the sustainability of aquaculture. There is certainty that in

Box 5. Meeting social and economic challenges of aquaculture in Southeast Asia

ISSUES

- Commercial aquaculture has grown fast leaving behind many small-scale/small-holder aquaculture operations in Southeast Asia
- Inequitable distribution of opportunities and benefits especially for aquaculture farmers in rural areas
- Misuse of aquatic resources for aquaculture purposes
- Mechanisms and infrastructures that will encourage adoption of better aquaculture practices by farmers at all levels are still lacking

RECOMMENDATIONS

- Enhance the role of aquaculture (contributions and impacts) in addressing national/regional development issues
- Promote sustainable aquaculture through enabling policies, mechanisms, institutions and infrastructure that encourage the adoption of better aquaculture practices
- Address emerging issues on the impacts of climate change and global trade on aquaculture with emphasis on small-holder fish farmers
- Enhance multi-agency collaboration between and among stakeholder groups
 - Improve linkages and strengthen the capacity of various stakeholder groups

Box 6. Supply of good quality seed for sustainable aquaculture

ISSUES

- Inadequate seed supply and poor quality of broodstock and hatchery bred seeds
- Possible negative impacts on biodiversity and reduction of genetic quality in improved stocks
- Lack of proper husbandry techniques at larval and broodstock phases to produce good quality seeds
- Lack of policy, guidelines on genetic management schemes
- Risks associated with translocation of stocks
- Climate change effects on farming systems and operations

RECOMMENDATIONS

- Build and/or further strengthen public-private sector partnerships
- Governments need to establish, strengthen and maintain links with major players in seed production and distribution chains
- Small-scale farmers to seek assistance from the Government to (i) build capacity in adopting new simple technologies and innovations, (ii) gain access to quality broodstocks and seeds, (iii) establish effective marketing channels
- Scientists to continue doing research on existing genetic resources and improvement
- Key players must establish links to collectively address genetic issues, support sound policies and promote implementation of better farm management practices

Box 7. Healthy and Wholesome Aquaculture

ISSUES

Nutrition to promote healthy farmed aquatic animals

- Need for more effective feeding management
- Fish meal substitutes not adequately studied

Disease diagnosis, control, monitoring and surveillance for aquatic animals

- Diagnostic procedures favouring the intensive and large-scale operators
- Investigations lacking to prove efficacy of probiotics
- Promotion and wider application of biosecurity needed
- Transboundary diseases

Environmental integrity and food safety

- Over-development of aquaculture that exceeds the carrying capacity of the environment
- Contamination of fish meat with domestic wastes
- Emergence of zoonotic disease agents and spread of disease to wild populations

RECOMMENDATIONS

Nutrition to promote healthy farmed aquatic animals

- Fast-track the search for suitable alternative fish feed ingredients
- Good and thorough evaluation of fish meal substitutes in artificial feed
- Assess viability of alternative protein sources
- Social and cultural acceptance of consumers to be considered in search of alternative feeds
- Promote the culture of species that require no or low fish meal diet
- Develop and apply good feeding practices

Disease diagnosis, control, monitoring and surveillance of aquatic animals

- Widespread use of standardized diagnostic tests
- Heighten the understanding of diseases in rural communities through training and provision of simple manuals
- Encourage the use of levels 1 and 2 diagnostic techniques in small-holder and rural communities
- Governments to provide support to facilitate the use of affordable, field friendly method of detection and screening of diseases
- Continue support for training of fish health specialists to develop capability for fish disease diagnostic techniques
- Conduct large-scale field trials or evaluation surveys to scientifically assess the efficacy of probiotics and immunostimulants
- Apply widely the concept of biosecurity (through Good Aquaculture Practices; compliance to Code of Conduct)
- Develop domesticated and genetically improved SPF stocks for all cultivated species
- Government to engage in high health broodstock development to facilitate access to small-scale hatchery operators
- Enhance collaboration among agencies to control serious disease outbreaks
- Member Countries to support coordinated regional initiatives to handle new and emerging diseases
- Extend surveillance of diseases to wild population of aquatic animals

Environmental integrity, certification and food safety

- Create and enforce regulations to avoid conflict in use of common resources
- Member Countries to support and participate in initiatives to set up coordinated Asian regional standards, certification
- Develop and promote environment-friendly aquaculture systems
- Meet food safety requirements and ensure that aquaculture products do not contain biological/chemical hazards

the next decade, practices that threaten food safety and create negative impacts on the ecosystem (for instance, the indiscriminate use of antibiotics, chemicals, and abuse in the use of fish meal and fish oil in commercially available artificial feeds) will continue. To assist the Member Countries in addressing the problem, SEAFDEC has been promoting the concept of a 'healthy and wholesome aquaculture'. The concept, which was adopted as part of the 2001 Resolution, is a holistic approach to fish disease management for food safety and security (Lavilla-Pitogo *et al.*, in press). It also promotes the use of efficient feeds (cost effective and low polluting) to optimize production of robust and healthy farmed aquatic animals with the least negative impact on the environment.

Box 8. Adapting to Climate Change

ISSUES

- Aquaculture contributes less to climate change; finding ways to mitigate greenhouse gas emissions from aquaculture still needed
- Adverse changes in physico-chemical parameters in fresh and seawater due to climate change (water acidification, warming of water temperature, rise in seawater levels and drought)
- Research needs/strategies that will help aquaculture sector adapt better to climate change is another big challenge in the region

RECOMMENDATIONS

Mitigating emissions of greenhouse gases from aquaculture

- Review energy consumption in aquaculture and greenhouse gas emissions associated with direct energy inputs
- Define strategies for mitigating gas emissions from aquaculture

Adaptation techniques

- Conduct mapping of aquaculture sites that are vulnerable to climate change
- Identify aquaculture species, strains, farming systems, techniques that will adapt better to climate change
- Assess and improve infrastructures/habitat to ensure safety of coastal farming/fishing communities
- Enhance awareness on the importance of aquaculture/fisheries in climate change initiatives
- Increase resilience and overall capacity of various stakeholder groups on aquaculture to enable them to adapt to climate change. Capacity building and knowledge transfer are strategies that could strengthen the stakeholders
- Improve cooperation within the aquaculture sector and with other sectors

Box 9. Protecting the environment

ISSUES

- Excessive use of antibiotics and chemicals
- Abuse in feeds and fertilizers

RECOMMENDATIONS

- Implement stricter monitoring and control to avoid excessive use of antibiotics and other chemicals in aquaculture
- Improve feeding and fertilization management and efficiency and develop effective substitutes for fish derived feed ingredients
- Improve the management of aquaculture sector and strictly enforce regulations to ensure activities are carried out in an environment-friendly manner

Protecting the Environment and Adapting to Climate Change

Much of the current controversy is centered on the continued destruction of the aquatic environment and resources due to irresponsible aquaculture practices. SEAFDEC and its Member Countries are strong supporters of the FAO Code of Conduct of Responsible Fisheries (CCRF) and have committed to responsible aquaculture. However, despite the progress on SEAFDEC initiatives that promote the CCRF, and as pressures increase on the natural resources of the region, the ASEAN aquaculture sector is still confronted with issues related to environmental protection and wise and efficient use of resources. Increasing the efficiency in aquatic resource use and minimizing adverse environmental interactions and impacts due also to climate change (**Box 8** and **Box 9**) will continue to be the priorities for the next decade.

Conclusion

The issues and recommendations of the 2010 RTC on Aquaculture shall be presented at the ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security in June 2011 to refine and finalize the resolution and plans of action on aquaculture towards 2020. These strategies are expected to make aquaculture in the region sustainable for future generations, improve the economies of the ASEAN countries, and uplift the lives of rural folk in the region.

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Ensuring Quality and Safety of Fish and Fisheries Products through Improved Post-harvest Technologies and Safety Management Systems

Yeap Soon Eong and Melvin Chow Wing Chung

Improving post-harvest technologies and safety management systems has been the focus of the activities of SEAFDEC Marine Fisheries Research Department (MFRD) to ensure quality and safety of fish and fisheries products for food security in the Southeast Asian region. The activities are being undertaken in conjunction with Singapore, which is the Lead Country for the Key Cluster on Post-harvest and Safety of Fish and Fishery Products under the ASEAN Consultative Fisheries Forum (AFCF) Work Plan (2010-2012). Moreover, the activities are aimed at fulfilling the mission of MFRD which is to promote the development of fisheries post-harvest technology in Southeast Asia through research and development and transfer of technology to the fish processing industry in the region.

Post-harvest and Safety of Fish and Fisheries Products encompasses all aspects of fisheries post-harvest technology from handling at sea and on-shore, processing, marketing, until the distribution of fish and fishery products. This also includes the safety and quality aspects of fish products from the waters to tables incorporating both governmental and industrial safety control and regulatory systems. Guided by the Resolution and Plan of Action that was adopted in 2001, MFRD in collaboration with the Agri-Food & Veterinary Authority (AVA) of Singapore through its Post-Harvest Technology Centre supported the ASEAN countries in their efforts towards developing technologies that would optimize the utilization of catch and reduce post-harvest losses, improve quality of traditional fish products, and institute measures to comply with international food safety requirements. With major funding coming from the Japanese Trust Fund through SEAFDEC, the assistance provided by MFRD comes in the form of institution building, human resources development, technology transfer, and standardization of fishery post-harvest procedures and analytical methodologies for both the government and the private sector in the region.

For the sustainable development of fisheries for food security in the Southeast Asian region, post-harvest technology is vital as it could place or displace the region's fish and fisheries products in the world market, and could largely impact the region's economies. It should be considered that in 2007, the Southeast Asian region contributed about 18% or 7,369,862 mt (total world export

of fish and fishery products in 2007 was about 42,172,000 mt (FAO, 2010)) to the international export trade of fish and fishery products, which was valued at 14,395,040 million US Dollars (SEAFDEC, 2010). Moreover, the sustainable development of fisheries post-harvest technology could also lead to the increased availability of quality and safe fish and fisheries products for human consumption by the peoples of the region (Goh and Yeap, 2007).

In a related development, during the Second Meeting of the ASEAN Fisheries Consultative Forum (AFCF) in Brunei Darussalam in June 2010, the AFCF Work Plan for 2010-2012 was endorsed. The Work Plan described the clusters of priority fisheries management activities with the corresponding ASEAN lead countries, and with SEAFDEC as the key partner in many aspects of the implementation of the activities. Specifically, Singapore was identified as the Lead Country for the cluster on Fisheries Post-harvest and Safety of Fish and Fish Products with the main objective of establishing value-addition strategies to key fish products from both capture fisheries and aquaculture in order to make the ASEAN fish and fishery products competitive in the world market. As planned, this cluster is also expected to develop the guidelines on the monitoring system for chemicals, biological medicines and anti-biotic contaminants in fish and fishery products for eventual adoption in the region. Thus, with the Post-Harvest Technology Centre of AVA as the Collaborating Center of SEAFDEC for MFRD programmes, activities have been conducted to promote the safety of fish and fisheries products through improved fisheries post-harvest technologies.



Training on fish processing conducted at MFRD in Singapore

The achievements of MFRD in fisheries post-harvest technology led to the improvement of the fish processing industry in Southeast Asia, and contributed in many ways, to the sustainability of fisheries in the region. This had been achieved through maximizing the utilization of fish catch and reduction of post-harvest losses; improving the quality of traditional fish products through the promotion of quality assurance programs; and upgrading of the regional fish processing industry which were coupled with intensified technology transfer and information dissemination.

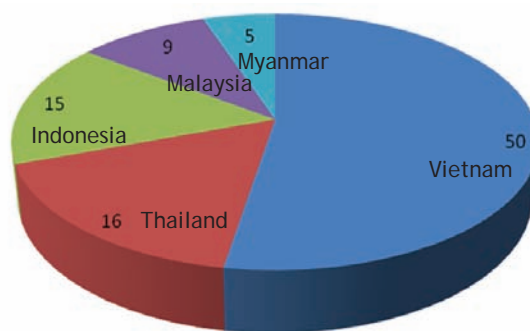
Maximizing Utilization of Catch and Reduction of Post-harvest Losses

It is of utmost importance that fish catch is responsibly utilized and post-harvest losses are minimized in order to attain food security for the fish-eating peoples in the Southeast Asian region. Thus, for the sustainable development of fisheries post-harvest technology in the region, Goh and Yeap (2007) suggested that it is necessary to maximize the utilization of fish catch and at the same time reduce post-harvest losses while ensuring the safety and quality of the products. Towards this goal, MFRD conducted activities that include the utilization of under-utilized marine and freshwater fish species for the development of surimi and value-added fish products.

In early 1970s, MFRD had introduced for the first time, the surimi processing technology to the region, using tropical fish species such as threadfin bream, croaker, and big-eye snapper, among others. The development of surimi production which included double-step heating to increase the gel strength and shorten setting time resulted in the production of a wide range of surimi products such as chikuwa, fish balls, fish cakes, shrimp balls and imitation crabsticks.

The introduction of the surimi technology by MFRD has considerably led to the development of the surimi industry in Southeast Asia. While surimi technology was unknown in the region in the 70s, through the activities of MFRD, 20 factories were established in the 90s which increased to 32 in 2003, and eventually increasing to 60 in 2006 and to 95 in 2010. Moreover, in 2009 almost 200,000 tons of surimi was produced in the region accounting for about 30% of the world's total surimi production.

Moreover, it should be noted that the development of the surimi industry in the region had offered market for what was considered before as low-value fishes (Siriraksophon *et al.*, 2009). Considering that fish species such as the threadfin bream (*Nemipterus* spp.), lizard fish (*Saurida* spp.), big-eye snapper (*Priacanthus* spp.), croaker (*Johnius* spp.), goatfish or red mullet (*Upeneus*



Number of Surimi factories in Southeast Asia (2010)

spp., *Parapeneus* spp.) used to produce surimi, are economically important for the ASEAN countries, a project on information collection of these species in the Southeast Asian region in terms of fishery resources and their use as raw materials in the surimi industry was conducted by MFRD. The results showed that small fishes could be used to produce frozen surimi considering that these species are often regarded as low economic value due to its poor consumer preference and poor quality because of improper handling onboard fishing vessels (Goh and Tan, 2008).

Thus, using these low-value fish species a wide range of value-added products had been developed for human consumption such as fish sausage, fish loaf, fish burger, fish tofu, fish bah kwa, fish floss, fish cracker, fish siew mai, fish muffin, among others (SEAFDEC/MFRD, 2003 and 2006).

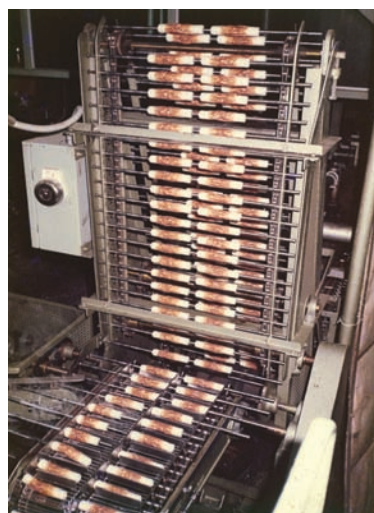
Moreover, MFRD also explored the possibility of turning the waste and trimmings from the fish processing industry into fish products. One of the activities was on the use of by-products of tuna and swordfish processing as raw materials. With Indonesia as the pilot country, the activity was conducted at the National Center for Fish Quality Control and Processing Technology Development (NCQC) in Jakarta, where breaded and battered products as well as fish sausage from the tuna and swordfish trimmings were produced.



In addition, tuna pico was developed from tuna and marlin meat trimmings. All final fish products were found to have acceptable flavor and texture (SEAFDEC/MFRD, 2003). Moreover, retort pouch technology was also developed and introduced for the production of tuna in mayonnaise, seafood in sweet and sour sauce, and retort pouch for squid.

For the utilization of under-utilized freshwater fish species, Cambodia served as the pilot country for the development of value-added products using common freshwater fish species such as the featherback (*Notopterus* spp.), snakehead (*Channa micropeltes*), moonlight gourami (*Trichogaster microlepis*), and soldier river barb (*Cyclocheilichthys enoplos*). The minced meat of featherback fish and snakehead fish trimmings were also used as raw materials for the development of fish siew mai, fish tofu, fish crackers and fish bah kwa (a sweetmeat), while the soldier river barb was used to produce value-added products such as fish murukku and fish satay (SEAFDEC/MFRD, 2005a).

Moreover, pilot studies on the use of pelagic species such as mackerels (*Rastrelliger kanagurta* and *R. brachysoma*) and round scads (*Decapterus maruadsi*, *D. macrosoma* and *D. russelli*) for processing into fisheries products was conducted in Thailand, Malaysia and Philippines, after which the Standard Operating Procedures for the maximum utilization of pelagic fish resources had been established (SEAFDEC/MFRD, 2006). Specifically, the development of fish sauce using the round scad (*Decapterus russelli* and *D. macrosoma*) and Indian mackerel (*Rastrelliger kanagurta*) using the enzyme protease and “koji” starter



Production of fish chikuwa

culture was carried out, while *R. kanagurta* was also used for the production of fish sausage and ready-to-eat (RTE) braised fish.

In the Philippines, the pilot project was implemented by the Post-harvest Technology Division of the Bureau of Fisheries and Aquatic Resources (PHTD-BFAR), where surimi was processed from *D. maruadsi*, which was then used to produce fish “tapa” and fish cube. Two other products such as fish “kikiam” and fish sausage were developed from *D. macrosoma*. The pilot project activities in Thailand were implemented by the Fishery Technological Development Division of the Department of Fisheries of Thailand (FTDD-DOF).

Two snack products, such as the seasoned dried minced fish sheet and semi-dried fish stick, were developed from *D. maruadsi*, *Rastrelliger brachysoma* and *R. kanagurta*. In order to promote the production of RTEs and other fish products from various fish species in the ASEAN region, MFRD conducted Regional Training Courses in Fish Processing and Packaging (Pelagic Fish) and Technical Consultations in Singapore which had been attended by participants from the ASEAN countries. Processing methods and shelf-life were established for 20 value-added products developed through the pilot projects utilizing the target pelagic fish species. Specifically, the manual which was an outcome of the pilot activities included the processing methods for fish sausage from MFRD, fish crackers from Malaysia, seasoned dried minced fish sheet (pla pan) from Thailand, and fish *kikiam* from the Philippines.

Moreover, an activity which aimed to improve the processing of fish sauce was conducted. This was aimed at reducing the fermentation time (SEAFDEC, 2003a) which usually is about one to two years, was conducted using koji (soya bean mash starter culture) and the enzyme takajastse (derived from the fungus *Aspergillus oryzae*).



Improving the Quality of Traditional Fish Products

A database on the traditional fish products of Southeast Asia had been compiled through a survey of the region's traditional fish products with Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Singapore and Thailand as participating countries. MFRD also assisted the Department of Fisheries of Myanmar in developing HACCP plans for selected traditional fermented fish products in order to upgrade the country's local fish processing industry. As a result, product descriptions, production flow diagrams, hazard analysis and HACCP plans were developed for the following fermented fish products of Myanmar: *nga-pya-ye* (fish sauce), *nga-pi* (whole fish), and *nga-pi* (paste). Assistance was also provided to the Export Quality Control Laboratory (EQCL) of the Department of Fisheries of Myanmar, which is the national laboratory supporting the implementation of the country's HACCP program, to upgrade its laboratory expertise, by training the EQCL officers on the techniques of analyzing histamine (scombroid poisoning) and pesticide contents in fish and fish products.

While carrying out the objective of upgrading the fish processing industry of the Southeast Asian region, MFRD promoted the mechanization of the processes to increase productivity and to work towards automation of the production line. In this regard, equipment that included meat-bone separator, silent cutter, fish ball forming machine, and fish cake forming machine had been modified to suit the capability of the countries in the region but maintaining the performance and efficiency of such equipment.

Advances in Quality, Safety and Control Systems for Fish Products

MFRD promoted the concept of Hazard Analysis and Critical Control Point (HACCP) in fish processing to the Southeast Asian region in 1990s, and developed the regional capability for the application of HACCP in the fish processing industry (SEAFDEC/MFRD, 2003b). MFRD also continued to promote fish quality and assurance, and preservation by studying the shelf-life of iced and frozen fish and fish products; nutritional composition of fish and fish products; safety of fish and fish products by monitoring heavy metals, antibiotic and pesticide residues; harmonizing the analytical methods through validation and proficiency testing; upgrading the credibility of key regional laboratories through good laboratory practices; and promoting traceability systems for aquaculture products.



Above: Fermenting fish using koji; and
Left: Fish meat-bone separator

The harmonization of analytical methods through a network of key laboratories in the various ASEAN Member Countries aimed to enhance the status of ASEAN as a coordinated fish-exporting bloc to importing countries, such as Canada, USA, Japan and EU. This has also been envisaged to help facilitate trade in fish and fishery products within and beyond the ASEAN region, by enhancing the capability of the key laboratories in ASEAN through methods validation and inter-laboratory proficiency testing. In order to achieve this goal, a series of training workshops on methods validation was conducted by MFRD for personnel from key laboratories in the region as well as promoting inter-laboratory proficiency testing. MFRD has developed such capability and in 2002, the SAC-SINGLAS Council Committee for Laboratory Accreditation approved the ISO/IEC 17025 accreditation of the MFRD Chemistry Laboratory. The five methods of laboratory testing accredited are for total arsenic, total cadmium, total mercury, total lead and moisture, with all the methods validated.

The concepts of laboratory quality management and implementation of quality management system were included in the training workshops to enable the participants to meet the accreditation requirements and clients needs as well as achieve effective control over their respective laboratories. Factors that could lead to compliance with the requirements of the ISO 17025 accreditation were also included in the training workshops.

The progress made by the lead laboratories had been monitored by MFRD specifically on the progress made by the countries in the preparation of their Laboratory Quality Management Manuals (LQMMs) and implementation of good laboratory practices in their respective lead laboratories. The results of the survey indicated that in 2005, 10 laboratories in seven countries have completed and published their LQMMs, while the other laboratories were still in the various stages of developing their manuals.



Training of staff of regional key laboratories on good laboratory practices

In addition to the preparation of the LQMMs, the lead laboratories also started implementing good laboratory practices, and as a result, 7 laboratories from five ASEAN countries have already implemented good laboratory practices in their laboratories (SEAFDEC/MFRD, 2008).

Moreover, laboratories in four countries have started the measurement of uncertainties for their laboratory methods. In addition, laboratories in 7 ASEAN countries have also completed their methods validation for some methods, although the other laboratories are still in various stages of developing their respective methods of validation. A compilation of validated methods from key regional laboratories was published and circulated to the ASEAN countries. Using the data collected through the survey, the First Regional Inter-laboratory Proficiency Testing for SEAFDEC Key Laboratories, Metallic Contaminants Series, Round 0401 for determination of Arsenic, Cadmium, Lead and Mercury had been initiated by MFRD. Each participating laboratory received an individually numbered Dogfish Liver Material, to be analyzed for Total Arsenic, Total Lead, Total Mercury and Total Cadmium. Meanwhile, MFRD continued to take part in the Inter-Laboratory Proficiency Testing under the Food Analysis Performance Assessment Scheme (FAPAS) for the determination of total mercury, arsenic, cadmium, lead, moisture, ash, total fat and nitrogen.

A series of Regional Workshops on the Application of HACCP in the Fish Processing Industry in Southeast Asia were conducted to assess the application of HACCP in the fish processing industry in the region and provide a regional platform for sharing of information and knowledge on HACCP application among the ASEAN Member Countries (SEAFDEC/MFRD, 2003b). Moreover, a fish and fish products safety information network was established which comprises experts and institutions specializing in seafood safety in the region. In this connection, the website (<http://www.fishsafetynfo.com>) was launched while country

coordinators were designated and as agreed, information on issues relevant to seafood safety in the region had been shared. The Regionalization of the Code of Conduct for Responsible Fisheries (RCCRF) Phase IV: Post-harvest Practices and Trade was also undertaken as a means of identifying and addressing the issues related to post-harvest practices as well as clarifying the applicability of the global CCRF on post-harvest practices in the context of the Southeast Asian region. The Regional Guidelines for Responsible Fisheries: Responsible Post-harvest Practices and Trade was published in April 2005 (SEAFDEC, 2005).

While it has been recognized that many small and medium size fish and processing establishments (SMEs) in the ASEAN countries have difficulty in implementing quality management systems due to economic and technical constraints, MFRD carried out an activity to address this concern. These SMEs largely comprise the Pre-Processing Establishments (PPEs), which produce semi-processed raw materials for main processing establishments and the Traditional Fish Products Processing Establishments (TPEs). The ASEAN countries have identified that this sector of the industry requires assistance to upgrade their quality management programs, beginning with the basic GMP and SSOP (SEAFDEC/MFRD, 2008a and

Box 1. Development of GMP/SSOP programs for Pre-Processing Establishments (PPEs)

Country	Types of PPE
Cambodia	Crab meat (picking)
Indonesia	Fish meat/fillet (for surimi)
Malaysia	Shrimp pre-processing Fish meat/fillet (for surimi/otoshimi)
Myanmar	Shrimp pre-processing
Philippines	Shrimp salting (for shrimp paste) Crab meat (picking)
Thailand	Shrimp pre-processing
Vietnam	Shrimp pre-processing

Box 2. Development of GMP/SSOP programs for Traditional Fish Products Processing Establishments (TPEs)

Country	Types of TPE
Brunei Darussalam	Fermented shrimp paste (<i>belacan</i>)
Indonesia	Salted boiled fish (<i>pindang</i>)
Lao PDR	Dried fish (<i>pa heang</i>)
Malaysia	Fermented cracker (<i>keropok lekor</i>)
Myanmar	Fermented (pickled) fish (<i>ngachim</i>) Fish sauce (<i>ngan pya ye</i>)
Philippines	Smoked milkfish (<i>tinapa</i>) Shrimp sauce (<i>alamang</i>)
Singapore	Fish balls/fish cakes
Thailand	Fish sauce (<i>nam pla</i>) Dried shrimp
Vietnam	Fish sauce (<i>nuoc mam</i>) Fermented tiny shrimp paste (<i>mam tom</i>)

2010). Moreover, the development of the GMP/SSOP programmes for the PPEs and TPEs (**Box 1** and **Box 2**) had also been envisaged to enable the ASEAN countries to achieve *Measure No. 46* of the ASEAN Roadmap for the Integration of the Fisheries Sector under the ASEAN Framework Agreement for the Integration of Priority Sectors. Specifically, *Measure No 46*: prescribed the need to develop and apply fisheries quality management system that could ensure food safety and support the competitive position of ASEAN fisheries products in the world markets through implementation, validation, verification of Hazard Analysis Critical Control Point (HACCP)-based systems and improved laboratories practices, and adapting quality and safety management systems for possible application by the small enterprises in ASEAN.

Chemical residues in fish and fisheries products in Southeast Asia was also investigated by MFRD where the methodologies on biotoxins analyses were developed through human resource training for understanding the levels of biotoxin occurrences and incidences in fish and fisheries products in the countries in the region. In this regard, Regional Technical Consultation on Biotoxins Monitoring in ASEAN and the Regional Training Course in Biotoxins Analysis were conducted in 2009 and 2010, respectively. In addition, the Research and Analysis of Chemical Residues and Chemical Contamination in Fish and Fish Products and in Environment such as Fishing Ground and Aquaculture Field were also undertaken to obtain an understanding the levels of chemical contaminants in fish and fish products in Southeast Asia.

A regional survey on heavy metals (arsenic, cadmium, lead and total mercury) in fish and fish products was conducted in the ASEAN countries, through the participating regional laboratories in Cambodia, Indonesia, Malaysia, Myanmar, Singapore, Thailand, and Vietnam (SEAFDEC/MFRD 2008b). Fish and fish products that are of economical and social importance to the participating countries were targeted, and results of the survey were deposited in the database of the Fish and Fish Products Safety Information Network. In addition, to ensure the accuracy and comparability of the different methods used by Member Countries, Inter-laboratory Proficiency Testing for the test methods was conducted by MFRD and in the process, MFRD also assisted in the upgrading of regional laboratory personnel skills in conducting heavy metals analysis using Atomic Absorption Spectrometry (AAS) through a series of on-site training at project sites in Indonesia, Myanmar and Vietnam.

Upgrading the capability of staff from the regional laboratories was also carried out to enable them to conduct pesticide residues analysis using Gas Chromatography

Mass Spectrometry (GC-MS) and facilitate the implementation of the regional surveys on the pesticide residues (organochlorines) in fish and fish products in the SEAFDEC Member Countries (SEAFDEC/MFRD, 2004). The results of the survey were deposited in the database of the Fish and Fish Products Safety Information Network. In addition, the survey of Histamine Levels in Fish and Fish Products in Southeast Asia was conducted especially for the naturally occurring toxin, histamine, in fish and fish products. As agreed during the Mid-term Review Meeting in 2007, although the analysis of fermented fish and fish products such as shrimp paste and fish sauce was included in the survey, the countries were given the option to decide on the type of fermented fish and fish products to be surveyed considering the financial resources of the countries. Moreover, with the assistance of the Department of Fisheries (DOF) of Thailand, on-site training courses for histamine analysis using fluorometric and High Performance Liquid Chromatography (HPLC) method were conducted in order to upgrade the technical capability in histamine testing in the region.

Training on the analysis of antibiotics especially in the detection of prohibited drugs such as chloramphenicol and nitrofurantoin used in aquaculture farms was also conducted (SEAFDEC/MFRD, 2005). The Vietnam National Agriculture, Forestry and Fisheries Quality Assurance Department (NAFIQAD) and MFRD co-organized the training for three methods, namely: Chloramphenicol, Nitrofurantoin and Malachite Green using Liquid Chromatography Mass Spectrometry (LC-MS-MS) method. Regional surveys of chloramphenicol, nitrofurantoin, malachite green and leuco-malachite green in fish and fish products were then conducted by the participating regional laboratories in Indonesia, Malaysia, Myanmar, Philippines, Thailand and Vietnam. Nevertheless, in view of the different analytical methods used in the survey, the participating countries took part in the inter-laboratory proficiency testing under FAPAS Round 02109 for chloramphenicol in shrimp sample. The results of the activities were deposited in the database of the Fish and Fish Products Safety Information Network.

Traceability Systems for Aquaculture Products in the ASEAN Region

A Consultation on the implementation of traceability systems in the ASEAN countries was organized in Singapore in October 2010 where the country participants presented country reports to share their knowledge on food fish traceability systems. The Consultation agreed to conduct the first on-site training for food dish traceability in Vietnam in 2011 and the 2nd on-site training for shrimp traceability systems in Thailand in 2013.

Way Forward

As indicated in its goals, MFRD aims to: establish the Department as a coordinating center for research and development in fisheries post-harvest technology in the region; sustain the Department as the Regional Training Center for the ASEAN and the Third Country Training in Fisheries Post-harvest Technology; and promote the Department as the Regional Information Hub in fisheries post-harvest technology through the ASEAN Fisheries Post-harvest Technology Information Network. In order to attain such objectives, MFRD is committed to driving the regional effort towards sustainable fisheries development in fisheries post-harvest technology by: optimizing the use of limited fisheries resources; developing value-added products from under-utilized fish species; reducing post-harvest losses and wastage; harmonizing analytical procedures and testing capabilities; promoting the implementation of quality assurance programmes and food safety management systems; upgrading the regional fish processing industry especially the small and medium size enterprises; and developing human resources.

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Sustainable Management of Aquatic Species of International Concern: SEAFDEC Initiative

Abdul Razak Latun, Abu Talib Ahmad, and Virgilia T. Sulit

Sustainable utilization and environmental conservation of aquatic resources are currently some of the general concerns of the international community as well as for the countries in the Southeast Asian region. SEAFDEC has been monitoring the progress and actions of the SEAFDEC Member Countries on the sustainable management of aquatic species especially those of international concern as well as those proposed to be listed under the appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Internationally, wildlife trade including the trade of aquatic species is regulated through the CITES of which all Southeast Asian countries are signatories to it.

The international concern for global aquatic biodiversity started in the 80s when the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Environment Program (UNEP) convened an Expert Consultation on Conservation of the Genetic Resources of Fish. Although the focus of the Expert Consultation was on fish genetics, their conclusions and recommendations were not different from what the international biodiversity community is now currently seeing. Moreover, various factors were identified during the Consultation as major threats to aquatic biodiversity. These include: (1) Habitat destruction and degradation; (2) Over-exploitation (*e.g.* extraction, hunting, fishing); (3) Pollution; (4) Aquatic Diseases; (5) Invasion of alien species (*e.g.* exotic fishes, planktons, pathogens); and (6) Global climate change (*e.g.* changes in migratory species, coral bleaching). Threats in marine and freshwater systems may have been inadequately understood but it appears that overexploitation is presently the greatest threat to marine species, followed by habitat loss. Meanwhile, the introduction of alien species, land-based pollution, as well as habitat loss and alteration of waterways through damming and water diversion all contribute to the declining levels of aquatic biodiversity in freshwater environments, but habitat loss continue to be the most severe threat to freshwater species followed by pollution and introduction of alien species.



Photo by Sid Tendencia of AQD (2011)

Common Positions of the ASEAN-SEAFDEC Countries on Fisheries Management and Trade

The ASEAN Member Countries came up with generic common positions for the management of fisheries. Specifically, the ASEAN countries emphasized that management of commercial fisheries including shark fisheries should be considered under the purview of FAO Code of Conduct for Responsible Fisheries (CCRF) and not under CITES. The common positions were discussed through the ASEAN mechanisms and were subsequently endorsed by the ASEAN authorities. Such general common positions are summarized in **Box 1**. The common positions were again discussed during the ASEAN-SEAFDEC Regional Technical Consultation on Fish Trade and Environment from 14 to 16 October 2002 in Bangkok, Thailand, where SEAFDEC Member Countries agreed to support the common positions endorsed by the ASEAN.

Aquatic Species of International Concerns

Recently, various aquatic species have been considered under international concerns as discussed through consultations and covered by a number of international treaties concerning the conservation and management of aquatic biodiversity (**Box 2**). The aquatic species that had been considered as main international concerns include the sea turtles, sharks, sea cucumbers, cetaceans, sea horses, corals, and humphead wrasse.

Sea turtles

The Southeast Asian region is home to six of the seven sea turtle species recognized worldwide. Among them are the leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), olive ridley (*Lepidochelys olivacea*), loggerhead (*Caretta caretta*), and flatback (*Natator depressus*). All six species are nesting across the Southeast Asian waters, with the exception of flatback, which is mostly reported in Indonesian waters.

Records have shown that the sea turtle populations declined over the last 20 years across much of Southeast Asia and the Pacific. For example, nesting populations of the Eastern Pacific leatherback turtles have dropped by 90% in the last 20 years. Today, it has been estimated that as few as 2300 adult nesting leatherback females are found across the entire

Box 1. Common positions of the ASEAN countries on fisheries management endorsed in 2002

- a. Proposals for listing in the CITES Appendices should be based on the principle of sustainable use of the resources in relation to any species
- b. Proposals should be backed by scientific-based data to be provided by competent scientific authorities
- c. Other than CITES, there are other competent authorities (e.g. FAO, ITTO) tasked to sustainably manage the species concerned should be encouraged to address any prevailing issues
- d. ASEAN as a group should proactively promote the management of marine and other aquatic species
- e. ASEAN countries should also try to support other countries on relevant CITES issues even if such issues are not of direct interest to the ASEAN region

Box 2. International treaties concerned with the conservation and management of aquatic biodiversity

- 1. RAMSAR Convention on Wetlands (1971)
- 2. United Nations Convention for the Law of the Sea (UNCLOS, 1982)
- 3. Convention on Biological Diversity (CBD, 1992)
- 4. Chapter 17 of Agenda 21 (1992)
- 5. GEF/UNDP/IMO Global Ballast Water Management Program (GloBallast)
- 6. UNEP Global Plan of Action for the Protection of the Environment from Land-Based Activities (GPA, 1995)
- 7. Cancun Declaration on Responsible Fishing (1992)
- 8. FAO Code of Conduct for Responsible Fisheries (1995)
- 9. UN Agreement on Straddling and Highly Migratory Fish Stocks (1995)
- 10. Kyoto Declaration (1995)
- 11. World Summit on Sustainable Development (Johannesburg, 2002)
- 12. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) - (1st July 1975)

Pacific Ocean. In 1970, close to 2000 nesting leatherback females were tagged in Terengganu, Malaysia, but only nine returned to nest in 1999 and only one or two per year thereafter (Liz *et al.*, 2005).

Hundreds of green turtles and hawksbill turtles have been illegally captured and killed for illegal trading. Moreover, turtle eggs are widely collected and eaten throughout Southeast Asia with serious consequences to the turtle populations. Another serious threat is the rampant trading of turtle shells and stuffed whole turtles. Almost 30,000 items made from the critically endangered hawksbill turtles were found on sale in Vietnam in 2002 (TRAFFIC Southeast Asia Indochina, 2004), signalling the death of thousands of these marine creatures.

As early as 1988, the Department of Fisheries Malaysia (DOFM) started its program on the conservation of sea turtles which included seven activities (Zulkifli *et al.*, 2004), namely: (1) tagging of sea turtles in Terengganu and Pahang; (2) nursing experiments of leatherback turtles; (3) studies on the ecology of the painted terrapin (saw-jawed

turtle, *Batagur borneoensis*) in Kuala Setiu, Terengganu; (4) studies on the incubation of sea turtle eggs in shaded and elevated hatcheries; (5) turtle beach surveys in Pahang, Terengganu, Malacca, and Perak; (6) monitoring of sea turtle hatchery operations; and (7) monitoring of sea turtle nesting populations.

Upon the establishment of the SEAFDEC Marine Fishery Resources Development and Management Department (MFRDMD) in Terengganu, Malaysia in 1992, the Department had been tasked to carry out the program on Marine Conservation and Stock Enhancement of Sea Turtles. Thus, with the collaboration of the SEAFDEC Member Countries, the Program was pursued starting in 1998 with financial support from the Japanese Trust Fund in SEAFDEC (SEAFDEC, 2008) with the objectives of compiling information on the status of research, conservation and management of sea turtles in Southeast Asia; establishing a mechanism for regional collaboration in the research and conservation of sea turtles; and undertaking studies on incidental catch of sea turtles in the region by various fishing gear. In addition, stock enhancement of sea turtles has also been carried out which includes stock identification, multiple paternities detection, tagging and satellite telemetry, head starting technique to enhance survival of hatchlings, cloning, and interaction between sea turtles and fisheries (Mahyam *et al.*, 2008). Moreover, the SEAFDEC Training Department (TD) also carried out activities aimed at reducing the interactions and mortality of sea turtles from fishing (Bundit, 2008; Isara *et al.*, 2009). TD also promoted the use of C-hook in hook-and-line fishing in the SEAFDEC Member Countries to minimize the by-catch of sea turtles (SEAFDEC, 2011).

Sharks

In Southeast Asia, the issue on conservation and management of sharks has been given high priority due to the rising number of proposals that have been raised for the possible listing of several commercially-exploited species of sharks in the CITES Appendices. The shark biodiversity of the region covers the tropical waters of South China Sea and adjacent waters, considered as among the richest in the world with at least 136 species of sharks. However, little is known about the biology and ecology of most shark species.

Indonesia is the world's leading nation in terms of elasmobranch species landings followed by Thailand,



Research on sea turtle foraging population by genetic study (SEAFDEC, 2011)



Small shark, *Hemigaleus microstoma*

Malaysia, and the Philippines (Chen, 1996). Sharks are commercially in demand for their fins, cartilage, skin, meat, oil, and liver. Nevertheless, since the meat of most sharks species is not of high economic value, carcasses are often discarded in the sea to save space on deep sea fishing boats. Records have shown that shark fin products exported from Malaysia amounted to about 10 metric tons in 2001, while Indonesia and Singapore exported dried shark fins in the combined total of 76.85 mt in 1989, 103.33 mt in 1991, 198.28 mt in 1992, and 331.68 mt in 1993.

In response to the possible listing of shark species in the Appendices of CITES, SEAFDEC convened a number of regional meetings where it was agreed that SEAFDEC should carry out Data Collection on Status and Trends of Shark Fishery and Utilization in the Southeast Asian Countries (SEAFDEC, 2008). Moreover, with assistance from SEAFDEC, the Member Countries were encouraged to develop their respective National Plans of Action on Sharks (NPOA-Sharks) to be supported with scientific evidence in accordance with the International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks). In 2006, Malaysia developed its NPOA-Shark based on the guidelines set out in the IPOA-Sharks, to ensure the conservation and management of shark and their long-term sustainable use (DOFM, 2006).

Sea cucumbers

Sea cucumber also known as sandfish, is one of the most important commercially-exploited aquatic species in Southeast Asia. Although the status of its fisheries remains unknown, sea cucumber has been reported to be heavily exploited in China, Indonesia, Malaysia, Philippines, Thailand and Vietnam (Bruckner, 2005).

Efforts have therefore been made to improve the conservation and management of sea cucumbers in the region. Reports have indicated that Indonesia has the



Sandfish juveniles on sandy-muddy substrate (SEAFDEC, 2011)



Some of the sea cucumber species being studied in the Philippines (Photo: NFRDI (2007))

world's largest sea cucumber fishery, where there are regulations on trawling for sea cucumbers and maximum densities for cage culture of juveniles collected from the wild. In some locations, various voluntary community-based conservation measures had been carried out (Bruckner, 2004). In Malaysia, sea cucumbers exploitation had been dominant in Pulau Langkawi, Pulau Pangkor, Perak and in Sabah. On the other hand, Philippines is the second largest producer of sea cucumbers in the world, and sea cucumber fishery in the country is a year round activity with a peak season from March to June.

In Thailand, sea cucumbers are harvested for local consumption and export with *Holothuria scabra* and *H. atra* being the most popular, although overexploitation and shift to less valuable species have been reported. Considering that concerns had been raised at the various sessions of CITES to include the commercial sea cucumber species in the CITES Appendices, which could have negative impacts on sea cucumber fisheries in the region, SEAFDEC conducted a regional study on sea cucumber fisheries, trade and utilization in Southeast Asia in 2008. Moreover, the *ad hoc* Regional Working Group on Sea Cucumber Fisheries was established to support the planning and conduct of the said study (SEAFDEC, 2008b).

Cetaceans

Cetaceans are among the important aquatic species of international concerns, and issues on conservation and management have been raised at various fora particularly the CITES and International Whaling Commission (IWC). However, small cetaceans (*i.e.* small whales, dolphins, and porpoises) have become popular attractions in the animal display industry with the rise of marine aquaria. Since 1960s, reports indicated that Indonesia supplied its own three dolphinaria by occasionally importing mostly



Top: Bryde's whale (Bangsaen, Thailand, 2008);
 Middle: false killer whale (Phuket, Thailand, 2008);
 Bottom: long-beaked common dolphin (South China Sea, 2008)
 Source: SEAFDEC (2009a)

the bottlenose dolphins (Perrin, 2002) while Singapore imported six Indo-Pacific hump-backed dolphins from Thailand in 1999 (Sue and Randall, 2005).

In this connection, TD had initiated the collection of information on cetacean species in both marine and freshwater ecosystems in Southeast Asia since 2008, and reviewed the issues related to existing whales and dolphins, and habitats of cetaceans in the Southeast Asian countries, as well as the declining Irrawaddy dolphins in the Mekong River (SEAFDEC, 2009; SEAFDEC, 2009a). Meanwhile, efforts had been made in Myanmar to preserve the “cooperative fishing” between fishers and the Irrawaddy dolphins in the Ayeyarwady River, which the country considered as a fishery cultural heritage (Mya, 2007).

Sea horses

All sea horses (Syngnathidae) belong to one genus *Hippocampus*, which comprise about 33 species of the sea horses worldwide (Lourie, 2004). Sea horses are threatened by direct exploitation, accidental capture in non-selective fishing gear (as by-catch) and degradation of their habitats. By-catch from trawlers appears to be the largest source of sea horses in international trade, while the trawls also damage their coastal habitats. More research needs to be done to assess the loss of sea horse habitat, especially the sea grass beds, and its impact on the wild populations.

A total of 15.95 million sea horses had been traded annually with 15.83 million comprising wild-caught individuals and 0.12 million from breeding farms. At least 19 species had been traded with the most commonly traded species

being the *Hippocampus kuda*, *H. trimaculatus* and *H. spinosissimus*. Thailand and Vietnam export the largest volumes of sea horses with Thailand's export reported to account for over 90% of the sea horse traded (Vincent, 2010). A single shipment of dried seahorses in Poland, comprising of an estimated 1–2 million specimens, was reported to have originated from Indonesia although Indonesia reports low levels of export in sea horses.

In an effort to address the threatened extinction of the sea horses, SEAFDEC through its Aquaculture Department (AQD) continued refining the seed production techniques to improve production of hatchery-bred juveniles (SEAFDEC, 2009a). Although the culture of sea horses could be an option to address the declining population, conservation is of utmost priority to revive the wild populations. Vincent and Koldewey (2005) pointed out that such conservation efforts should include reduction of fishing efforts and responsible conduct of sea horse aquaculture to ensure that the wild populations are kept intact.

Corals

Southeast Asia has the highest coral diversity in the world, with Indonesia, Malaysia and the Philippines along with Papua New Guinea forming the Coral Triangle which is the center of global coral diversity. The region has 100,000 km² of coral reefs (34% of the world's total), which are home to over 600 of the 800 reef building coral species of the world (Tun *et al.*, 2004; Burke *et al.*, 2002).

However, 38% of the coral reefs in Southeast Asia had been destroyed, while another 28% are critically threatened and 29% are threatened, with only 5% which are at low risk from human activities (Tun *et al.*, 2004). Imports of corals are difficult to monitor accurately, and as noted by Bruckner (2001) tracking trade using the CITES Trade Database provides limited information, because corals are reported up to genus only, and the volume is reported by item or weight. The CITES mechanism, however, could promote the development of strategies to protect corals. While certain Southeast Asian countries have developed management plans for the sustainable harvest of corals, this mainly targets the CITES-listed species.

Humphead or Napoleon wrasse

Humphead or Napoleon wrasse, *Cheilinus undulatus* is a distinctive coral reef fish which can grow to over two meters in length, and found broadly in the Indo-Pacific waters from East Africa to French Polynesia, Australia to India. This species is currently listed under the CITES Appendix II and classified as endangered under the IUCN Red List. Sabah is the major supplier and source of humphead wrasse in Malaysia, where an extensive visual census survey showed that only two out of 30 survey

sites have more than one fish per square km and only two reproductive sites were identified. Population of humphead wrasse in Sabah was reported to have declined since 1974. This species is found mainly in the marine protected area (MPA) of Peninsular Malaysia (e.g. Pulau Payar in the west coast) and in Mabul Island, Bodgaya Island (Semporna District) and Sipadan Island in Sabah in the east coast (Canbanban, pers. comm.; Allen, WWF unpublished data). Nevertheless, the humphead wrasse is nowadays rarely seen by divers in much of eastern Malaysia where most of the country's coral reefs are located, except at Pulau Layang Layang, west of Sabah and Pulau Sipadan (TRACC, 2004). In the Philippines, the humphead wrasse is only found in Palawan which appears to be the stronghold for this species in the country, but where the species has also been extracted in numbers. In many areas around Indonesia, the humphead wrasse is now rarely seen especially in diving spots which once served as habitats for the species. However, juveniles could be observed again once the live reef fishery operation is stopped (Erdmann, pers. comm.) and the illegal, unregulated and unreported (IUU) fishing and trading of humphead wrasse, *Cheilinus undulatus* is controlled. Reports have indicated that in the Philippines, Indonesia and probably in Sabah of east Malaysia, illegal harvesting of the humphead wrasse with cyanide still occurs. In fact, in the Kei Islands of Indonesia, one out of the two ships involved in the export of humphead wrasse did not have the appropriate permits. At any rate, the export of humphead wrasse from Southeast Asia declined by 22% over the one year period from 1995-1996.

Adults are uncommon in most fished areas and 80-90% of individuals now in trade are large juveniles. Despite the introduction of management measures in a number of countries, illegal, unreported and unregulated harvest for international trade continues and the species has recently been reclassified by IUCN from Vulnerable to Endangered. Although the species does not form a significant economic component of the trade, the high retail value of the humphead wrasse (sometimes exceeding US\$ 130/kg) is a considerable incentive to continue fishing even if it has become harder to catch the decreasing stock of the species.

Conservation of Aquatic Species under International Concerns: SEAFDEC Initiatives

Since 1999, SEAFDEC has been paving the way for the ASEAN-SEAFDEC Member Countries to discuss international issues related to fish and fish products. Through the series of Consultations, SEAFDEC was able to provide the fishery authorities of the ASEAN countries with necessary information on trade-related issues and environment-related tasks on the conservation

of species of international concern such as the issues under UN General Assembly, WTO, FAO and CITES as well as the requirements of importing groups such as the EU. SEAFDEC analyzed the outcomes of the regional discussions in order to come up with future regional action plans to help the countries in generating common/coordinated positions that would safeguard the interests of the countries at international fora.

Meetings and consultations

In monitoring the emerging international fish trade-related issues and environment related tasks, and in implementing projects on responsible fisheries as well as on conservation and management of aquatic species of international concerns, SEAFDEC provides the Member Countries with appropriate channel to reflect the respective country's efforts in managing fisheries. SEAFDEC also assists the Member Countries in developing regional common/coordinated positions, as well as push forward the views from the fishery agencies in the region into those of the international instruments. For this purpose, SEAFDEC convened a series of meetings and consultations, some of which are listed in **Box 3**.

Research activities

With the collaboration of the Member Countries, SEAFDEC continues to undertake several initiatives (**Box 4**), which include the conservation and management of sharks and marine turtles; and seed production of species under international concerns, e.g. sea horses, humphead wrasse, abalone, giant clam, sea cucumbers, angel-wing clam, among others for stock enhancement purposes.

In the conservation and management of sharks, SEAFDEC collaborated with Member Countries for the regional study on Shark Production, Utilization and Management in the Region, the outcome of which was published and disseminated to concerned people and organizations/institutions. Some Member Countries have already established their National Plans of Action on Conservation and Management of Sharks (DOFM, 2006). On sea turtles, initiatives have been undertaken by SEAFDEC on the introduction of selective fishing gear to minimize turtle by-catch, e.g. TEDs for purse seine and J-Hook/Circle Hook for long-line fisheries, as well as modified the drifting fish aggregating devices to mitigate sea turtle mortality from fishing.

Way Forward

It is obvious that regional data and information on aquatic species of international concerns are still insufficient therefore efforts must be intensified to collect data and information on the status, utilization and trade of such

Box 3. Initiatives of SEAFDEC on the conservation of aquatic species of international concerns

1. SEAFDEC Preparatory Meeting on Issues of International Fish Trade and Environment (November 1999)
2. ASEAN-SEAFDEC Regional Technical Consultation on Fish Trade in ASEAN Region (April 2001)
3. Meeting of ASEAN Expert Group on CITES (AEG-CITES) (August 2002)
4. ASEAN-SEAFDEC Regional Meeting on Fish Trade and Environment (October 2002)
5. ASEAN-SEAFDEC Regional Technical Consultation on Fish Trade and Environment (March 2004)
6. ASEAN-SEAFDEC Regional Technical Consultation on Fish Trade and Environment (February 2005)
7. ASEAN-SEAFDEC Preparatory Meeting on Environmental Related Tasks in Southeast Asia: Sharks & Sea Cucumbers (October 2005)
8. ASEAN-SEAFDEC Regional Technical Consultation on International Fisheries-related Issues (September 2006)
9. ASEAN-SEAFDEC Preparatory Meeting on Environmental Related Tasks in Southeast Asia: Sharks & Sea Cucumbers (October 2006)
10. ASEAN-SEAFDEC Regional Technical Consultation on International Fisheries-related Issues (February 2007)
11. ASEAN-SEAFDEC Regional Technical Consultation on International Fisheries-related Issues (February 2008)
12. ASEAN - SEAFDEC 1st Regional Workshop on Information Gathering and Cetacean Research in the Southeast Asian Waters (July 2009)
13. ASEAN-SEAFDEC Regional Technical Consultation on International Fisheries-related Issues (February 2010)
14. ASEAN-SEAFDEC Regional Technical Consultation on International Fisheries-related Issues (January 2011)

Box 4. Research activities of SEAFDEC on the conservation of aquatic species of international concerns

1. Regional Study on Sharks Production, Utilization and Management in the ASEAN Region by TD
2. R&D on Stock Enhancement for Threatened Species of International Concern by AQD, Iloilo, Philippines
3. Breeding and artificial seed production technologies of humphead wrasse by AQD
4. Breeding, seed production, and grow-out techniques for *Hippocampus kuda* and *H. barbouri* by AQD
5. Cetacean Research in Southeast Asian Waters: Cetacean Sighting Program by TD
6. Stock Enhancement of Sea Cucumber *Holothuria scabra* in Vietnam by AQD
7. Research on stock enhancement of sea turtles by MFRDMD
8. Information gathering from Member Countries on sea turtle poaching by MFRDMD
9. Responsible fishing gear (C-hook in hook-and-line fishing) to sea turtle by TD
10. Survey of shark utilization in Southeast Asia - DNA analysis of shark fins by MFRD

species. In order to ensure the sustainable exploitation and conservation of such species, regional technical consultations should formulate future follow-up actions besides formulating regionally coordinated positions. Moreover, SEAFDEC Member Countries should identify enforcement-related difficulties and constraints that may arise when certain species are proposed to be listed in the Appendices of CITES and develop the country's capacity to conduct Non-detrimental Finding (NDF) studies.



Above: Sea turtle entangled in abandoned fish aggregating devices with garbage in the Andaman Sea (SEAFDEC, 2009b); and Left: Sea turtle eggs are still being collected in many countries of Southeast Asia for human consumption (SEAFDEC, 2009b)

Furthermore, SEAFDEC would foster closer cooperation with FAO and CITES in order to help the ASEAN countries in developing and implementing programs for the establishment of National Plans of Action and adoption of standardized sets of commodity codes for products that are both CITES-listed and non-listed species. Moreover, there is also a need to monitor the harvest and trade (export, import and re-export) of the various threatened species. However, more funds and more human resources would be needed to be able to deal with the increasingly complex aquatic species trade dynamics.

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Addressing Emerging International Fish Trade Concerns to Support the Sustainable Development of Fisheries

Sawitree Chamsai and Somboon Siriraksophon

International fish trade is a complex web of actions of importers and exporters, considering that global trade in fishery commodities involves billions of US dollars. In 2008, global fish trade reached US\$ 102 billion (export value) representing an 11% growth relative to that of 2004. The top five global fish markets were Japan, USA, Spain, France, and Italy meanwhile Thailand and Vietnam were among the top five exporters of fishery commodities (FAO, 2010). About one-half of all fish exports are produced in developing countries, while the big consumers are developed countries accounting for 80% of all imports. This indicates that developing countries have found a stable market that can be relied on, the market niche carved for the fish and fisheries products from developing countries, providing them bright future in terms of job opportunities and increased incomes, contributing to the socio-economic well-being of their people. Nevertheless, developing countries do not have the same resources, guidelines or know-how that developed countries have such as the United States and Japan. Thus, if developing countries do not take advantage of such guidelines and know-how, the growth of the countries' export fish trade could be jeopardized. Moreover, if unsustainable fishery practices continue to prevail in developing countries, food security could even be threatened. Therefore, promoting responsible international trade in fish and fisheries products should be seriously considered by developing countries, where advocating such important issue is also being addressed during discussions and negotiations in the global arena.

With the objective of promoting fish trade in a sustainable manner, the global Code of Conduct for Responsible Fisheries specified that "*Promotion of international fish trade and export production should not result in environmental degradation or adversely impact the nutritional rights and needs of people for whom fish is critical to their health and well-being*". Specifically for the ASEAN region, the 2001 Resolution and Plan of Action on Sustainable Fisheries for Food Security stipulated that ASEAN Member Countries should "*Strengthen the joint ASEAN approaches and positions on international trade in fish and fishery products indigenous to the region by harmonizing standards, criteria and guidelines*".

The establishment of the COFI Sub-committee on Fish Trade in 1986 illustrated the importance of global fish trade. The Sub-committee is tasked to provide a forum for consultations on the technical and economic aspects of international trade in fish and fishery products including the applicable standards for production and consumption.

However, the issues on trade in fish and fisheries products have also been greatly discussed and driven by international markets and by various trade-related agencies which rarely involves the fisheries authorities and sometimes even devoid of contributions from the aspects of sustainable fisheries development and management. The developing countries are therefore confronted with difficulties in integrating such global instruments and requirements into their national trade legislations and policies. Nevertheless, global instruments which are agreed or enforced by international organizations should ascertain that the impacts of such instruments on the sustainable development of fisheries in developing countries and particularly on the small-scale fisheries in Southeast Asia are taken into consideration during the formulation of such instruments. Since it is important to reconcile the international driven issues with the promotion of sustainable fisheries development, therefore the implications of fish trade to the fishery resources and the environment, and on the quality and safety of fish and fisheries products as well as the adoption of trade barrier agreements both tariff and non-tariff on imported fisheries products, should be raised for negotiations in the international arena.

Fish Trade-related Measures

In 2008, the total fishery production of the Southeast Asian countries was 27.3 million metric tons valued at US\$ 28.6 billion of which production from marine capture fisheries, inland capture fisheries and aquaculture accounted for 51%, 9% and 40% of the total production, respectively (SEAFDEC, 2010). In 2009, the annual growth rate of fish exported as food from Southeast Asia was recorded at 7%



with reference to that of the data in 2000 (WTO, 2010). Fisheries also create employment opportunities for peoples in the region, where in 2007 for example, the fisheries sector engaged about 3 million people accounting for 1.5% of the total employed persons in the region (SEAFDEC, 2008).

While the demand for fish and fisheries products continues to increase, the concern on food quality and safety is also escalating. The sustainable use and proper management of the resources have been brought into the picture by various agencies and importing countries. The exporting countries are therefore forced to comply with the requirements reflected in the growing concerns of consumers on contamination and transfer of diseases from animals and on the chemical residues in fisheries products, as well as on the trade measures that aim to address the sustainable harvesting of resources by the fisheries sector.

Box 1. Concerns raised by ASEAN countries with regards to the application of SPS and TBT

Several concerns have been raised by the ASEAN countries with regards to the application of such Agreements:

- Limited knowledge and expertise in risk assessment and SPS/TBT measures constrained the further strengthening and harmonization of the technical regulatory mechanism within ASEAN;
- Insufficient involvement of scientific expertise from the academe and industry, as well as consumers in strengthening the scientific basis for food control decision making processes;
- Difficulties in accessing information on import requirements and limited financial support for capacity building and harmonization activities like ASEAN training activities, meetings and other means of sharing information and experiences; and
- Limited capacity in terms of laboratory facilities where only few countries have their laboratories accredited for ISO/IEC 17025. Currently, key laboratories in Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam have been accredited for ISO/IEC 17025 (FASOR, 2011).

Box 2. ASEAN regional position on fisheries subsidies

- Fisheries subsidies is recognized as a tool either used as temporary or long-term measures under a broad national development and management framework to ensure sustainable fisheries development
- The use of fisheries subsidies needs to be coupled with close monitoring and evaluation of status of fishery resources as well as the impacts of subsidies on socio-economic and the resources, which are different from countries to countries
- Fisheries subsidies contributing to sustainable fisheries as well as people livelihoods and poverty alleviation should be permitted
- Some fisheries subsidies whether they should be permitted or removed will depend on a number of factors including management regime, status of resources and the length of time that subsidies will be applied
- Fisheries subsidies contributing to over-exploitation of resources or unsustainable fisheries and trade distortion must be removed
- Close coordination between fisheries related agencies and trade related agencies in each country should be promoted to reflect the requirements and complexity of the fisheries

As a step towards the realization of the ASEAN Economic Community in 2015, the ASEAN Ministers adopted in November 2004 the ASEAN Framework Agreement for the Integration of Priority Sectors. The roadmap which is an integral part of the Agreement, includes issues specific to the fisheries sector, as well as horizontal issues cutting across all sectors such as: tariff elimination; non-tariff measures; customs cooperation; effective implementation of the Common Effective Preferential Tariff (CEPT) scheme; Improvement of Rules of Origin, Standards and Conformance; future investments; and improvement of logistics services. Among others, assurance that actions relevant to SPS/TBT on the development and application of fisheries quality management systems that ensure food safety through the implementation, validation and verification of the Hazard Analysis and Critical Control Point (HACCP) had also been required. Such efforts had been envisaged to enable the ASEAN community to be more competitive in trading its fish and fisheries products. As a condition for exporting fish, several measures related to trade of fish and fisheries products both non-voluntary and voluntary, have been initiated by international organizations and agencies. Among such regulatory measures are the General Agreement on Tariffs and Trade (GATT), the Agreements on the Application of Sanitary and Phytosanitary Measures (SPS) and Technical Barriers to Trade (TBT) shown in **Box 1**, the Agreement on Subsidies and Countervailing Measures (SCM) shown in **Box 2** and **Box 3**, and CITES issues. Moreover, some of the voluntary schemes include: Catch Certification, Catch Documentation and related documentation schemes (**Box 4**); Aquaculture Certification (**Box 5**); Traceability (**Box 6**); Eco-labeling (**Box 7**). It should be noted that the international NGOs have a strong influence in shaping the regulatory framework of trade in fish and fisheries products. Some NGOs lobby with the WTO and UN agencies to raise the profile of the environment, sustainable development and food safety in their trade agenda. Other organizations such as the Marine Stewardship Council (MSC) also set up practical tools such as eco-labeling schemes to foster sustainable trade in fish and fisheries products (**Box 8**).

Non-voluntary International Agreements

Tariff

Tariffs are duties levied on imported products. Tariff barriers are however, considered obstacles to trade and remained the principal legitimate type of government intervention. Nevertheless, tariffs could also be subjected for negotiations and could be progressively decreased based on the provisions spelled out by the World Trade Organization (WTO) which is the main international structure responsible for dealing with rules/negotiations on trade among nations. At the Uruguay Round of WTO

Box 3. Progress on the WTO negotiations on fisheries subsidies

The debate among the WTO Member Countries could not yet be settled, since there is no right answer to the different fisheries situation that vary throughout the world. Therefore, the Chair of NGRs set up a “Roadmap for Discussion on Fisheries Subsidies” which requires a stronger and more detailed justification from the Member Countries. Currently, the negotiation on fisheries subsidies at the WTO is under the third round of negotiation under the new Chairman of the NGRs and it had been changed from open-ended discussion to plurilateral format with limited number of participants by invitation only and thus far, has not included the ASEAN countries. Such plurilateral meetings are usually followed by open-ended transparency sessions where the Chair reports the matters discussed during the plurilateral meetings. In the recent open-ended informal meeting of the NGRs in February 2011, the only ASEAN Member Country Malaysia had the opportunity to meet the “Friends of the Chair (FOC)” who were appointed to take care of issues on fisheries management and that the FOC would consult with the WTO members on the technical inputs on fisheries management. After consulting with the delegations of several Member Countries, the FOC reported to the Chair that the core elements which should be mandatory for all members in respect of all sorts of fisheries and “tools” or “illustrative”, would be applied as appropriate.

The six core elements identified by the Chair of Negotiating Group on Rules (NGRs) during its open-ended informal meeting in February 2011 are as follows:

- 1) **Institutions and legislation**, to ensure that there is a management authority with sufficient legal power to do its work;
- 2) **Stock assessments**, to assess the state of the resource, with a variety of methods identified, including counting landings, catch, by-catch etc., to develop trends on how well the stock and possibly associated species are doing;
- 3) **Capacity assessments and management**, which could be effected through vessel registries, maintaining data on boats and licenses, and similar measures, with the idea being that the size of the fleet and its capacity to fish should match the amount of fisheries resources;
- 4) **Effort controls**, which could take the form of input controls, such as limits on areas, fishing seasons, gear, vessel sizes, and so forth, and output controls, that is, limits on how much a vessel can catch, through the setting of total allowable catches, quotas, etc.;
- 5) **Monitoring, surveillance and control**, which can be effected through direct control where all fish are landed in one place and counted by an inspector, or through periodic sampling, or through various forms of community organizations, including marketing cooperatives through which all fishers must sell their catch. More sophisticated methods and tools were also identified including satellite-based vessel monitoring systems, GPS, and video cameras, although such methods were not viewed as appropriate or possible for all fisheries; and
- 6) **Enforcement**, in particular penalties for violating the applicable fisheries management requirements. In some cases, there are criminal penalties, in others community based peer pressure is a main enforcement tool. In regard to all of these elements, the Friends reported that a large number of delegations had stressed the importance of technical assistance, capacity building and appropriate transition periods, which might vary by type of fishery.

As this is still an on-going process of discussion, the ASEAN Member Countries are encouraged to consult and provide views and experiences to FOC for the appropriate provision on fisheries management as updates for the Chair.

negotiations in 1995, it was agreed that 36% reduction of tariffs would be applied for the developed countries and 24% for the developing countries.

Within the Southeast Asian region, the ASEAN Free Trade Agreement (AFTA) in 1992 concurred to reduce tariffs on most processed agricultural and industrial products intended for intra-regional trading by 0.0 to 5.0% by 2003 (ASEAN, 2011).

The ongoing establishment of an ASEAN Economic Community or a single ASEAN market by 2015 has accelerated the pace of the regional integration to unify and extend the ASEAN Free Trade Area to the ASEAN Investment Area and the ASEAN Framework Agreement on Services, which are clearly aimed at facilitating trade. Although trade facilitation measures within the ASEAN had been agreed at the regional level or among a subset of members, most trade facilitation is non-discriminatory. Meanwhile, it should be noted that improved documentation, port logistics and so forth could reduce costs of trade with all partners (Pomfret and Sourdin, 2009).

Agreement on Technical Barriers to Trade (TBT)

The Agreements on the Application of Sanitary and Phytosanitary Measures (SPS) and on Technical Barriers

to Trade (TBT) were established and entered into force in 1995 during the Uruguay Round of Multilateral Trade Negotiations of the WTO to address the emerging debate over the use of standards in international trade. SPS measures aim to address and ensure that human and animal food is safe from contaminants, toxins, and diseases. It covers all relevant laws, decrees, regulations; testing, inspection certification and approval procedures; packaging and labeling requirements directly related to food safety. Nations are asked to apply only those measures that are based on scientific principles, and only to the extent necessary and not constituting a disguised restriction on international trade. The Agreement encourages the use of international standards where they exist and identifies the Codex Alimentarius Commission (CAC) food standards, guidelines and other recommendations as consistent with the provisions of SPS. Where a WTO member considers that a higher level of sanitary protection than afforded by Codex is necessary, it will have to produce scientific evidence based on valid risk assessment techniques.

The Agreement on TBT is concerned with the technical regulations on traditional quality factors, counterfeit practices, packaging, labeling, other than the standards covered by the SPS Agreement imposed on countries but

Box 4. Catch certification, Catch documentation and related documentation schemes

Catch certification refers mainly a certification scheme of the European Commission (EC)'s regulation 1005/2008 which came into force on 1 January 2010 and requires imported fisheries products entering the EC to be accompanied by a catch certification (Article 12) validated by the competent authority of the flag state of the vessel where the fish was caught. Indirect imports to the EC must be accompanied by additional traceability documentation provided by a third country. The scheme places strong emphasis on checking, inspection and verification activities. However, these requirements are not linked to the food-safety traceability and certification requirements applied to the same products.

"Catch documentation" in general refers to schemes established by Regional Fisheries Management Organizations (RFMOs) requiring documentation to accompany particular fish and fish products through international trade by identifying the origin of the fish for the purpose of determining levels of unreported fishing. There are two main types concerned under these scheme which are catch documentation schemes and trade documentation scheme.

One key difference between these types is that "catch certifications" are issued at the point of harvesting and cover all fish to be landed or transshipped while "trade documents" are issued only with respect to products that enter international trade. Both types of documents contain information relating to the fish in question, although catch certifications contain more comprehensive data. The terms "catch certification", "catch documentation" and other related terms have not been consistently applied in international practice. However, those schemes have the principle to combat IUU fishing and those documents accompany the fish through trade.

Considering that multiple formats required by each certification body may create confusion and burdensome administration and paperwork placed on operators/exporters, harmonization of these schemes would create incentives towards compliance, would promote international trade in fish products and would reduce deceit possibility or fraud. However, such catch documentation scheme should align with those of relevant RFMOs and the EC Catch Certification.

In Southeast Asia, there is a concern on the need to develop a common catch documentation scheme for the region that complies with those of the RFMOs' and EC's requirements, in order to facilitate intra-regional trade of fish and fishery products. Indonesia, for example, currently is a member of the Indian Ocean Tuna Commission (IOTC) in July 2007 and the Commission for the Conservation of Southern Blue Fin Tuna (CCSBT) in April 2008, has already adopted a catch certification scheme for tuna fisheries, which could be taken into consideration in the development of the Catch Documentation Scheme for the region. However, in the development and implementation of such common scheme, caution should be made as such scheme could adversely affect regional trade, particularly for countries that could not comply with the requirements of such scheme.

will not be more restrictive on imported products than on products produced domestically. Technical measures applied should not create unnecessary obstacles in international trade, have a legitimate purpose and the cost of their implementation should be proportional to the purpose of the measure. If the proposed measure is considered to violate the provisions of any of the two Agreements, it can be challenged and brought before the WTO dispute settlement mechanism. These agreements balance the competing demands for domestic regulatory autonomy and the global harmonization of product standards. At the same time, the agreements attempt to prevent standards from becoming a protectionist device.

The issues underlying the causes of unsatisfactory conditions in food quality and safety control in food trade include complexity of market systems, as well as the interaction and cooperation between the industry and government on food safety control matters. Several concerns have been raised by the ASEAN countries with regards to the application of those Agreements (**Box 1**).

In line with the imperative for accelerated economic integration towards the realization of the ASEAN Economic Community in 2015, the adoption and implementation of the new ASEAN Trade in Goods Agreement (ATIGA) effective in May 2010 which contains new obligations in both the SPS and TBT areas would facilitate and strengthen

intra-ASEAN trade. Under this Agreement, ASEAN has obligated its SPS related-activities in line with international standards and would explore additional opportunities for intra-ASEAN cooperation. For the TBT agreement, where applicable, ASEAN also obligates its technical regulations and conformity assessment procedures to be aligned with international standards and practices without sacrificing trade in the ASEAN. However, technical and financial assistance are still necessary to match the requirements imposed by SPS and TBT Agreements especially the insufficient capacity to assess the scientific justification of importing countries' SPS requirements, to undertake risk assessment and demonstrate any equivalence.

Fisheries Subsidies under the Agreement on Subsidies and Countervailing Measures (SCM)

With the deteriorating trend of the fishery resources globally, various international organizations are attempting to advocate the world scenarios in protecting these resources and discontinuing any actions that would threaten their sustainability. Fisheries subsidies become one of the global agenda discussed at WTO negotiations. A number of questions have been raised with regards to the financial support from governments to the fisheries sector, the incentives of which had not helped in achieving sustainable fisheries but seemed to encourage over-fishing activities. Thus, fisheries subsidies had been considered as linkage that contributes to over-exploitation of fishery resources.

The Doha Ministerial Conference in 2001 launched the negotiations to clarify and improve the WTO disciplines on fisheries subsidies, and during the Hong Kong Ministerial Conference in 2005, there was broad agreement on strengthening those disciplines especially the appropriate and effective Special and Differential Treatment (S&DT) for developing and least-developed Members which should be made integral part of the fisheries subsidies negotiations. The Chair of Negotiating Group on Rules (NGRs) circulated in November 2007 the Draft Consolidated Chair Texts of the Anti-dumping and on Subsidies and Countervailing Measures (AD and SCM) which includes disciplines on fisheries subsidies. Since then, a number of proposals pertaining to the Draft Consolidated Chair Texts have been submitted to the Chair especially the proposal on the “Need for Effective Special & Differential Treatment for Developing Country Members in the Proposed Fisheries Subsidies Text” submitted by India, Indonesia and China. The progress of the discussion has extended the disciplines on the prohibition of certain forms of fisheries subsidies to undertake further detailed work for appropriate and effective S&DT.

As such, trade negotiations in fisheries could be even more complex than in agriculture as the specificities of the sector are often overlooked. Among the specificities, the renewable nature of the resources and the question of property rights had been most manifested. These issues will again surface when the question of access to the resources and of the protection of the small-scale fisheries is dealt with. Many developing countries do not have the capacity to be active in so many fronts, especially that some countries do not have permanent representations in the WTO in Geneva and thus, would require profound assistance to be successful in those negotiations. In the past, only representatives from trade or from foreign affairs with inadequate information on the difficulties of implementing fisheries subsidies attended the negotiation rounds. With issues on fisheries raised during the negotiations, the consequent relationship between sustainable fisheries management and trade liberalization could receive less attention to some extent.

Besides, the requirements that would enable developing countries to grant fisheries subsidies in the Chair’s Text seemed too stringent and that many of such requirements would be impossible to fully comply with at this time. Such concerns had been discussed among the ASEAN-SEAFDEC Member Countries through various consultations and meetings in the last few years. The ASEAN regional position on fisheries subsidies is summarized in **Box 2** while the progress on the negotiations on fisheries subsidies is summarized in **Box 3**.

CITES issues

With the aim of ensuring the international trade in specimens of wild animals and plants without any threats to their survival, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement entered into force in July 1975. There are currently 175 Parties including all countries in Southeast Asia. CITES works by subjecting international trade in specimens of selected species to certain controls. All import, export, re-export and introduction from the sea of species covered by the Convention has to be authorized through a licensing system. The species covered by CITES are listed in three Appendices, according to the degree of protection they need. Appendix I includes species which are threatened with extinction; Appendix II includes species which are not considered threatened with extinction but may become so if their trade is not regulated, while Appendix III includes species which are not considered threatened with extinction, but are under special management in certain countries.

CITES is one of the important issues for trading of international and regional aquatic species since any goods which may be wildlife products or even live animals controlled by international treaties must be required to have special permits to export, import, and re-export the items legally. Without necessary permits, those goods are subject to seizure and forfeiture, and the importers/exporters are liable to prosecution. In order to secure trade-flow of such species, there are more concerns on the listing of commercially-exploited aquatic species into the Appendices of CITES. Many aquatic animals of economically importance have been increasingly proposed for listing in the Appendices, *e.g.* tuna, humphead wrasse, sea horses, and sharks.

The number of proposals related to commercially-exploited aquatic species submitted to CITES are still rising, which are pushed forward by environmentalists and developed countries. Most pressure points to the species that are highly



Box 5. FAO Technical Guidelines on Aquaculture Certification

The increasing importance of aquaculture in providing fish supply for human consumption, has led to a number of aquaculture certification schemes which were established to ensure responsible aquaculture operations and product safety for human consumption. The guidelines, after four years of discussion and debate among governments, producers, processors and traders, were adopted by the FAO COFI in February 2011. As non-binding in nature, the guidelines cover animal health and welfare, food safety, environment integrity and socio-economic aspects associated with aquaculture.

The use of the guidelines will help the public and private standards to work in the same direction, reducing pressure on non-tariff barriers. During the discussion at the Regional Technical Consultation on International Fisheries-related Issues (2011) in January 2011, it was suggested that issues related to social aspects in the technical guidelines should be left under the purview of the International Labor Organization to avoid duplication of efforts. There are also concerns on the possible increased production costs resulting from the adoption of the Guidelines and under environmental integrity. The concerns should be made on the effect of the creation of trade barriers when exporting aquaculture products. Therefore, the possible assistance from FAO and developed countries in the adoption of the Guidelines should be explored.

Box 6. Traceability

The Codex Alimentarius Commission (2004) defines traceability or product tracing as “the ability to follow the movement of a food through specified stage(s) of production, processing and distribution”. Traceability makes it easy to pinpoint the source of a food safety problem very quickly. For contamination in a particular area, authorities can quickly determine exactly where the contaminated products originated. Without traceability it can take weeks to find the source of the problem. Lengthy food-safety scares can result in large recalls, unnecessarily discarded food and reduced consumer confidence. Traceability systems are basically record-keeping systems and the concepts generally used to distinguish theoretically between different kinds of traceability systems (Codd, *et al.*, 2008). Internal Traceability is traceability of the product and the information relating to it, within the company. Internal traceability systems are also aimed at productivity improvement and cost reduction. The “one step forward and one step back” approach articulates the required state at each link in the chain knowing where the products come from and where they are delivered. Chain traceability is information on the origin of materials and parts, processing history, and the distribution and location of the product at various points in its production.

By using traceability measures (ICTSD, 2006), regulators seek to: identify unsafe products that can be withdrawn and distinguished from post market safety aspects; provide consumers with information on quality *e.g.* nutritive or medical claims and air practices; comply with security aspects of food marketing such as those that fall under the US *Bioterrorism Act*; and achieve business management goals associated with quality controls, business partnerships, production and distribution and industry integration. Recently, governments and organizations around the world have also been developing different systems on seafood traceability *e.g.* TraceFish (EU), TraceShrimp (Thailand). For example, TraceFish, the short title for the “Traceability of Fish Products”, was the project funded by the European Commission. The objectives were to bring together companies and research institutes to establish common views with respect to what data should follow a fish product through the chain from catch/farming to consumer. The main outputs were three voluntary consensus-based standards for recording and exchange of traceability information in the seafood chains including Farmed Fish Standard, Captured Fish Standard and Technical Standard (TraceFish, 2011).

In order to achieve full traceability for the entire food industry, it must have traceability system of the products in the whole supply chain. Meanwhile, the costs associated with technical compliance to these tracing systems are often high and would be economical in large volume production and exports. These costs normally paid by exporting countries, relatively create problems and difficulties in accessing international market by exporting countries where small-scale and artisanal fisheries are the main contributors. During the 12th Session of the COFI Sub-Committee on Fish Trade, 2010 it was agreed that traceability initiatives were useful tools to verify the integrity of the supply chain however, recognized that the traceability requirements for food safety were somewhat different from those linked to sustainability. Therefore, it was suggested that FAO should have an ongoing role in providing technical assistance to countries implementing traceability systems or seeking to integrate their traceability systems. FAO should also monitor the technical developments and assess their applicability in traceability systems (FAO, 2010).

In addition, the SEAFDEC Program on “Traceability for the Aquaculture Products in the ASEAN region” implemented from 2010-2014 aims to provide a platform for the sharing of information and experiences among the ASEAN Member Countries on traceability systems to better enable the regional aquaculture industries to implement appropriate traceability systems for aquaculture products and to meet international traceability requirements in the network of aquaculture production, marketing, and trade.

harvested without proper management. There are different opinions between resource management organizations and wildlife conservation organizations debating during the past decade in this forum. Since Southeast Asian region is considered as an area with diverse commercially-exploited aquatic species, close monitoring on the issues should be made. However, since lack of scientific data had been noted especially on shark production and identification of shark species, countries in the Southeast Asian region may face the difficulties in the debates and negotiations on the inclusion of such species into the Appendices.

In the region, deliberations on the issues have been carried out through several fora and it was agreed that the listing of commercially-exploited aquatic species to CITES Appendices should be done under the purview of competent organizations like FAO. An FAO *Ad-hoc* Advisory Panel for CITES was therefore established in order to review the listing of commercially-exploited aquatic species and to provide the technical/scientific advice, which could also incorporate the relevant technical/scientific information from other relevant Regional Fisheries Bodies including SEAFDEC.

Among the recommendations for Southeast Asian countries are priority areas, *i.e.* improvement of data collection on sharks at the national level in order to improve compilation of fishery statistics and information on sharks and rays in the region (*e.g.* CPUE, stock assessment, population dynamics), and implementation of HRD activities on species identification of major shark species in the region as well as to continue monitoring the issue and try to come up with relevant information as basis for discussion and formulation of common/coordinated position among the Member Countries.

Voluntary Instruments

With different features from the abovementioned measures, voluntary instruments are known to be sound policy

options and could be associated with the market-driven measures. These voluntary instruments are concerned about the awareness of consumers on safety and quality of fish and fisheries products while embracing the context of ecological integrity underlining the need to address the sustainable use of the resources and ecosystems. Such measures have motivated the fisheries industry and markets to reconcile credible certification schemes to support responsible and sustainable fisheries as well as to maintain international and regional trade.

The initiatives of the recent measures are now shifting towards market-driven standards and the need for consumers' acceptance for fisheries products. Several standards and certification schemes have been developed and introduced which are mostly regulatory and voluntary

Box 7. Eco-labeling

Eco-labeling was first publicly promoted by Unilever PLC/NV and the World Wide Fund for Nature (WWF) at their Marine Stewardship Council (MSC) initiative in early 1996 (FAO, 2011). The failure of traditional governance structures to successfully implement sustainable fisheries management policy has created a niche for environmental non-governmental organizations to play an active role in drawing public attention to unsustainable fishing practices around the world and bringing pressure to bear on governments and RFMOs entrusted with fisheries management to implement more conservation-minded and sustainable measures (Shelton, 2009). Eco-labeling issues have become a special interest in the international fish trade forum which viewed eco-labeling as a potential tool to stimulate more responsible fisheries and aquaculture practices and hence improving sustainability. Whilst the eco-labeling principles are consistent with the sustainability concepts, there are however major concerns given to its impacts on barriers to trade due to compliance cost and/or lack of capacity to comply (where there is a strong demand for labelled products) as well as burden of compliance particularly on small-scale producers.

The SEAFDEC-Sida project has since the SEAFDEC Council meeting in Brunei Darussalam in 2006 worked towards the aim of developing a regional strategy regarding eco-labeling. In this effort, consultations and an expert meeting on the role of governments has been held. The results emphasized that the government has several important roles to play, particularly when it comes to being pro-active and the prerequisites for opening up for labelling and certification (food safety, infrastructure, combat illegal fisheries, market access etc.) However, the overall impressions about eco-labeling (Bjerner *et al.*, 2006), which are the main cause of hesitation in adopting eco-labeling, and the general perceptions about eco-labeling include: Eco-labeling is seen as a regulation imposed by importing countries to discriminate ASEAN products; Eco-labeling criteria is not practical for multi-species fisheries in ASEAN; Eco-labeling market is not guaranteed, neither is the premium price; and Costs associated with certification systems can be a major barrier especially for small-scale producers.

However, the study found that there are national eco-labeling schemes in some countries which could be adopted or adjusted to fisheries and aquaculture products as well as the concern on its potential to add value on traditionally produced products and to facilitate market access.

Box 8. Marine Stewardship Council Initiative

The initiative led by *Marine Stewardship Council (MSC)* is to provide support on certification, which is regarded as market incentive. The MSC became an autonomous, global, non-profit organization in 1999 whose role is to recognize, via a certification program, well-managed fisheries and to harness consumer preference for seafood products bearing the MSC eco-labeling of approval. The MSC has established a process for third-party certification of fisheries or fish stocks as well as for fishing practices. It recognizes that a sustainable fishery should be based on three principles: (1) maintain and recover healthy populations; (2) maintain integrity and diversity of ecosystems which the fishery depends; and (3) maintain and develop an effective fisheries management systems including compliance with relevant local and national laws and standards and international understandings and agreements (MSC, 2010). Its eco-labeling program is fully consistent with the guidelines for eco-labeling of fish and fishery products developed in 2005 by the Food and Agriculture Organization of the United Nations (FAO).

The greatest challenge for MSC, however, has been certifying small-scale tropical fisheries. The first small-scale tropical fishery from a developing country to be certified to MSC was the rock lobster fishery in Baja California, Mexico, in 2005. The certification expired in 2009, and is now under reassessment. So far, MSC has certified the hard clam fishery of Vietnam which is the only case of a tropical fishery certified in the Southeast Asian region (MSC, 2011).

During the Regional Technical Consultation on Adaptation to a Changing Environment in November 2010 in Bangkok, Thailand, the RTC mentioned that as MSC is not universal standards therefore, it is not possible for MSC to modify its standards to suit any particular region. However, in order to meet standards/requirements, the region could emphasize its attempts to: improve fisheries management; implement harvest strategies and harvest control rules; support catch documentation scheme and data collection; and support traceability systems.

based on the requirements of importing countries. The voluntary instruments elaborated in this paper include measures such as catch certification, the FAO Technical Guidelines on Aquaculture Certification, Traceability, Eco-labeling, and the Marine Stewardship Council initiatives.

Conclusions

In order to strengthen fisheries trade in the Southeast Asian region and beyond, it is necessary to ensure that the various measures and instruments imposed by importing countries are regularly examined in order that such requirements do not comprise the unnecessary barriers to trade. In addition, the regulatory requirements for food safety and the general voluntary schemes had encouraged many exporting countries to look into voluntary labels or certifications allowing producers and exporters of fish and fisheries products to target specific segments of consumers, and thus gaining a competitive advantage. Furthermore, the criteria on environmental sustainability and social stability should be viewed from the aspect of gaining increased access to new markets.

Although the growing global concern on environmental status, including climate change, human rights, social well-being also comprise the more stringent requirements of importing countries, such concern should also be considered from the advantage of tracing the quality of the products through the whole production chain. Therefore, in order to ensure the effectiveness and credibility of the production processes from catching the fish to processing and transporting, non-voluntary schemes should be considered and complied by the countries, and mainstreamed with their national regulations. Considering that the ASEAN countries are main exporters of fish and fisheries product to the world market, the countries should keep track of the developments of the various schemes, measures and instruments especially those which are binding with respect to sustainable fisheries and environmental practices. In this way, the countries could secure the benefits from fisheries trade as well as ensure smooth intra-regional-international trade and at the same time promote the sustainable utilization of the fisheries resources.

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Promoting Effective Fisheries Co-management through the Community Fisheries in Cambodia

Ing Try and Hort Sitha

In 2000, Cambodia formalized the cooperative arrangement between the government and local communities for the management of the fishery resources, resulting in the emergence of a concept which is known as Community Fisheries. As a policy of the government under this concept, fishing areas are allocated to the community fisheries for them to manage in a sustainable and equitable manner with the main purpose of alleviating poverty in fisheries communities. In view of the intensified promotion of its Community Fisheries, Cambodia had been identified as the Lead Country for fisheries management and decentralization under the Work Plan of the ASEAN Fisheries Consultative Forum for 2010 to 2012, with the main target of developing the country's national policy and program on the implementation of co-management based on the concept of Community Fisheries.

Cambodia covers an area of 181,035 km² and features a 435 km coastline along the Gulf of Thailand, with a water area of 4,869.84 km². About 30% of the country's land area is seasonally flooded making water, fisheries and forests the dominant features of the country. The Mekong River watershed which covers up to about 86% of the country's landmass, includes the Tonle Sap Great Lake one of the largest floodplain lakes and the most productive inland ecosystems in the world.

The fisheries sector of Cambodia encompasses extensively the inland capture fisheries in floodplains, rivers and lakes as well as rice field fisheries; marine capture fisheries operating mainly in the country's EEZ of about 55,600 km²; and some relatively small number of aquaculture activities. Fish production from inland capture fisheries of Cambodia

has been estimated to be between 230,000 and 400,000 metric tons per year, and in 2007 it accounted for about 21% of the total production of Southeast Asia from inland fisheries (SEAFDEC, 2010) and about 4% of the world's total production from inland capture fisheries.

Freshwater fisheries provide 75% of the protein requirement of Cambodians, which is estimated at 67 kg/person/year. Since more than 60% of the country's inland capture fish production is produced from the Tonle Sap Great Lake, it has been estimated that between one and three million people depend directly on Tonle Sap fisheries for their livelihood and food security. During the wet season, the Tonle Sap Great Lake increases in size by four times from 250,000 ha to about 1,000,000 ha, contributing to a network of wetlands which occupy up to 30% of the country's total land area, playing an important role in the economic, social and cultural life of the Cambodians. Moreover, the country's freshwater ecosystems host a high diversity of species, where it was reported that more than 500 species of freshwater fishes are present or are likely to be in existence in the Cambodian Mekong River while more than 700 species had been recorded in Cambodian freshwater fisheries (FishBase: November 2010).

On the other hand, the coastal zone of Cambodia supports diverse habitats including mangrove forests, coral reefs and sea grass beds, and marine habitats. These ecosystems are known to support more than 435 marine fish species from over 97 families including the globally endangered marine mammals such as dugong and marine dolphins (FishBase: November 2010). In 2008, the country's fish production from marine fisheries was 66,000 metric tons. Since aquaculture is a new economic venture in Cambodia, the country's fish production from aquaculture in 2008 was recorded at 39,700 metric tons (SEAFDEC, 2010).

Co-management in the Fisheries Sector

Co-management in the fisheries sector is a process of management in which the government shares power with the fishery resource users, and where the users are given specific rights and responsibilities relating to information, decision-making, and implementation of the fishery management activities. **Fig. 1** shows the interconnectivity of the various stakeholders in fisheries co-management in Cambodia.



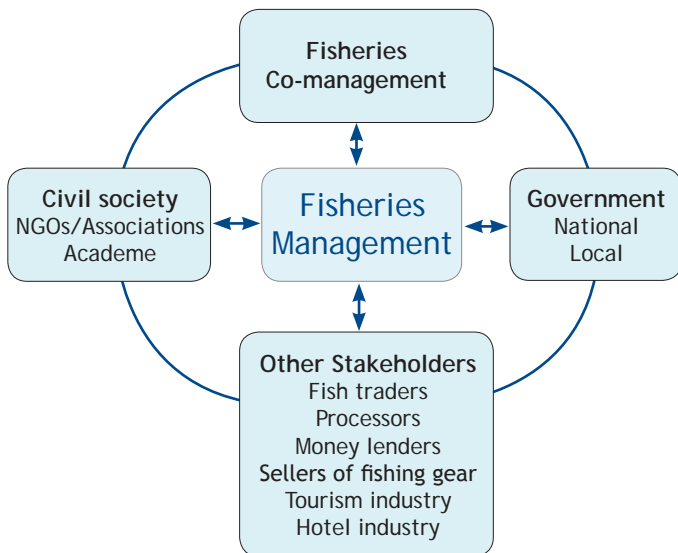


Fig. 1. Interconnectivity of the various stakeholders in fisheries co-management in Cambodia

Community Fisheries in Cambodia

In 2000, the Government of Cambodia through its Fisheries Administration (FiA) formerly the Department of Fisheries (DOF) reformed the fisheries policies of the whole country by empowering the local communities to manage their resources by themselves, which the government dubbed as “community fisheries” or CFs. As of 2006, there were 509 established CFs, 469 of which were inland CFs while the rest were coastal CFs (Serywath and Sy Vann, 2009). The main features of the CFs in Cambodia are shown in **Box 1**.

Box 1. Main features of the Community Fisheries (CF) in Cambodia

- CF is a cooperative arrangement between the government and local community in fisheries co-management
- CF is voluntarily formed by groups of people in one or more villages
- Government allocates fishing areas for the CF to manage in a sustainable and equitable manner in order to contribute to poverty alleviation
- Roles, rights and obligations of CFs and government are clearly defined in the Sub-decree on Community Fisheries Management
- CFs should be led by committees which develop their respective agreements and management plans, as well as implement their plans

Issues and Constraints of the Fisheries Sector of Cambodia

The Government of Cambodia has a policy that aims to centralize and commercialize the country’s fisheries resources. At the central level, the Fisheries Administration (FiA) formerly the country’s Fisheries Department, awards the concession rights to concerned communities for the use of the fishery resources including the country’s richest

fishery resource, the Tonle Sap Great Lake. The role of the FiA is mainly to enforce the law and facilitate the surveillance and control of fishing activities, including the issuance of fishing licenses as well as collection of fees and taxes from the stakeholders engaged in fishing activities.

Nevertheless, with the establishment of CFs in some areas, license fees were no longer required for medium-scale operations in inland fisheries and to some extent the license fees for some selected coastal fishing gears had also been reduced. The current Fisheries Law was promulgated in 1987 under the Socialist Government of Cambodia. Since then, privatization of the exploitation of fishery resources had been promoted, but enforcement and implementation of the law had been inadequate which could be because the provisions under the law are mainly copied from a 1956 decree, which has been considered obsolete especially in dealing with the rapid changes in fisheries in particular and in the country’s economy in general.

Such concern was also coupled by the fact that the enforcement of the country’s fishing law had been stymied by corruption and inadequate human and financial resources. As a result, uncontrolled fishing operations led to overfishing which has become a serious concern in recent years, considering that fish production had steadily decreased to an all time low.



Consultations conducted by FiA to disseminate the need to conserve the country’s fishery resources



Left: Reforestation of the flood forests; and Below: Mangrove reforestation



The large- and medium-scale fishers as well as small-scale family fishers operate under the extensive regulations enforced by FiA. However, since enforcement of the regulations in protecting the resources had been weak, over-fishing and illegal fishing practices continued to be practiced by the user groups in order to maximize their catch from the diminishing common resource pool.

Commercial fishing lot system had been in existence in Cambodia since about 1864, which initially received guidance and advice from the French protectorate authority. However, as the country's population grew at a very fast rate and with the natural resources starting to degrade, commercial pressure on the diminishing resources had a great impact on the livelihoods of the local people. The struggle for survival of the local fisherfolks led to serious conflicts with the fishing lot owners, as both parties compete for their respective fishing rights and interests. While the interest of local fisherfolks was mainly for survival, the interest of the fishing lot owners was to maximize profits that could be derived from their fishing operations. The mechanism of the Government did not seem to operate for the protection of the livelihoods of the local fisherfolk. As a matter of fact, the Fisheries Law may have been developed without taking into consideration the need to solve any such conflicts because the Law seems to focus mainly on protecting the interests of the fishing lot owners as major source of revenues for the national budget. Apart from the

various factors that affect the fishery resources leading to eminent decline, the country's population had also been fast increasing.

The population of Cambodia is reported to be 13 million of which 84% live in rural areas, and over 85% of the rural people depend directly on the diminishing natural fishery resources for their livelihoods and food security. Moreover, due to poor fishery resources management over-fishing became rampant while many fishers had been operating irresponsible fishing gear, while the people also continued to over-exploit the flood forests including cutting of trees and mangroves, mainly due to inadequate awareness on the need to conserve the resources and the absence of community fisheries law.

In addition to the unregulated use of natural resources, the overall fishery situation had worsened due to the impending dam construction in the upstream area of Mekong River System which could impact the fisheries and ecology of the Mekong River and especially that of the Tonle Sap Great Lake. In addressing the problems of depleting fishery resources and complete dependence of the various stakeholders particularly the country's poor rural population on these resources, the FiA had been exerting efforts to assist the rural people through the promotion of community development projects and activities including the reforestation of the flood forests and mangrove areas.

Effectiveness of Co-management in Community Fisheries

In order to address the aforementioned constraints, the concept of fisheries co-management had been promoted by FiA as a tool to improve fishery management. The approach appeared very promising since under the framework, the resource users at different levels would make their own decisions and take subsequent actions in safeguarding the fishery resources most especially the fish stocks for their own benefits. Moreover, expansion of the fishing lot system to include the floodplain habitats and prompting greater involvement of the fishing communities in management and operation of the fishing lots, were considered major strategies in the improvement of the fishery management.

Co-management is not a new concept in the history of Cambodian fisheries. During the socialist regime of the country, the people were organized to work together in groups known as solidarity groups or *Krom Samaki*. The activities of the fishing solidarity groups had some similarities with that of the concept of co-management. Nevertheless, experience had shown that this system did not work as there were allegedly some loopholes. Considering

that the key in the co-management of fisheries is in the sharing of power, responsibilities and benefits between the government and the concerned communities, during the socialist government of Cambodia it was impossible to ensure equal power, responsibilities and benefits between the grassroots and the government's higher authorities.

Nonetheless, in the late 1990s the concept of Community-based Natural Resources Management (CBNRM) was initiated by local NGOs working in local villages to improve the livelihoods of the communities and initiate natural resources management. This concept eventually led to the subsequent establishment of Community Fisheries (CFs) in some provinces located in the upper areas of the Mekong River with financial support from the Oxford Committee for Famine Relief-Great Britain (Oxfam GB) and Oxfam America starting in 1998. Later in 1999, CFs were established in Siem Reap Province with support from the Food and Agriculture Organization of the United Nations (FAO) and on the same year, the concept of community coastal resource management was initiated in the country's coastal areas with financial support from the Danish International Development Agency (DANIDA).

Prior to 2000, there was no law on community fisheries or specific legal framework that would involve the fisheries communities in the management of the fishery resources. Since the concept of CFs initiated by the NGOs was promoted with different guidelines depending on the experience and capability of the NGOs, the FiA strengthened the process of establishing community fisheries throughout the country taking into consideration the relevant provisions under the Fisheries Law which was promulgated in 1987.

When the Royal Government of Cambodia decided to reduce the concession fishing lots in late 2000s, to an area of about 538,522 ha or 56% of the total fishing lots, and released this area to the local people for small-scale fishing lot concessions, the FiA intensified the establishment of CFs throughout the country for both freshwater and coastal



Alternative livelihood in CFs: plastic pond culture of freshwater fish

areas. In promoting the CF concept, representatives from local communities, local authorities, local and international NGOs as well as government institutes had been actively involved in the preparation of the necessary legal documents such as CF guidelines, internal regulations, sub-decrees, by-laws, CF agreements, and CF management plans. As a result, from the total number of 509 CFs covering both inland and coastal fishery areas, 309 CFs had already their own regulations, 197 CFs had developed mapping systems, 58 CFs have their respective management plans, 142 have action plans, and 95 CFs had established fish sanctuaries and *refugia* systems (Serywath and Sy Vann, 2009; Ing Try *et al.*, 2010).

The methodologies for promoting CFs include building awareness and dissemination of the fisheries law and sub-decree on community fisheries which are necessary to ensure the sustainable utilization and management of the fisheries resources. Therefore, training sessions were conducted to develop the functional skills of the community members especially on financial management, administration, patrolling role, CF management, and on the advantages and aspects of conserving the fisheries resources, among others. Moreover, study tours were made part of the human capacity building especially for the CF members to enable them to learn lessons from the other CFs and exchange experiences on the important role of CFs in resources management for the development in their respective communities.



Demarcation of lots under the CF system

Box 2. Interventions of the Royal Government of Cambodia through the FiA to strengthen the CFs

- Preparation of the CF registration documents for submission to the Ministry of Agriculture, Forestry and Fisheries
- Demarcation of CF boundaries
- Preparation of CF fishing area management plan
- Implementation of alternative livelihood programs
- Stock enhancement through establishment of fish sanctuaries and artificial habitats
- Protection and reforestation of flood forests and mangrove areas
- Strengthening coordination and collaboration with key stakeholders, especially with the commune councils

Starting in 2007 and after CFs had been established in almost all the important fishing areas of the country, the Government of Cambodia focused its efforts in strengthening the capability of CFs in resources management considering that some CFs had not been functioning well, while some CFs still need support from the government to ensure their sustainability. In this regard, the government through the FiA continued to extend assistance and interventions for the development and strengthening of the CFs (**Box 2**).

Accomplishments of Fisheries Co-management in Community Fisheries

After the component gap in fisheries co-management of the CFs was addressed, the outcomes and accomplishments had

Box 3. Accomplishments of fisheries co-management in Community Fisheries

- Legal documents related to CF management are in place
- Management structures to support CFs had been subsequently established at the national level (Community Fisheries Development Department); the provincial level (Community Fisheries Development Units); and at the local level the members of the Community Fisheries Committee (CFC) had been elected
- Network to support CFs were established, namely: (i) Technical Working Group on Fisheries have been formed and functioning well; (ii) Local and International NGOs are strongly and actively supporting the activities of the CFs; (iii) Commune Councils closely cooperates with the CFs (where CF management plans had been integrated with commune development plans)
- Capacity of CF committees had been built through training, exchange visits, information dissemination, project demonstrations, and conduct of seminars
- Out of the total CFs established throughout the country, 236 CFs have been registered at the Ministry of Agriculture, Forestry and Forestry (MAFF) and the rest of the CFs are still in the process of preparing their registration documents and requirements

been positive as shown in **Box 3**. It should be noted that the CFs also played a significant role in the establishment and management of a *refugia* system for blood cockles for food security of the coastal fishers considering that blood cockle is one of the important economic commodities in the coastal areas of Cambodia (Ing Try *et al.*, 2010). Moreover, considering that the advantages of co-management focused on environmental protection as well as on social and economic gains for all concerned, certain positive changes had been brought about after the intensive promotion of co-management through the establishment of the CFs as shown in **Box 4**. Nevertheless, the sustainability of the CFs is still being confronted with various challenges as shown in **Box 5**.

Box 4. Positive changes brought about by the promotion of co-management in the CFs

- Awareness of the local people on the role of the CFs had been enhanced, thereby improving the participation of local people in resource management
- Collaboration between the CFC and the commune council is strengthened
- Access rights to fishery resources of CF members are more secured
- Flood forests and fisheries resources in the CF fishing areas are well protected
- Flood forests and mangrove areas are reforested
- Fisheries resources have increased in some CFs
- Alternative livelihoods of CF members are promoted and implemented

Box 5. Main challenges in the sustainability of Community Fisheries

- Most CFs still depend on external support
- CF Committee performs its role on a voluntary basis and there had been no regular incentives for its members
- There had been no proper source of income for the CF Committee to implement their activities
- Capacities of CF Committee are still limited and to some extent inadequate





Conclusion and Way Forward

The fishery resources in Cambodia had been decreasing year by year especially after the civil war that lasted for over twenty years and the rapid adoption of the free market economy in the 1990s. The factors that affected such decline included the country's increasing population, poor fisheries resources management, unregulated utilization and exploitation of the natural resources, and development of structures in the upstream part of the Mekong River System that had impacted on the fisheries and ecology of the Mekong River.

After the fisheries policy of Cambodia was reformed, and considering the enormous importance of fisheries resources to the country, effective fisheries co-management has been promoted through the establishment of Community Fisheries. The CFs had been promoted with the underlying objectives of improving governance and ensuring more equitable and sustainable allocation of the resources, with co-management in the fisheries sector playing an important role in the development and strengthening of the CFs. To date, 236 CFs had been registered with the Ministry of Agriculture, Forestry and Forestry (MAFF) and other CFs are still preparing for registration and are being assisted by the FiA to comply with the requirements because all CFs are supposed to have their respective legal CF management documents, management structures and networks to support their activities. Moreover, the capacity of CF committees is enhanced through human capacity development as well as information exchange and dissemination being promoted by the FiA. However, not all CFs are ready with all these requisites, therefore continuing assistance is necessary and should be urgently extended to them.

Moreover, as indicated in the AFCF Work Plan for 2010-2012, the government through the FiA has been expected to formalize the national policy on the implementation of fisheries co-management and decentralization approach.

Specifically, the country would pursue the task of developing and implementing relevant activities in support of the implementation of the national policy to promote fisheries co-management, and exchanging experiences with other ASEAN countries through workshops and seminars, especially the lessons learned by Cambodia in the implementation of fisheries co-management through the concept of Community Fisheries.

However, as mentioned in the foregoing Cambodia still needs support in terms of financial and human resources, to be able to conduct the activities related to the sustainability of the CFs and more particularly for undertaking the activities lined up under the AFCF Work Plan for 2010-2012. Nevertheless, recognizing that such activities would contribute to increased awareness of local people, increased local participation in resources management, better working relationship between CFs and government authorities, and sustainable conservation of fishery resources and habitats, FiA is intensifying its efforts to strengthen the role of CFs in fishery resources management which is the main requirements for the sustainability of the CFs and enhancement of livelihoods for the betterment of the local people especially those in the fisheries communities.

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Combating Illegal, Unreported and Unregulated (IUU) Fishing to Attain Food Security and Alleviate Poverty: Initiative of Indonesia

Achmad Poernomo, Purwanto and Ahmadi

It is true that there is a global crisis in the midst of the fisheries sector in the form of illegal, unreported and unregulated (IUU) fishing, which brings about negative impacts on economic, social and ecological attributes of fisheries affecting food security. Specifically, IUU fishing has contributed to the reduction food supply, lost livelihoods and state revenues, diminishing fish stocks, and damaged ecosystems, with the most devastating effects concentrated in developing countries due to their greater vulnerability. These illegal activities form a complex web - from illegal fishing activities, to illegal trade, and finally to consumers demanding catch from unsustainably fished stocks due to the underlying objectives of getting high profits from illegally caught fish. Moreover, there is no denying that IUU fishing is a significant contributor to global fisheries trades and that international/regional dialogues on the issue have been increasingly moving towards the implementation of measures to combat IUU fishing.

Strengthening regional and sub-regional efforts to combat IUU fishing is one of the priority actions of the ASEAN countries towards the development of the ASEAN Economic Community. Therefore, this concern has been reflected in the work plan that was developed, agreed upon and adopted by the ASEAN Fisheries Consultative Forum (AFCF) during the AFCF Meeting in Hoi An, Vietnam in June 2009 and by the ASEAN Sectoral Working Group on Fisheries (ASWGF) also in Hoi An in June 2009. The AFCF Work Plan for 2010-2012 was later endorsed by the 30th Senior Officials Meeting of the ASEAN Ministers on Agriculture and Forestry (SOM-AMAF) in Brunei Darussalam in October 2009. The Work Plan included the “key cluster areas” for each country under the AFCF Framework, and Indonesia was designated as the lead country for the cluster on Combating IUU Fishing. Thus,



Indonesia is expected to establish a regional network of monitoring, control and surveillance (MCS) in the ASEAN region as well as consolidate supporting activities to implement the regional initiatives related to IUU fishing.

Efforts to combat IUU Fishing and to promote sustainable fishing practices and management of fishing capacity have also been considered high priority areas under the SEAFDEC mechanism. Further initiatives and efforts to combat IUU fishing had been promoted in the region and sub-region through a series of meetings convened by SEAFDEC and other organizations as well as those by the collaborative project of SEAFDEC and the Swedish International Development Cooperation Agency (Sida) such as the Workshop on Fishing Vessel Record and Inventory in Satun, Thailand in July 2009, the First Meeting of the Andaman Sea sub-region in Phuket, Thailand in October 2009, the Forty-Second Meeting of the Council of the SEAFDEC in Lao PDR in April 2010, the Expert Consultation on Managing Fishing Capacity to Combat IUU Fishing in Southeast Asia in Bangkok, Thailand in September 2010, and the Asia Pacific Coordinating Meeting on Combating Illegal Fishing and Promotion of Maritime Economy in Phuket, Thailand in November 2010.

At the bilateral level, Indonesia and Philippines have recently adopted collaborative measures to address IUU fishing in their shared waters with a memorandum of agreement on combating IUU fishing. At the trilateral level, Indonesia, Malaysia and Singapore have regularly conducted collaborative patrol activities under the MALSINDO (Malaysia, Singapore and Indonesia) program and the joint “Eye in the Sky” air patrol to combat IUU fishing activities in the Strait of Malacca. There are also a number of regional initiatives involving Indonesia, Malaysia and Philippines with respect to combating IUU fishing in Sulawesi Sea, which include the participation of these countries in the Sulu-Sulawesi Marine Ecoregion Programme of the World Wide Fund (WWF) for Nature, and the Regional Plan of Action (RPOA) to Promote Responsible Fishing including Combating IUU Fishing, as well as in joint patrol exercises, and in intensifying cooperation among local business enterprises of these three countries on the management of fishing capacity and in combating IUU fishing.

Combating IUU Fishing in Indonesian Waters

The increasing demand for fish by the increasing population coupled with the diminishing fishery resources are concerns that confront the Southeast Asian region which had been linked to the rising cases of IUU fishing. Torell *et al.* (2010) analyzed that illegal fishing in Southeast Asia is a serious problem that impedes the attempts to manage the fishing capacity and to a large extent, has negatively affected the efforts of the countries in the region towards attaining sustainable fisheries development and food security.

As with some countries in Southeast Asia, Indonesia has encountered and experienced IUU fishing in various forms, including foreign fishing vessels illegally using the Indonesian flag, fishing without or with a fake license, fishing without or with fake vessel registration papers, vessel with fishing license but the specification of vessel is different from the vessel specification written in the license, vessels carrying more than one flag, fishing in waters outside the permitted fishing areas, operating prohibited fishing gears and methods, landing of fish in unauthorized ports, transfer at sea of catch from Indonesian fishing grounds and unreported or misreporting or underreporting of catch. These IUU fishing activities are being conducted by both domestic and foreign fishing vessels flying the flags of Indonesia, Malaysia, Philippines, and those of other neighboring and distant water fishing states such as Thailand, Vietnam, People's Republic of China, and Chinese Taipei. There are approximately more than 1000 foreign vessels involved in IUU fishing in the Exclusive Economic Zone (EEZ) of Indonesia every year.

Indonesia is an archipelagic island country which is located on the crossroads of the Indian Ocean and Pacific Ocean, and bridges the two continents of Asia and Australia. It is the largest archipelago of the world and encompasses about 17,508 islands with a total land area of 1,919,317 km² and total coastline of 54,716 km. The country has five main islands: Sumatra, Java, Borneo (also known as Kalimantan in Indonesia), Sulawesi, and New Guinea as well as two archipelagos: Nusa Tenggara and Maluku Islands. The country's sea area is about 7.9 million km² including its EEZ which is more than 1.0 million km².

Included in the territory of Indonesia is about 93,000 km² of inland seas comprising straits, bays, and other inland water bodies. Natuna Sea (between east and west Malaysia and Kalimantan), North Sulawesi Sea (eastern part of the Celebes Sea), and Arafuru Sea (between Irian Jaya in western New Guinea and northern part of the Australian Continent) are some of the Indonesian water areas where IUU fishing often takes place. Considering that IUU



Registered fishing vessels in Pelabuhan Ratu, Sukabumi, Indonesia

fishing weakens fishery resources management because of overfishing, as a result, it has been estimated that Indonesia loses revenues of more than US\$ 4.0 billion annually due to IUU fishing. This estimate does not include the social and environmental costs of the losses of future access to the country's fisheries resources.

In this connection, the Minister of Marine Affairs and Fisheries (MMAF), H.E Fadel Muhammad declared during the Asia-Pacific Coordinating Meeting on Combating Illegal Fishing and Promotion of Maritime Economy in Phuket, Thailand in November 2010 that "the MMAF has been consistently exerting efforts to combat IUU fishing and punish the offenders based on Indonesia's sovereignty". He also justified that this move takes into consideration the fact that IUU fishing practices is an action deemed to undermine a nation's sovereignty, and is an organized transnational crime seriously harming Indonesia and the other Asia-Pacific countries. Nevertheless, the increasingly often-asked question is "*Why is IUU fishing continuing?*" In responding to such question, some major factors that are considered driving forces leading to the rampant occurrence of IUU fishing in the waters of Southeast Asia are listed in **Box 1**.

Box 1. Factors that lead to the practice of IUU fishing in the Southeast Asian waters

- Increasing demand for fish by increasing population
- Inadequate regulatory control over nationals and fishing vessels including regulations on the transshipment of catch at sea, MCS systems and networks
- Lack of effective management tools to manage fishing capacity
- Weak enforcement of fishing legislations
- Productive fishing grounds and possible benefits in some areas
- Unproductive/overexploited fishing grounds in the countries of origin of illegal vessels
- Irreversible investments
- Evading payment of fishing fees and taxes
- Absence of maritime boundary agreements
- Fisheries management measures among the littoral states vary, resulting in incompatible legal frameworks to promote combating IUU fishing

Laws and Regulations on Fisheries in Indonesia

The main fisheries law in Indonesia is *Law No.45/2009 on Fisheries (amending Law No.31/2004)*. This law which encourages the sustainable development of fisheries resources, includes is Article 7, a provision that gives the power to the Minister of Marine Affairs and Fisheries to establish fisheries management plans; allocate the fishery resources; determine the total allowable catch; allocate aquaculture areas including broodstock and hatchery areas; determine the types, quantity, positions of fishing gears and zones or seasons of fishing; promote responsible fishing practices; designate protected fish species and sea areas; and implement vessel monitoring system, management of fishing ports, establish marine protected areas and conduct other related activities.

Indonesia has adopted a registration and licensing system for fishing vessels to ensure that only licensed vessels are allowed access to the country's fishery resources including those in the country's EEZ. In accordance with Article 27 and 28 of the Fisheries Law, owners and/or operators of Indonesian and foreign-flagged vessels as well as fish carrier vessels are obligated to bring their original licenses (SIPI/SIKPI) during fishing operations. This obligation however, does not prevail for the small fishers or small fish farmers. Any actions to falsify or use mendacious licenses are prohibited and punishable under the Law.

The central Government of Indonesia issues fisheries business licenses (SIUP), fishing licenses (SIPI), and fish carrier licenses (SIKPI) to Indonesian vessels as well as foreign fishing vessels under bilateral agreements with gross tonnage of 30 GRT and over, and engine power of 90 horsepower (Hp) or more. The license conditions include the capacity of the fish hold, name and address of vessel's master, number of crew, type and number fishing gear, vessel identification marks, intended fishing ground, port and place where catch should be reported, and conditions of the catch. The provincial Government is also given the power to issue licenses to vessels between 10 to 30 GRT and/or vessels with less than 90 Hp, with outboard or inboard engines and without foreign workers and capital or investment. The district Government has the power to issue licenses to non-motorized fishing vessels less than 10 GRT and/or vessels with less than 30 GRT, without

outboard or inboard engines, and without foreign workers and capital or investment.

Since 2000, Indonesia has been exerting efforts to implement concrete measures to control the licensing of fishing vessels that include the re-registration of fishing licenses (2001-2002); verification of vessel ownership, nationality and flag (2001-2005); computerization of the licensing system including the administrative processes, logistics, license database, and reporting system (2001-2004); and improvement of staff capability to undertake licensing services (2001-2004). Moreover, there has been significant improvement in the monitoring and control components of the country's MCS system, particularly for such measures as re-assessment of fishery resources (1997-1998 and 2001) and evaluation of fishing intensity (2001-2005).

Furthermore, Indonesia has also increased its activities and developed its capacity for fisheries surveillance including observations at sea, from air, and in ports as well as community-based surveillance mechanisms. Increased surveillance activities also include onboard and port observers' program and joint sea surveillance efforts with the country's Navy and Marine Police, and the Air Force. According to MMAF, the intensified naval operations alone have successfully reduced illegal fishing in Indonesian waters by 40%. During the period from 2005 to 2009, the operational patrol vessels inspected 803 vessels and were found to be involved in illegal fishing and were adhoced to the closest port. These adhoced fishing vessels consisted of 441 Indonesian vessels and 362 foreign vessels (**Table 1**).

The country's surveillance activities in ports include the establishment of the Technical Implementation Unit for Fisheries Surveillance (FS-TIU) especially in areas where fisheries violations mostly occur. Initially set up in five locations, the FS-TIU is now being supported by Fisheries Surveillance Post (FSP) in 58 locations of the country. Indonesia has further increased the number and capacity of its Fisheries Surveillance Officers (FSO) and Fisheries Investigators (FI), and as a result there are now 225 FSOs and 608 FIs. However, it has been estimated that Indonesia will still need 5,000 FSOs to be able to undertake effective fisheries surveillance activities. Furthermore, Indonesia has also established fisheries courts in areas where there are more cases of fisheries violations and a

Table 1. Number of adhoced vessels by the surveillance vessels of MMAF (2005-2009)

Unit: Number

Year	2005		2006		2007		2008		2009		Total	
	I	F	I	F	I	F	I	F	I	F	I	F
Adhoced Vessels	91	24	83	49	95	89	119	124	53	76	441	362

I = Indonesia, F = Foreign

national coordinating forum involving relevant government institutions to increase the effectiveness of the enforcement of the fisheries law.

In accordance with its *Ministerial Decision of Marine Affairs and Fisheries No.29/2003*, Indonesia has implemented the Fishing Vessels Monitoring System (VMS) which aims to enhance fisheries management through monitoring and surveillance, and provide accurate data and information on the activities of fishing vessels in Indonesian waters. However, this regulation still has not met the optimal surveillance coverage. Through the *Ministerial Decree of Marine Affairs and Fishery No.05/2007*, VMS and its equipment were developed. Owners of all Indonesian vessels (>60 GRT) and foreign-flagged vessels are obligated to have their vessels installed with *transmitters*, and which should be registered with the Directorate General of Surveillance and Controlling for Marine and Fisheries Resources. The vessels should be equipped not only with *fishing license and/or fish carrier license but also with transmitter activation certificate*. For vessels larger than 100 GRT, the transmitter should be activated from within 200 nautical miles before entering the Indonesian EEZ. However, fishing vessels between 30-60 GT should be equipped with *transmitter offline* provided by State. As of February 2009, a total of 2867 units of transmitters have been installed on fishing vessels. The use of VMS and radar facilities as well as satellite data transmitter is aimed at providing instantaneous information on vessel name, location and activity to be integrated with the VMS data within MMAF in order to support its fisheries surveillance efforts at sea.

It is noteworthy that the technical cooperation in MCS between Indonesia and Australia has also been particularly successful resulting in a drastic reduction in the number of illegal vessels fishing in Arafura Sea and an increase of about 31% in shrimp trawlers' productivity following increased surveillance and enforcement. Furthermore, the collaborative patrol effort of Indonesia, Malaysia and Singapore under the MALSINDO program and the joint "Eye in the Sky" air patrol have significantly prevented IUU fishing practices in the Malacca Strait.

Another means of enhancing MCS in Indonesia is through the community-based fisheries surveillance system, where community groups undertake the observation at sea and land, and to report to proper authorities in their communities the suspected fishers and vessels conducting illegal fishing. It was reported that 1,419 community groups have been involved in fisheries surveillance in 2009 and the number tends to increase year by year. The involvement of community groups in MCS is an integral part of a nation's sovereignty.



Archipelagic fishing port of Pelabuhan Ratu, Sukabumi, West Java

In addition to arresting the offenders, the present efforts of Indonesia in combating IUU fishing is focused on the promotion of sustainable and optimum management of the fishery resources through the *Minapolitan concept*, which was developed by MMAF in 2009. The *Minapolitan concept* is a scheme for marine and fishery economic development based on a regional management approach governed by the principles of integration, efficiency, quality, and acceleration. *Minapolitan* is part of the MMAF's *Blue Revolution program*, which is one of the pillars in changing the people's *land mindset to maritime mindset*. As envisaged the *Minapolitan concept* would be effectively implemented in 197 regencies/cities in 33 provinces to enhance the production from fisheries by 353% from 4.78 million tons in 2009 to 16.89 million tons in 2014.

Currently, MMAF have established 41 *Minapolitan* areas as sequential projects comprising 24 aquaculture areas, 9 fishing areas, and 8 salt industry areas, where one district/city could have several centers of production. Promotion of the SEAFDEC initiative on "One Village, One Fisheries Product (FOVOP)" to improve the livelihood for local communities has been included as an integral part of the *Minapolitan concept* considering that *Minapolitan* is hinged on the naturally existed condition, where the

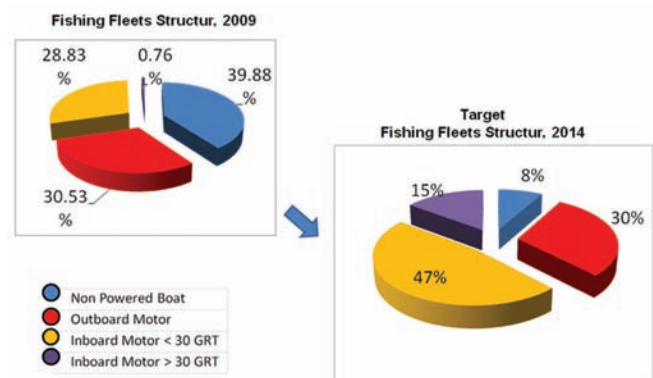


Fig.1. Restructuring of the Indonesian fishing fleets from 2009 to 2014

areas are established on the basis of superior fishery commodity, regional commitment, conformity between strategic plan and Regional Space Management Planning, environment feasibility and the availability of production, processing, and marketing units. The superior commodities in the *Minapolitan* program cover tuna, shrimps, grouper, milkfish, catfish, carps, tilapia, *Pangasius patin*, giant gourami, and seaweeds. With such concept, the MMAF is ambitiously targeting to make Indonesia the *World's Largest Producer of Marine and Fisheries Products by 2015*. While China and Peru were top highest producers of fish in 2007, Indonesia had already replaced the United States of America in the third position (FAO, 2010).

Thus, the MMAF initiated efforts to restructure and modernize the country's national fishing fleets to prevent and deter IUU fishing in accordance with the *Presidential Instruction No.1/2011*. Currently, there are about 2.7 million Indonesian fishers engaged in fishing activities and together compete with a huge number of foreign fishers. In 2009, Indonesia had a total of 596,230 fishing boats (Table 2) involved in fishing operations, 80% of which are small-scale and traditional vessels under 30 GRT.

In this regard, MMAF proposed to replace 1000 small fishing boats (≤ 5 GRT) with fishing vessels ≥ 30 GRT to be installed with the necessary equipment to enable them to sail to open seas more than 12 miles from the shore. However, such proposal would entail a total budget of US\$ 1.5 trillion. The proposal also aims to reduce the density of fishing activities in some of the country's fisheries management areas, minimize conflicts among fishers, and help fishers increase their incomes. Moreover, the proposal was also envisaged to guarantee the fishers their rights of access to the country's fishing grounds as well as safety protection at sea.

Furthermore, a proposal was also made to restructure the country's fishing fleets from 2009 to 2014. Fig. 1 shows the proposed restructuring of the fishing fleets in Indonesia, which indicates a decreasing trend for non-powered boats from about 40% to 8% and an increasing trend for fishing vessels under 30 GRT from about 29% to 47%, and over 30 GRT about 15% accordingly. In order to achieve such objectives, the MMAF planned to procure 253 units of fishing vessels (≥ 30 GRT) in 2011 to be distributed to 33 provinces of the country. In addition, the MMAF provides insurance for 4,000 fishers against accidents at sea and in this regard, about 256,000 fisher's cards had already been issued in 15 provinces. Currently, MMAF is developing a special fishing zone under its *Minapolitan concept*, where every fishing zone will be provided with fish processing factories, ice factories, fish cold storage and other supporting facilities, and market access. In other words, capture fisheries can be integrally managed starting from pre-fishing, fishing, processing to marketing. Such scheme includes the need to balance industrial-scale fisheries serving the export markets with small-scale fisheries that cater to needs for local food security and employment in coastal communities. In this connection, pilot projects had already been implemented in nine fishing-based sites located in Belawan in North Sumatra, Sungai Liat in Bangka-Belitung, Pelabuhan Ratu in West Java, Muncar and Tarempa in East Java, Cilacap in Central Java, Ternate in North Maluku, Bitung in North Sulawesi, and Ambon in Maluku.

Moreover, since stock enhancement is necessary for the sustainable management of fish stocks, Indonesia heeded the successful implementation of fish enhancement activities in Japan, Norway, Australia and Canada. From the lessons learned, Indonesia is currently promoting the concept of "one man one thousand fry" to encourage its

Table 2. Number of marine fishing boats by category and size (Indonesia: 2005-2009)

Category and Size of Boats		Year				
		2005	2006	2007	2008	2009
TOTAL		555,581	590,317	590,314	596,184	596,230
Non Powered Boat		244,471	249,955	241,889	212,003	205,460
Outboard Motor		165,314	185,983	185,509	229,335	233,530
Inboard Motor		145,796	154,379	162,916	154,846	157,240
Size of Boat (GRT)	< 5	102,456	106,609	114,273	107,934	109,590
	5-10	26,841	29,899	30,617	29,936	30,400
	10-20	6,968	8,190	8,194	7,728	7,910
	20-30	4,553	5,037	5,345	5,200	5,280
	30-50	1,092	970	913	747	750
	50-100	2,160	1,926	1,832	1,665	1,670
	100-200	1,403	1,381	1,322	1,230	1,230
	>200	323	367	420	406	410

people to enhance the fish resources in all water bodies. The activity is implemented by releasing fish fry into waters with high natural productivity but limited natural recruitment, and also by installing fish shelters. In 2011, MMAF would release fish fry in the territorial seas and archipelagic waters in 30 provinces as well as in inland public waters in 32 locations. Recently, Indonesia has opened up its marine fisheries sector, especially at the eastern part of the country for bilateral cooperation. The MMAF is developing a *Mega-Minapolitan* project as an enlarged replica of the *Minapolitan* program where major investors would be provided with a number of conveniences and amenities. One of the *Mega-Minapolitan* establishments will be developed in Morotai Island in North Maluku with US\$ 2.0 billion investment. Taiwan has reportedly expressed interest in investing and in developing the island as the largest center for aquaculture and fisheries.

The most concrete and successful bilateral efforts in marine fisheries is the joint venture established in 2002 between Indonesia and Filipino fishing companies, where a total of 255 fishing vessels and 300 Filipino light-boats were allowed access to a defined area of the Indonesia EEZ and designated ports. So far, only 54 fishing vessels (38 vessels <250 GRT) and 11 single purse seiners (all >250 GRT) have been endorsed to fish in Indonesia waters. Under the arrangement, most of catch was unloaded in Philippine ports and some at the Philippine-operated canneries in Bitung and Manado in North Sulawesi, which require at least US\$ 12 million cross-border investment and an additional 7,000 jobs for the residents of North Sulawesi. This cooperation has therefore increased the growth of the fishing industry in both countries and as reported, almost half of the tuna processed in General Santos City of the Philippines comes from Sulawesi Sea.

Law Enforcement

Based on the provision of Law No. 45/2009, stringent penalties would be imposed on IUU fishing offenders. Specifically in Article 85, the penalty for possessing, controlling, and using destructive fishing gears is imprisonment for a maximum of five-year and fine of up to Rupiah (Rp) 2 billion (about US\$ 230,000). In Article 93, the owner and/or operator of Indonesian-flagged vessels including fish carrier vessels who have no fishing license or not bringing the original license (SIPI) will be liable to a six-year maximum imprisonment and fine of up to Rp 2 billion (about US\$ 230,000), and up to Rp 20 billion (about US\$ 2,300,000) for those who use foreign-flagged vessels. In Article 94A, anyone who falsifies or uses mendacious licenses will be liable to imprisonment for maximum of seven-year and a fine of up to Rp 3 billion (about US\$ 342,000). In 1997, it was reported that

the Indonesian Navy arrested at least 50 boats fishing in Maluku and North Sulawesi, mostly about 30 to 2,000 GRT and flagged to Philippines or Chinese Taipei. At the time of the apprehension, the fishing vessels did not have proper authorization to fish in Indonesian waters. In 2003, Indonesian authorities impounded 107 foreign fishing vessels carrying the flags of Thailand, Philippines, Vietnam, and People's Republic of China, for fishing illegally in Sulawesi Sea. In 2004, through the Trisila marine operation task force of Indonesia, 10 fishing vessels without proper fishing permits were impounded. In addition, two illegal fishing vessels from Thailand were apprehended around the Sulawesi Sea area, the vessels were confiscated and the captain of one of the vessels was sentenced to jail for two years while the owner of the other vessel was fined Rp 24 million (about US\$ 2,500).

In 2005, Indonesian authorities arrested nine Malaysian fishing vessels poaching in East Kalimantan waters, although the vessels were using Indonesian flags these were found to have Malaysian crew and owners. In 2007, the Indonesian Navy apprehended two Philippine-flagged fishing vessels operating close to Ambalat in Sulawesi Sea. These vessels were carrying 10 mt of fish and a crew of 18 Filipinos, but believed to be leased by a Malaysian company. At present, penalties given for owners, operators, captain, and crew of IUU fishing vessels include the imposition of fine and confiscation of the fishing boats. Some cases have been brought to court and the crew had been released from custody after brief interrogations. In the case of Filipino vessels illegally fishing in Indonesia waters, Indonesian authorities confiscated the vessels and its equipments, and turned over the fishers to the Philippine Consulate in Manado for repatriation. In 1997, the Philippine Consulate repatriated about 400 illegal Filipino fishers. The illegal fishing activities of foreign fishers in Indonesian waters not only cost substantial amount of money for the countries of origin to repatriate the illegal fishers from Indonesia, but also threaten the smooth relationship between Indonesia and the countries involved.

Future Actions

Indonesia would continue its national effort to enhance and strengthen the overall level of conservation and management, including development of Management Plan for each fisheries management areas and finalization of National Plan of Action (NPOA) on Managing Fishing Capacity and NPOA on Combating IUU Fishing. Moreover, the country would also undertake common and collaborative approaches to promote responsible fishing practices and to combat IUU fishing in the region, including the implementation of “*the Regional Plan of Action (RPOA)*”, as shown in **Box 2**.

Box 2. Common and collaborative approaches to be pursued by Indonesia to combat IUU fishing

- Undertake a survey (or stock take) of fisheries management data, information, priority needs and gaps
- Establish a Regional MCS Network and three Sub-regional MCS networks
- Develop a matrix of national, sub-regional and regional MCS issues and to serve as guide for the networks
- Establish a Coordination Committee and develop a forward work plan
- Identify the need to strengthen the existing laws relevant to port inspection and compliance
- Identify the measures to be developed and implemented in compliance with: (i) EC Regulation 1005/2008; and (ii) FAO Port State Model Scheme
- Identify trans-shipment activities that need to be urgently regulated
- Identify fisheries legislations that urgently need to be revised consistent with RPOA objectives
- Review and adopt MCS Training Curriculum and identify funding strategies to be developed to support the sub-regional and regional MCS courses

Moreover, Indonesia would continue to improve its MCS mechanism to contribute to the consolidation of regional efforts of promoting the MCS in the region. As indicated in the relevant elements to combat IUU fishing in Southeast Asia (Awwaluddin *et al.*, 2011), Indonesia would also continue to improve port monitoring through enhanced vessel registration and licensing.

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Putting a Plug on Increasing Fishing Capacity: NPOA for the Management of Fishing Capacity in Malaysia

Mohamad Shaupi, Abdul Khalil, Abu Talib Ahmad, Ahmad Saktian, Abdul Rahman, and Halimah Mohamed

The word ‘capacity’ is commonly used to describe skills, capabilities or competence, but in fisheries this word may also be related to several specific issues that include harvesting fish by fishing vessels as well as to the biological concept of fishing mortality, fishing technologies, fishing power, and economics. In order to accommodate the differences in the definitions of fishing capacity, the Food and Agriculture Organization of the United Nations (FAO) has adopted a definition of fishing capacity as the “amount of fish (or fishing effort) that can be produced over a period of time (e.g. a year or a fishing season) by a vessel or a fleet if fully utilized and for a given resource condition”. The existence of too many fishing vessels operating over limited fishery resources is one of the major contributors to the depletion of fishery resources due to overcapacity. Therefore, countries all over the world are taking actions to curb this problem, and Malaysia as a maritime nation has addressed this concern by putting in place its National Plan of Action for the Management of Fishing Capacity (NPOA - Fishing Capacity).

The National Plan of Action for the Management of Fishing Capacity (NPOA – Fishing Capacity) in Malaysia aims to manage fishing capacity in order to balance fishing efforts with available resources in a sustainable manner. The development of the NPOA – Fishing Capacity is based on results of the country’s efforts to assess the fish stocks with particular attention given to cases requiring urgent measures, and is meant to address the management of fishing capacity for stocks recognized as significantly overfished. The NPOA – Fishing Capacity therefore focuses on the management of fishing capacity in marine capture fisheries through the implementation of a range of policies and technical measures aimed at ensuring the

desired balance between fishing inputs and outputs in terms of production (Ali, 2010).

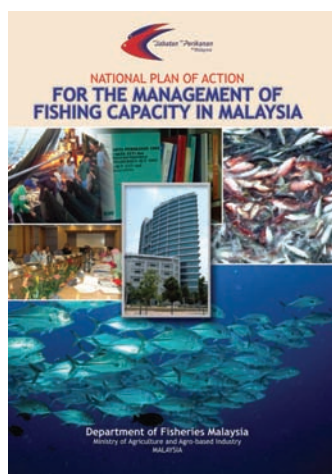
Moreover, the development of NPOA – Fishing Capacity is also in accordance with Section II of the International Plan of Action for the Management of Fishing Capacity which stipulates the need to “develop, adopt and make public by the end of 2002, national plans for the management of fishing capacity”. However, the success of the implementation of the NPOA – Fishing Capacity would depend on the close cooperation between the implementing agencies and stakeholders, and in the process should be able to address the need to overcome several issues and challenges, some of which are shown in **Box 1**.

Management Initiatives to Control Fishing Capacity

The list in **Box 1** may not be exhaustive but considering that the issues and challenges are real, countries in the region should exert efforts to address such issues. In this connection, Malaysia has paved the way by drawing up some initiatives (**Box 2**) to demonstrate its government’s commitment to control fishing capacity in the country.

Fishing zones

The zoning system in Malaysia implemented since the 1980s, has demonstrated some forms of good management of fisheries and fishing capacity. The division of the sea area into 5 zones, namely: A, B, C, C2 and C3 according to gear type and tonnage (**Fig. 1**) was initially meant to minimize conflicts among users, as well as provide a fair share of resource distribution among the fishers.



Box 1. Issues and challenges that need to be addressed for the successful implementation of the NPOA - Fishing Capacity in Malaysia

- Multi-species and multi-fleet situation of the country’s marine capture fisheries
- Small-scale nature of the fisheries
- Coastal resources are fully exploited
- Use of destructive fishing as well as less selective gears and methods
- Habitat destruction
- Encroachment of vessels into coastal waters or illegal fishing
- Presence of illegal fishing vessels in national waters
- Inadequate enforcement capability
- Inadequate public awareness and insufficient community participation
- Conflicts in policies and objectives

Box 2. Management initiatives undertaken by Malaysia to control fishing capacity

- Formulation of several other National Plans of Action, *i.e.* NPOA-Sharks, NPOA-Sea turtles, NPOA- Invasive alien species, NPOA-Dugong, and NPOA-Sea cucumber
- Establishment of fishing zones
- Establishment of marine protected areas and turtle sanctuaries
- Putting in place a good infrastructure for the Vessel Monitoring System (VMS)
- Implementation of the ‘Exit Plan Programme’
- Deployment of artificial reefs
- Establishment of a good licensing policy
- Formulation of good legislative arrangements to control fishing activities
- Development of a very comprehensive database on the fishers and fishing vessels
- Regular collection of data on fish landings

Vessel Monitoring System

It is noteworthy that the Exit Plan Programme albeit being voluntary has reduced the fishing capacity within the country’s Zone B fishing areas but the lacuna it had created should be closely monitored to ensure that new level of capacity is maintained. More importantly, the country’s Vessel Monitoring System (VMS) has helped in monitoring the movement of fishing vessels and managed



Above: Trawlers from Zone B under the Exit Plan Programme converted into artificial reefs. *Source: Ali (2010)*
Below: Artificial reefs for conservation and enhancement of resources

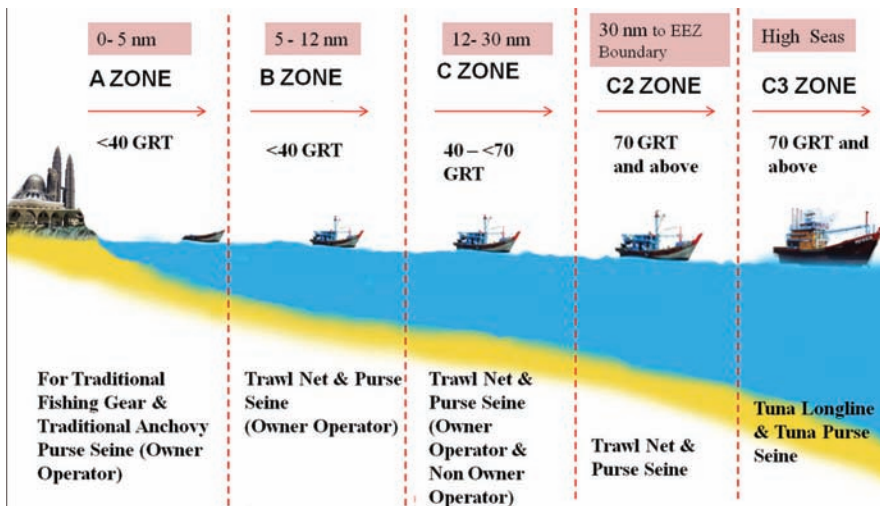


Fig. 1. The fishing zones in Malaysia

Moreover, the zones had provided some forms of control and enabled close monitoring of fishing activities to ensure that the balance between capacity and available resources is maintained.

Exit Plan Programme

In order to reduce the fishing effort within the zone B, Exit Plan Programme was developed and implemented from 2007 to 2010. Under this Programme, trawlers from Zone B are bought from the owners at current value and are converted into artificial reefs, and installed at strategic areas. Results have been encouraging and the Programme offered a range of advantages as shown in **Box 3**.

Artificial reefs

The artificial reefs deployed along the coast within Zone A have helped in controlling and preventing the encroachment of trawlers into such sensitive area. The structures also facilitated the management of fishing capacity within the zone as well as minimized the conflicts among the users.

Box 3. Impacts of the Exit Plan Programme

- Reduced pressure on the resources at the coastal areas
- Competition among coastal fishers mostly using traditional gears had been reduced
- Vessels disposed as artificial reefs enhanced the inshore habitats that indirectly contribute to the conservation of resources
- Increased catch per unit effort observed for fishing gears such as drift net, gill net, hook and line
- Indirectly improved the marine biodiversity, ecosystem and habitat
- More opportunities provided for existing vessel operators to operate further offshore with larger vessels
- Opportunities for alternative livelihood could be provided to fishers intending to leave the industry, since workers in vessels taken out from sea under the ‘Exit Plan Programme’ can seek employment in other vessels to alleviate the problem of shortage of workers

to keep them from going into areas that have been identified as ‘no entry’ areas. In addition, using the VMS (**Fig. 2**), vessels are monitored to ensure that their operations are within the designated area or zone.

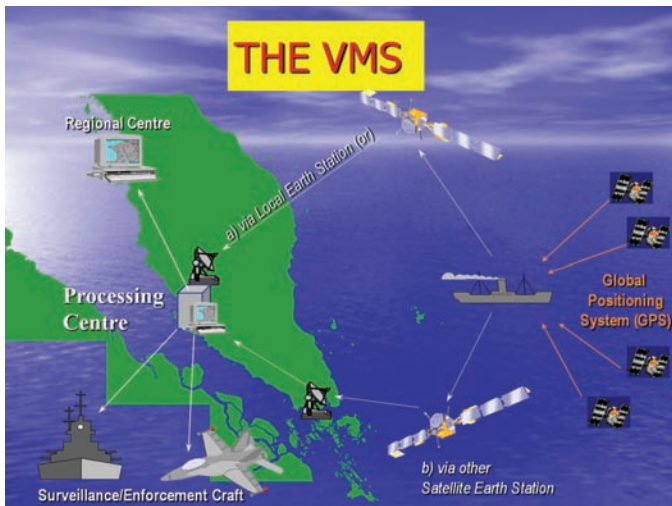


Fig. 2. The Vessel Monitoring System of Malaysia



Above: MCS conducted by Malaysian patrol boat;
Below: Artificial reefs in Malaysian waters. Source: Ali (2010)

However, having a good VMS infrastructure could only be effective for monitoring vessels that are equipped with the system. Therefore, there is a need for a good surveillance protocol so that the fishing capacity of vessels not equipped with VMS could also be monitored.

The aforementioned initiatives should therefore be effectively implemented in order to realize the successful advancement of the NPOA - Fishing Capacity and achieve its target, considering that the government is also faced with a daunting task of overcoming certain weaknesses. The inadequacy to carry out the MCS efficiently has somewhat been a bane in carrying out the NPOA - Fishing Capacity effectively. Since enforcement by the Department of Fisheries Malaysia alone is insufficient, the cooperation of other maritime enforcement agencies is necessary in which case close cooperation should be promoted among the maritime enforcement agencies. Moreover, in order to achieve good governance of the resources, all stakeholders should also play an important role in the implementation of the NPOA – Fishing Capacity.

The current inadequate involvement of the stakeholders should be improved and strengthened especially in controlling IUU fishing. Furthermore, it is also necessary to improve the legislative aspects including the formulation of specific laws that aim to address overfishing as well as in the use of the VMS as a tool for management. Although Malaysia has put in place some forms of Monitoring, Control and Surveillance (MCS) management system, the country still seems inadequate in addressing surveillance, because such effort would entail a huge budget which in the past few years had been insufficient making it difficult to control over the fishers. Another approach which is now being pursued with respect to monitoring the fishing capacity is enhancing the participation of local communities in the MCS, giving them a basis for striking a balanced level of authority and responsibility during the management of the resources which they are exploiting, and also solving the local conflicts among the fishers.



Regular monitoring of fishing activities being done by the Department of Fisheries Malaysia

Finding Opportunities to Manage Capacity and Overcoming Threats

Malaysia has been designated as the lead country for the ASEAN Fisheries Consultative Forum (AFCF) key cluster on fishing capacity and responsible fisheries practices, and therefore the country is in a position to take the opportunity to monitor any progress made by the ASEAN countries in implementing the IPOA – Fishing Capacity in their respective countries. Considering that IUU fishing has been identified as an important factor that impedes the efforts to control fishing capacity, Malaysia also sees the opportunity to put in place certain initiatives that concurs



Catch inspection on board

well with the requirements of the European Council (EC) Regulation No. 1005/2008 in Combating Illegal, Unreported and Unregulated (IUU) Fishing. Following the EC Regulation, other countries are also taking measures to combat IUU fishing and that many importing countries also require that a system of traceability on fish and fishery products should also be put in place. This augurs well with

increasing concern on the need to control excess fishing capacity particularly those that are engaged in IUU fishing.

Being the AFCF lead country for fishing capacity and responsible fisheries practices, Malaysia through the Department of Fisheries Malaysia (DOFM) also promotes 'responsible fisheries' which focuses on the importance of enhancing awareness and providing education to the fishers especially on resource conservation and methods of exploitation in a responsible manner. In addition, the DOFM also inculcates upon the fishers the use of environment-friendly gears and the practice of precautionary approach in order to ensure resource sustainability in the long term.

Nonetheless, in trying to put a cap on fishing capacity, there also appears to be certain threats that could hamper the actions taken. The fact that the coastal resources had been fully exploited and are over-fished, the absence of specific legislations on fishing gear that promotes advancements in fishing technology should be addressed as this has led to uncontrollable fishing capacity. Furthermore, the ever increasing demand of the people for food fish, and

Box 4. Strategies adopted for the promotion fishing capacity management

Strategies	Activities
Review and implement effective conservation and management measures	<ul style="list-style-type: none"> a. Control the number of fishing vessels b. Evaluate the suitability of the Individual Quota by Species (IQS) via Total Allowable Catch (TAC) c. Establish 'fish <i>refugias</i>' - closed season, restricted fishing areas d. Implement Exit Plan Programme and encourage alternative livelihoods e. Create consortiums through buy back scheme for trawlers f. Eliminate illegal fishing vessels g. Stop issuance of new licenses for coastal waters. h. Transfer Zone C2 vessels to others potential areas i. Cancel licenses of non-performing Zone C2 vessels j. Evaluate regularly the status of fishing capacity
Strengthen enforcement capacity and capability	<ul style="list-style-type: none"> a. Allocate assets and adequate budget b. Enhance skills and competence of the enforcement team c. Establish special coordinating fishery body to implement surveillance d. Develop co-management mechanisms e. Deploy artificial reefs as a barrier to deter encroachment by trawlers f. Install VMS on commercial vessels and deploy special monitoring vessels equipped with radar to monitor fishing activities g. Conduct patrols on regular basis h. Enhance coordination among local enforcement agencies i. Enhance cooperation at the regional level
Promote public awareness and education program	<ul style="list-style-type: none"> a. Organize dialogue sessions and provide briefing sessions for local politicians to keep them abreast with the local scenario b. Build institutional capacity at all levels through leadership training c. Promote community development and management d. Involve stakeholders as a 'key partners' in managing sustainable fisheries e. Active involvement of stakeholders in implementing local program
Promote responsible fishing practices	<ul style="list-style-type: none"> a. Conduct R&D b. Enforce legislation on mesh size on trawls. c. Promote the use of juvenile and trash excluder device (JTED), turtle excluder device (TED) and selective fishing methods d. Improve existing fishing methods so as to be more environment and resource friendly. e. To design educational programs to instill on the people a positive attitude towards responsible fishing practices

the apparent increased dependence of the processing and aquaculture industries on marine capture for raw materials and feeds, respectively, have also plagued the efforts to control capacity. In addition, the willingness of boat crew to work longer hours is also seen as a threat to the recovery of the resources and leads increased capacity. While the NPOA - Fishing Capacity is voluntary in nature, the incidence of IUU fishing cannot be ruled out.

Another important aspect that threatens the successful implementation of the NPOA - Fishing Capacity is the impacts of subsidies and economic incentives which can lead to overcapacity. Subsidies will in a way contribute to the capability of a vessel to travel further and work longer hours, and therefore a controlling mechanism is needed to address the issue of overcapacity. Furthermore, the DOFM has developed four strategies in connection with the implementation of the NPOA- Fishing Capacity (**Box 4**).

Conclusion

Recently, sound and effective management of fishing capacity is one of the highest priorities that had been seriously addressed not only in Malaysia but also globally. In order to obtain the highest level of success towards the achievement of the above target, proper integration of all activities would be necessary, while more holistic actions should be undertaken to manage fishing capacity. Meanwhile, relevant agencies should pool their resources together in order to attain the common goal. The NPOA - Fishing Capacity has been a valuable avenue that paved the way for Malaysia to control fishing capacity. However, in order to sustain the effective implementation of the NPOA – Fishing Capacity, the country has to make sure that effective monitoring, evaluation and review of the status of the NPOA are conducted periodically.

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Strengthening R&D Mechanisms to Advocate Effective Feed Management in Aquaculture and Reduce Dependence on Fish Meal: Impact on Myanmar Fisheries

Khin Ko Lay, Win Myint Maung and Aung Naing Oo

Aquaculture plays an important role in the sustainable development of the Southeast Asian region considering its significant contribution to food security, poverty alleviation and socio-economic well-being of the people. However, the development of aquaculture is highly constrained by the insufficient and inconsistent supply of fish meal and other fish-based products leading to the rising cost of aquaculture feeds. Since a large portion of fish meal supply also goes to terrestrial animal feeds, the use of fish-based products for animal feeds had been questioned because it conflicts with the use of the same resources for direct human consumption of the region's growing population. In order to ensure the sustainable development of aquaculture, countries in the region should understand such situation and explore options in the production of aquaculture feeds using suitable and cost-effective substitutes for fish meal and fishery products.



It has often been declared that aquaculture has great potentials to fill the gap between supply and demand for food fish, especially in the Southeast Asian region where aquaculture has been developing faster than could be imagined. In 2008, the Southeast Asian countries produced about 11.1 million mt of fish from aquaculture accounting for 21% of the world's fish production from aquaculture of 52.6 million mt (FAO, 2010). The top five aquaculture

producing countries in Southeast Asia in 2008 (Table 1) were: Indonesia contributing 35% of the region's total production from aquaculture followed by Vietnam accounting for 22.3%, Philippines by 21.8%, Thailand by 12.0%, and Myanmar about 6.0% (SEAFDEC, 2010).

Nevertheless, the growth of the region's aquaculture industry has been confronted with various challenges including oil price fluctuation, unstable and inconsistent production, impacts of climate change, and disease outbreaks. In

Table 1. Aquaculture production of the Southeast Asian countries (Qty in '000 mt, Val in '000 000 US\$)

Southeast Asian countries	2004		2005		2006		2007		2008	
	Qty	Val	Qty	Val	Qty	Val	Qty	Val	Qty	Val
Indonesia	1,354.5	1,967.0	1,941.1	2,168.7	2,377.5	2,341.5	2,466.0	2,447.5	3,855.3	4,222.5
Vietnam	1,198.6	2,357.0	1,467.3	2,945.7	1,687.7	-	2,194.5	4,544.8	2,468.3	4,617.7
Philippines	1,717.0	799.8	1,895.9	892.5	2,092.3	1,085.0	2,214.8	1,334.7	2,407.7	1,718.6
Thailand	1,301.5	1,714.5	1,318.5	1,353.2	1,353.0	1,990.0	1,370.4	2,134.6	1,330.8	2,165.3
Myanmar	426.0	-	575.0	-	575.0	-	604.7	1,862.4	653.9	782.6
Malaysia	202.2	309.8	188.2	341.1	212.0	352.0	268.5	353.0	240.1	462.9
Lao PDR	64.9	-	78.0	-	78.0	-	63.3	81.3	64.3	91.2
Cambodia	37.7	-	42.0	-	41.4	-	50.2	-	39.7	61.8
Singapore	5.4	8.5	5.9	10.0	8.6	9.5	4.5	9.0	3.5	9.3
Brunei Darussalam	0.7	-	0.7	-	0.7	-	0.7	3.2	0.4	0.4
TOTAL (Aqua)	6,243.7	7,201.8	7,434.5	7,711.2	8,348.2	5,778.0	9,174.3	12,747.3	11,064.0	14,032.2
Region's Total Fish Production	21,053.7	15,148.5	22,880.0	16,417.0	24,394.1	15,466.2	25,211.2	23,937.9	27,260.1	28,583.6

Source: SEAFDEC (2010)

addition, the demand for eco-labeling of aquatic products and traceability documentation requirements of importing countries has made aquaculture operations in the region becoming more complex. Furthermore, other constraints continue to hound the development of aquaculture in Southeast Asia, especially in terms of limited land and insufficient supply of freshwater, shortage and rising prices of good quality feeds, inadequate power supply for processing and the continuing rising cost of oil, pollution and environmental degradation problems, and limited expertise among government officials (Hishamunda *et al.*, 2009). One very crucial factor that impedes the sustainable development of aquaculture is the over-reliance of aquafeed processing on fish meal and fishery products as main ingredients. In order to address such concern, the use of fish meal and fishery products as principal source of nutritional protein should be minimized, in which case there is a need to look for suitable and cost-effective substitutes for fish meal and fishery products in fish diets.

This concern was reiterated by Ekmaharaj (2009) who suggested that research on alternative ingredients as substitute to fish meal in aquafeeds should be intensified to reduce the use of fish food which in turn could reduce fisheries by-catch. In this regard, Lymer *et al.* (2008) reported that FAO has set the general principles on the use of fish as feeds in order to avoid the high demand of fish to be transformed into feeds. Platon *et al.* (2007) also suggested that any aquaculture system should also aim to decrease feed conversion ratio and reduce the quantity of feeds used through better feed management. In addition, Funge-Smith *et al.* (2005) further suggested that since the supply of low-value/trash fish in the Asia-Pacific countries have diminished but with prices that continue to increase, there might be a need to increase imports of fish meal from the global market for the region's aquaculture industry otherwise, fish meal should be replaced with other feed ingredients. Thus, the replacement of fish meal with alternative ingredients in aquaculture diets has become a major concern in international nutrition research. Since the use of low-value fish/trash and fish meal in aquaculture sector has already been unsustainable, the aquaculture industry should continue to exert efforts to reduce its dependence on fish as feeds through effective feed management practices and the development of better quality feeds using alternative ingredients (De Silva and Turchini, 2009).

In Southeast Asia, increased incomes led to increased consumption of meat and higher-value fish products especially those from aquaculture. Consequently, the need for aquafeeds also increased in order to sustain the aquaculture industry. Therefore, it is critical that effective regulation be established on the need to balance global

forage fish supplies and trash fish consumption. Naylor *et al.* (2009) suggested that balancing the demand-side regulation on feeds and supply-side management of forage fisheries should be promoted in order to create appropriate incentive for sustainable growth of the aquaculture industry. The Resolution on Sustainable Fisheries for Food Security for the ASEAN Region adopted in November 2001 provided the need to: “*Increase aquaculture production in a sustainable and environment-friendly manner by ensuring a stable supply of quality seeds and feeds, effectively controlling disease, promoting good farm management and transferring appropriate technology*”. Similarly, the adopted Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region emphasized on the need to develop programs to “*Improve the efficient use of aquatic feeds by regulating the quality of manufactured feed and feed ingredients, providing guidelines on farm-level food conversion ratios and levels of aquaculture effluents and supporting research into developing suitable alternative protein sources to reduce dependence on fish meal and other fish based products*”. Thus, to ensure the sustainable development of aquaculture *vis-à-vis* the efficient use of aquafeeds, countries in the region should understand the current status of its aquaculture vs. the aquafeed industry.

Aquaculture Development in Myanmar

The fisheries sector, which is one of the most important economic sectors after the agriculture, largely contributes to the protein requirement of the people of Myanmar and is an important contributor to the improvement of the socio-economic condition of Myanmar. Among the fishery sub-sectors, aquaculture has played a major role by contributing 21% to the country's total fish production of 3,147,600 mt in 2008, with production from marine capture sharing 53% (1,679,000 mt) and inland capture fisheries accounting for 26% (814,700 mt). In Myanmar, aquaculture is mainly conducted in ponds, and in 2008-2009 the total pond area was 176,852.2 ha consisting of 86,491.2 ha fishponds and 89,862.0 ha shrimp ponds. Freshwater pond fish culture is the major source of the country's aquaculture production with rohu (*Labeo rohita*) as the dominant species cultured.

In Myanmar, most farmers adapt the polyculture system by rationally utilizing all strata and the natural food in the pond water, especially for the culture of the Indian major carps, Chinese carps, common carps, tilapia, catfish (*Pangasianodon hypophthalmus*), and freshwater prawn (*Macrobrachium rosenbergii*). While farming of shrimps (*Penaeus monodon*) is mainly conducted in Rakhine State adopting the extensive plus and extensive or traditional culture methods, marine fish culture which is still in its initial development stage, focuses on grouper (*Epinephelus* spp.) and sea bass (*Lates calcarifer*) cultured in net cages



Above: Culture of soft-shelled crabs in Myanmar; and
Below: Trash fish being chopped to feed soft-shelled crabs
in Myanmar

using seeds from the wild, and is operated in the southern coastal area of Myeik.

Recently, soft-shell crab farming has become popular in Myanmar because of the high price and demand for soft-shelled crabs in the export market. Under marketable sized mud crabs are collected from the wild and reared individually in small boxes for a couple of weeks where the crabs are fed with trash fish chopped into suitable sizes, depending on the size of the stock. On the other hand, wild-caught crablets are farmed in intensive operations in which one or two crablets are held together and checked every other day for molting, since soft-shelled crabs could be ready for the market after two molts. The rapid progress of the country's aquaculture industry had made Myanmar one of the emerging important Southeast Asian countries with substantial growth in aquaculture both in freshwater and marine environments (De Silva and Turchini, 2009).

Development of Aquaculture Feeds in Myanmar

Freshwater fish farming in Myanmar utilizes farm-made feeds from locally available ingredients such as rice bran, ground-nut cake, and cotton seed cake, among others. The procedure involves cooking broken rice, ground-nut cake or cotton seed cake and rice bran (1:2:7) and fed to fish as a moist mash. Nonetheless, some large commercial fish farm owners operate their own feed mills to produce feed pellets for their farms on an experimental basis while fish farmers are already using the formula of rice bran and ground-nut cake (4:1) in feeds that are directly put in feeding bags made from mosquito netting materials and placed in the ponds. For tilapia and *Pangasianodon* catfish culture however, formulated feed pellets which are manufactured by private feed mills are used. Although there is no reliable source of feed formula and feed conversion ratio in the production of feed pellets by private feed mills, it is roughly known that the feed ingredients include broken rice, rice bran, ground-nut cake, soybean cake, and locally available fish meal added with vitamin premix.

Nevertheless, many fish farmers have shifted from the use of farm-made feeds to factory made feeds (sinking pellets) because of the existence of aquafeed mills owned by private companies as well as government-run. For feeding, some fish farmers use feeding bags with appropriate mesh size to contain the sinking pellets while others manually broadcast the pellets from feeding platforms in the ponds. Commercial feed manufacturers most often go out of their way to convince freshwater fish farmers to use their manufactured pellet feeds without assessing the need and economics of the use of such feeds in their fish farms.

There are now 27 fish feed production plants in Myanmar, seven of which are producing mainly freshwater fish feeds. The raw materials include a mixture of 60% rice bran, 14% peanut cake, 4% prawn shell dust, 12% wheat flour, and 10% soya bean, in which case manufacturing of the feeds makes use of plant protein instead of fish meal (**Table 2**).

Table 2. Freshwater fish feed plants and daily production of feeds

Fish feed production plants	Fish feed produced per day (tons)
Livestock Food Stuff and Milk Product Enterprise	250
Htoo Thit	200
Shwe Taung Ngwe Taung	150
Phyo Ayer	120
Myan Swan Htet	70
Shwe Myanmar	60
Ngwe Pin Lae	60

On the other hand, marine shrimps and freshwater prawns are fed factory-made pellets produced by local private feed mills but due to the decreasing number of semi-intensive and intensive shrimp and prawn farms, the demand for pellet feed had also been reduced. However, trash fish/low-value fish are the main food source for most cultured marine species such as grouper, *Epinephelus* spp. as well as mud crab (*Scylla* spp.). It is therefore very noticeable that the country's soft-shelled crab and marine fish farming thoroughly depend on trash fish as feeds. Considering that the country has huge potentials for aquaculture development, therefore there is a need to improve the quality of farm-made and commercial pellet feeds, and at the same time also reduce the use of trash fish for feeds for the sustainability of its aquaculture development. Along this rationale, the Department of Fisheries (DoF) of Myanmar had facilitated the conduct of workshops and seminars on aquaculture giving many of its staff the chance to attend high level training and graduate studies programs through scholarships. In 2010, the SEAFDEC Aquaculture Department (AQD) conducted two on-site training sessions of "farm-based feed preparation" and "fish health management" in Myanmar for the staff of DoF and members of the fish farmers' association, the Fisheries Federation of Myanmar. In addition, the DoF and Myanmar Fisheries Federation also conduct several regular training courses on various aspects of aquaculture. Moreover, the development of small-scale aquaculture emphasizing on the production of low-cost fish species and improvement of aquaculture techniques for food security of the local communities has been promoted by DoF in collaboration with Japan International Cooperation Agency (JICA) through the project on Small-scale Aquaculture Extension for Promotion of Livelihood of Rural Communities (SAEP) which was implemented from 2009 to 2011.

Issues and Concerns

In Southeast Asia, the development of sustainable aquaculture which is an important source of aquatic protein for the region's growing population is being constrained by the insufficient supply and high cost of nutrients, and inadequate feed ingredients and formulated feeds. In many Southeast Asian countries, the specific problem on aquaculture feeds and feeding management varies greatly according to the status of development of aquaculture and the culture systems adopted. While some countries are still using traditional feeding practices such as feeding unprocessed feeds which are available from near farm sources as well as agricultural by-products, and using small marine fish or trash fish, the other countries have already developed advanced feeding management for aquaculture through the use of manufactured pellet feeds. In order to minimize the disparity among the countries as

far as aquaculture feed development is concerned, the 2nd Meeting of the AFCF in Brunei Darussalam in June 2010, had designated Myanmar as the lead country for the key cluster on "Fish for Aquaculture Feed in the Region" with the main objective of developing and promoting alternative feed production by reducing dependence on the use of low-value or trash fish in aquafeeds. Although a gigantic task for the country to undertake, but Myanmar is taking giant strides in this aspect through enhanced collaboration with the other countries in the region as well as with SEAFDEC through its Aquaculture Department.

It should be noted that in intensive aquaculture system, 60 to 80 percent of the operation costs account for feeds whereas in semi-intensive aquaculture system, it could only be 30 to 60 percent of the operations cost including fertilizers. In order to improve feeds and feeding strategies for aquaculture species, it is necessary to understand the basic principles of fish nutrition such as the nutritional requirements of the cultured species and the nutritional values of feed ingredients, among others. Nevertheless, feeds and feeding management had been noted to vary largely in many countries in the region especially in Cambodia, Lao PDR, Vietnam and Thailand (Edwards and Allan, 2004). Nonetheless, only very few farmers have high level of understanding of the nutritional requirements of the species being cultured in fish farms.

Moreover, in preparing farm-made feeds, the best combinations of feed ingredients for different cultured species and culture methods should be taken into consideration as well as the availability of feed ingredients which differs very widely both regionally and seasonally. In order to improve feed management and feed formulation, it is imperative that the environmental, social and economical impacts should be taken into account because feed management is a crucial factor that could affect water quality and subsequently fish production. Proper feeding is essential for survival and growth of cultured fish, while inappropriate selection of feed quality and poor feeding strategy could affect the poor utilization by the cultured species of the feeds resulting in high food conversion ratio (FCR). Thus, proper feed management could be promoted by improving the feed conversion ratio through the use of appropriate amount of feeds, maintaining proper feeding duration, proper feeding frequency and timing. Appropriate feed management techniques and/or improving feed quality would contribute to the appropriate utilization of feeds without increasing the operational costs of producing the desired fish (Hasan, 2010). Therefore, feed management strategies should aim for optimizing feed inputs, reducing feed conversion ratios and reducing the potential impact of the feeds in the culture water and the environment.

Dependence of aquaculture on fish meal

Feeds and feeding usually represent the largest operating cost items in most fish and crustacean farming operations. Industrially compounded and farm-made aquafeeds as well as trash fish have been used as feed inputs in aquaculture farming. In 2006, Thailand, Indonesia, Philippines and Vietnam were the only countries in the region included in the top ten compound aquafeed producers of the world, where Thailand, Indonesia, Vietnam and Philippines produced 1.10-1.30 million tons, 0.75-0.90 million tons, 0.65-0.85 million tons, and 0.35-0.40 million tons, respectively (Tacon and Metian, 2008). Worldwide, 40% of all aquaculture production is dependent on industrial manufactured pellet feeds with the major part of the ingredients coming from the marine and coastal ecosystems (New and Wijkström, 2002).

Globally, the percentage of farms using commercial feeds varies from 100% in salmon and trout to 93% in shrimps, 73% in catfish and marine fish, and 47% in carp farms. Major aquaculture commodities, particularly carps had seen increased usage of commercial feeds from 20% in 1995 to 47% in 2007, and the use of commercial feeds in carp farming is expected to increase to 60% in 2020. Tacon and Metian (2008) declared that presently, 82-93% of all farmed shrimps are grown on commercial feeds while 95% of shrimp farming industries will be using commercial feed in 2020. Furthermore, Deutsh *et al.* (2007) pointed out that although carp feeds accounted for 60% of all aquafeeds produced, this change could have the greatest impact on fish meal quantities needed to meet the large volume of feed production. For the manufacture of formulated pellet feeds for farming of carnivorous fish species and marine shrimps in the world, the feed industry is still highly dependent on marine capture fisheries for the dietary nutrient sources of the feeds including fish meal, fish oil and low-value trash fish (Tacon *et al.*, 2006). Thus, Deutsh *et al.* (2007) added that while aquaculture is developing as a highly globalized trade-dependent industry, it will continue to increase the use of the marine fishery resources as can be traced and mapped from the patterns of the global trade flows for fish meal. Nonetheless, it should also be considered that fish meal is used not only in aquafeeds production but also for domestic livestock feeds (poultry, pigs, cattle, among others), although aquafeeds are largely used for carnivorous aquatic species and also as taste attractant for omnivorous and herbivorous fish species.

Traditionally, fish meal and fish oil have been used extensively in aquafeeds especially in high valued fish feeds, mainly due to their excellent nutritional properties such as source of energy and essential fatty acids. As natural ingredients, fish meal and fish oil have very high protein contents, including well balanced essential amino

Table 3. Ranges of fish meal (FM) and fish oil (FO) used in the manufacture of aquafeeds for specific cultured species

Species cultured	FM	FO
Shrimps	5 - 40%	0.5 - 10.0%
Salmon	20 - 50%	9.0 - 35.0%
Trout	15 - 55%	3.0 - 40.0%
Eel	40 - 80%	0.0 - 24.0%
Marine fishes	7 - 70%	1.0 - 15.0%
Tilapia	0 - 20%	0.0 - 10.0%
Milkfish	1 - 5%	0.0 - 2.0%
Freshwater prawns	5 - 25%	0.0 - 3.0%
Chinese carps	0 - 20%	0.0 - 2.0%
Catfish	3 - 40%	0.0 - 15.0%

acids, minerals and essential fatty acids (Omega-3 Highly Unsaturated Fatty Acids). The benefits of fish meal and fish oil in aquatic animal feeds could include higher survival and growth rates as these are highly digestible, increased appeal, promote fish health, and reduced incidence of deformities. Wide variation of the use of dietary fish meal and fish oil were observed within and between countries for the same species (**Table 3**). Moreover, the results of a survey conducted by Tacon *et al.* (2008) indicated that the major commercial culture fish species, compound feeds production, fish meal and fish oil used in Thailand, Indonesia, Vietnam and Philippines vary as shown in **Table 4**.

In 2006, the top global consumers of fish meal based on cultured fish species were marine shrimps, followed by marine fishes, salmon and Chinese carps whereas the top consumers of fish oil were salmon followed by marine fishes, trout and shrimps. Tacon and Metian (2008) predicted that the use of fish meal and fish oil (derived from wild capture fisheries) by the aquaculture sector in terms of compound aquafeeds will decrease in the long term. However, the use of fish meal and fish oil usage would still increase in high value starter and finisher in broodstock feeds. The reason for such scenario could be a variety of factors which include the static and/or diminishing global supply of wild forage fishes; increasing market price of small pelagic forage fishes; global increasing costs of energy, processing, and transportation; static and/or diminishing supply of fish meal and fish oil for export.

Rana (2009) pointed out that even though fish meal production has been stable, aquaculture output has been clearly expanding and thus, in looking at the challenges for stabilizing and increasing aquaculture growth one should also focus foresight beyond the fish meal debate, especially if forecasts for fish production are considered. Nevertheless, due to various reasons that include increasing

price and limited supply of fish meal and fish oil, many attempts have been made to replace fish meal and fish oil with alternative feed ingredients for the sustainability of the aquafeeds industry, an effort which has been pursued in the Southeast Asian region, where numerous protein and oil sources including animal by-products, plant proteins and oils, and marine products from lower trophic levels having potential uses in aquafeeds had been tried as substitutes for fish meal and fish oil. The use of plant origin ingredients as sustainable alternatives to marine fish meal and fish oil in aquafeeds has great potential because these ingredients are highly available globally at competitive prices and have nutritional properties that satisfy the nutritional requirements of some fish. However, plant derived ingredients could also present some problems and challenges to successfully complete the replacement of fish meal and fish oil especially in carnivorous marine fish diets. Many studies have shown that partial replacement of fish meal and oil by plant origin ingredients does not affect the health and growth of fish, but such replacement had been found to be considerably easier for herbivorous/omnivorous fish species than for the more nutritionally demanding carnivorous fish species (Hardy and Tacon, 2002). In fact, only a small amount of fish meal and fish oil

could be used in the diets for omnivorous and herbivorous fish species which are dominantly cultured in the world, mainly to increase fish appeal.

Since most of the Southeast Asian countries are agriculture countries, these countries have a comparative advantage over other parts of the world in terms of producing both feeds and fish. However, the recent opening of export market to the Middle East and Europe has influenced the culture practices of freshwater carps in Myanmar which has shifted to using formulated feeds to increase production (Aye *et al.*, 2007). It was however noted that in spite of the increased export of Indian major carps especially rohu (*Labeo rohita*), the availability and affordability of the fish to the local communities had not been affected (De Silva and Turchini, 2009). Nonetheless, the shifting trend from extensive to semi-intensive carp culture in Myanmar could increase the demand for feed ingredients. In this regard, Ng *et al.* (2007) suggested that for development of cost-effective farm- and factory-made feeds in Myanmar, research on nutrient and feeding requirements of major cultured species should be conducted, using locally available agriculture by-products such as rice bran and ground-nut cake. Moreover, farmers should be taught how

Table 4. Production of compound feeds, fish meal and fish oil used in the culture of major commercial fish species of selected countries in Southeast Asia

Country	Feed Production (tons)	Reported FCR	% Fish meal (ave)	% Fish oil (ave)
Shrimps				
Indonesia	312,000-400,000	1.4 -1.8 (1.6)	8-20 (15)	1.0-3.0 (2.0)
Philippines	15,000-30,000	1.2 -1.8 (1.5)	10-30 (20)	4.0-6.0 (5.0)
Thailand	650,000-750,000	1.2- 2.0 (1.5)	5-35 (25)	0.5-3.0 (2.0)
Vietnam	260,000-310,000	1.2-1.8 (1.6)	10-30 (20)	1.0-3.0 (2.0)
Marine fish (Barramundi)				
Thailand	1173	1.4-3.0 (1.8)	20-50 (35)	2.5-6.0 (4.0)
Tilapia				
Indonesia	84,000	1.8	3-8 (5)	1.0-2.5 (1.5)
Philippines	175,000	1.4-1.8 (1.6)	7	-
Thailand	151,200	1.3-1.7 (1.5)	0-20 (6)	1.0-3.0 (1.5)
Milkfish				
Indonesia	30,000-50,000	1.8	2-5 (3)	0.5-2.0 (1.0)
Philippines	200,000	1.8-2.7 (2.2)	5	-
Freshwater prawn (<i>M. rosenbergii</i>)				
Thailand	21,420	1.5-2.5 (1.7)	5-20 (15)	1.0-3.0 (2.0)
Common carp				
Indonesia	185,000-360,000	1.4-2.0 (1.7)	2-7 (5)	0.50-2.0 (1.0)
Catfish (include <i>Pangasianodon</i> spp., <i>Clarias</i> spp.)				
Indonesia	60,000-70,000	1.0-1.3 (1.2)	5-10 (7)	1.0-3.0 (2.0)
Thailand	113,400	1.2-1.5 (1.4)	5-20 (10)	1.0-3.0 (2.0)
Vietnam	400,000-500,000	1.4-1.8 (1.6)	5-15 (10)	1.0-2.0 (1.5)

Note: Adapted from Tacon and Metian (2008)



Above: Trash fish/low-value fish to be processed into aquafeeds in a fish meal factory in Myanmar; and Below: Fish meal powder products of Myanmar

to make good quality farm-made feeds and proper feeding techniques, while the government should establish and promote the guidelines for good aquafeed manufacturing practices to address sustainability and traceability issues.

Low fish meal content in formulated diet for aquaculture

The current growth in global aquaculture is paralleled by an equally significant increase in companies involved in aquafeeds manufacturing. Aquaculture industries raising particular economically valued species such as penaeid shrimps and some marine fishes would require feeds with high demands on feed ingredients resulting in significant acceleration in demand for properly formulated aquafeeds not only for the present aquaculture condition but also for the next decades. As requirements for aquafeeds increase, shortages are anticipated in various ingredients, especially the widely used protein sources such as fish meal. A variety of other protein sources have been considered as partial or complete replacement for fish meal, especially the plant protein sources such as soybean meal. In the past five years, vegetable protein meal production has increased by 10% while fish meal production has dropped over 50% since 1989, which has been largely attributed to overfishing and serious decline in wild fish stocks. Recently, waste product from fisheries processing industries had been explored as potential source of ingredient that could replace fish meal.

Feed costs are a major consideration in aquaculture especially for marine fishes, where high protein containing feeds using quality fish meal, can account for as much as 40 to 60% of production costs with about 67% of the actual feed cost is attributed to the fish meal protein fraction. Clearly, this is an untenable situation since global aquaculture had been increasing in size as well as in diversity of aquatic species cultured. Therefore, considerations such as cost and availability of commonly utilized aquafeed ingredients should also be recognized as new feed formulation practices development. Moreover, innovative approaches must explore the wide variety of processing by-products potentially available as source of nutritionally valuable ingredients in specific aquafeeds. However, this must be correlated with the availability of such ingredients, especially the plant and animal proteins in the local setting and the dictates of economic pressures. Notwithstanding such concerns, the final processed aquafeed must meet the specific physical standards such as water stability and palatability as well as satisfying the nutritional needs of the aquatic species being cultured.

Therefore, research effort is needed that could contribute to the compilation of feed ingredients particularly for sole protein source (fish meal) together with relevant performance data. This would be a worthwhile contribution to global aquaculture. The conduct of such study could also contribute to the better understanding of locally available aquaculture feed ingredients and in finding useful information on other potential feedstuffs for aquaculture diets through experimental feeding trials based on the needs of present day aquaculture. Hopefully, outputs of this effort will serve as a catalyst for further compilation and ultimate critical analysis of basic and applied information on a wide range of specific ingredients for use in commercial aquaculture.

Trash fish/low-value fish for aquafeeds

Another issue that confronts the aquaculture industry is the direct feeding of low-value or trash fish to higher value aquaculture species especially in grouper and soft-shell crab farming. Such practice is unsustainable, and in many cases created conflicts between the use of low-value fish for human consumption and use as feed ingredient. Nevertheless, the use of trash fish/low-value fish and/or other animal protein sources in farm-made feeds is still a common practice in freshwater and marine carnivorous fish culture as well as in crab and lobster fattening in Asia (De Silva and Turchini, 2009). Therefore, there is a need to know the extent of usage of fresh trash fish or low quality dried fish or meal against their direct use for human food, considering that the use of low-value or trash fish as feeds for high-value fish species is seen to be swelling in support of the expansion of aquaculture. This would place much

Table 5. Soft-shell crab farming areas in Myanmar and monthly total trash fish used (2010-2011)

State/Regions	Farms	Cultured Area (ha)	Total Stocking	Total trash fish fed (tons/month)
Tanintharyi Region	3	42.82	1,048,091	208.81
Yangon Region	5	42.38	2,147,000	89.76
Ayeyarwaddy Region	2	9.55	400,000	16.39
Rakhine State	2	14.28	106,000	16.44
Total	12	109.03	3,701,091	331.40

Note: 1.0 acre = 0.405 ha

pressure on the long-term sustainability of the fisheries in which trash fish are caught. Thus, while aquaculture production grows dramatically in the Southeast Asian region, development of improved diets that do not rely on low-value or trash fish to substantially increase its production without threatening wild stocks remains a key challenge in this region. In the case of Myanmar, trash fish is widely used in mariculture although the availability of commercial pellet feeds and its use in sea bass, grouper and soft-shell crab culture are still very limited. Soft-shell crab farmers in Myanmar are still using the trash fish/low-value fish because of the relatively low cost involved. Trash fish utilized for the feed of soft-shell crab production means that low value fish are transformed to high value products. Currently, there are 314 acres of soft-shell crab farms in Yangon, Tanintharyi, Rakhine and Ayeyarwaddy State and Regions and 331.4 tons/month of trash fish are used as feed for crab farming (Table 5). De Silva and Turchini (2009) suggested that pellet feeds can be more effective than feeding trash fish in which case soft-shell crab farms can significantly reduce the cost of production.

Reduced use of trash fish or low-value fish should be promoted in the manufacture the fish meal and fish oil. While in Asia, fish meal manufacture is based on species mix of marine trash fish and seafood industry waste, specifically Thailand, Indonesia and Vietnam are among the top 16 producers, importers and consumers of fish meal (IFFO, 2008). Fish meal consumption in Vietnam has increased to 82,000 tons in 2004 from almost zero in 1999 whereas the importations of Thailand decreased from 10,080 tons in 2004 to 4,800 tons in 2006 because of increased domestic fish meal production. Although the local production of fish meal in Thailand was insufficient, they were able to increase their supply for its increased fish meal consumption by expanding its supply network through the other countries in the region and increasing the supply from abroad (Deutsh *et al.*, 2007). In this regard, Deutsh *et al.* (2007) suggested that maintaining heavy fishing pressure at lower levels of food web, spurred in part by ever increasing demand for fish meal in the growing aquaculture sector, may make it difficult for marine fish species at higher trophic levels to recover even if fishing pressure on these stocks had been significantly decreased. De Silva and Turchini (2009) reported that since fish meal production in other countries of Asia is growing slowly, a nation such as Myanmar which produces nearly 12,000 tons of fish meal would be of utmost importance to the region. As reported, fish meals are produced in Myanmar using trash fish that are not suitable for direct human consumption. Aye *et al.* (2007) reported that through such industry, a potential waste is eliminated and employment is created, indirectly contributing to poverty alleviation and food security. There are 14 fish meal plants and 27 fish-feed production plants in Myanmar (De Silva and Turchini, 2009) and that a number of significant trends in feed development and management

Table 6. Fish meal production, exported and locally used in Myanmar

Year	Total production (tons)	Exported			Locally Used (tons)
		Amount (tons)	Value (US\$ Millions)	Price (US\$/ton)	
2006-2007	23,700.900	15,546.259	8.504	547.0	8,154.641
2007-2008	24,022.500	19,801.246	12.545	633.5	4,221.254
2008-2009	21,756.590	13,256.220	7.108	536.0	8,500.370
2009-2010	36,423.056	21,080.270	10.551	500.5	15,342.786

Table 7. Trash fish used, energy used and fish meal production by Division in Myanmar

Division	Years	Trash fish used (tons)	Fish meal production (tons)	Production rate (% of raw trash fish)
Thanintharyi	2006-2007	71,021.28	23,700.900	33.37
	2007-2008	76,206.94	24,022.500	31.52
	2008-2009	66,502.40	20,588.140	30.96
	2009-2010	108,802.77	35,561.850	32.68
Yangon	2008-2009	4,830.71	1,168.450	24.19
	2009-2010	3,613.08	861.206	23.84

that have a bearing on dependence on fish meal/low-value fish or fish meal from external sources are taking place in Myanmar. However, there is very limited quality control in the commercial fish feeds produced in Myanmar.

Fish Meal Production in Myanmar

Of the number of fish meal plants in Myanmar, two are in Yangon Division, two in Mon State, and the rest are in the Thantharyi Division. At present, two fish meal plants in Yangon and six plants in Thantharyi Division are in full operation. Most of the fish meal manufacturing plants are located near the major fish landing sites. The produce of the fish meal plants is mostly exported as well as used by local poultry feed factories and to a lesser extent used in aquafeed factories.

Normally, to produce one ton fish meal, 3-4 tons of trash fish would be required. Fish meal plants in Yangon Division are using 4,221.895 tons of trash fish to produce 1,014.848 tons of fish meal while factories in Thantharyi Division are producing 25,968.34 tons of fish meal by using 80,633.34 tons of trash fish. Fish meals produced in Myanmar contain 50-60 percent protein contents. Myanmar fish meal is exported to Malaysia, Bangladesh, Singapore, China, India, Japan, Kuwait, Vietnam and Thailand. Some details of the fish meal production of Myanmar are described in **Table 6** and **Table 7**. However, owing to limited information the effect of fish meal production on the fish stocks could not be analyzed.

Way Forward

In order to expand the aquaculture industry of Myanmar, R&D mechanism should be strengthened advocating effective feed management and reduced dependence on fish meal. In addressing these concerns, approaches should be promoted such as the culture of herbivorous fish species or bivalves and the practice of an integrated aquaculture system to simultaneously produce fish and shellfish. Using locally available plant by-products would be promoted in the research on nutrients and feeding management of major culture species. In Myanmar, quality control on commercial fish feeds and establishment of guidelines for good aquafeed manufacturing practices are most essentially and urgently needed. Data collection and analyses of the effects of fish meal production on the development of the aquaculture industry (dependence on resources: heavy fishing pressure at the lower levels of the food web) and on fish stock should be conducted to respond to the environmental concerns. This is true not only for Myanmar but for the Southeast Asian region as a whole. The small pelagic fish resources should be conserved for food web support and not just targeted for human catch at

the maximum sustainable yield. In addition, the uncertain impacts of climate change on small pelagic fisheries in the future are important points that should also be considered. Therefore, the implementation of an ecosystem approach to aquaculture and fisheries should be taken into consideration by the fisheries agencies in the region.

Fish for Aquaculture Feed

Based on the report of the 18th Meeting of the ASEAN Sectoral Working Group on Fisheries (ASWGF) in June 2010 in Brunei Darussalam, each ASEAN member country has to lead the implementation of various measures that would enhance the development of the fisheries sector in the region. In this connection, Myanmar has been tasked to serve as the lead country for the cluster on Fish for Aquaculture Feed. In carrying out such responsibility, a Working Committee would be organized by DoF of Myanmar to take charge of the development of fish meal replacement feed for aquaculture, explore the alternative protein sources for aquaculture feed, and coordinate with other ASEAN countries and regional fisheries organizations during research and development processes. Thus, Myanmar had set up its plan of action to implement these measures as shown in **Box 1**. Data collection and information on fish meal applied in freshwater and seawater aquaculture sector by the ASEAN countries will be conducted through the assistance of the Department of Fisheries of Thailand, while research activities focusing on the use of soybean meal, green pea and by-products of clam meat will be carried out by the DoF of Myanmar.

Box 1. Myanmar's Plan of Action for the development of fish meal replacement for aquaculture

- Organize the National Task Force for Fish for Aquaculture Feed Project
- Collect and compile data and information from the ASEAN countries on fish meal used in the freshwater and seawater aquaculture sector, the fish meal quantity used for aquaculture, impact of fish meal production on fisheries resources, other alternative sources to substitute fish meal feed in consultation with Thailand, the Alternative Chairperson of the ASEAN Fisheries Consultative Forum (AFCF)
- Implement research and development process by utilizing agro-based products and other by-products potentially available from local areas, for nutritionally valuable ingredients in specific aquafeeds
- Evaluate fish meal replaced feed research activities in other ASEAN Member Countries
- Cooperate with other ASEAN countries and regional organizations for the conduct of relevant research activities
- Organize workshops with the participation of ASEAN countries and regional fisheries organizations
- Conduct pilot scale production of fish meal replaced aquafeeds
- Assess and evaluate the pilot scale production of fish meal replaced aquafeeds

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Mitigating the Impacts of Climate Change: Philippine Fisheries in Focus

Mudjekeewis D. Santos, Jonathan O. Dickson and Pierre Easter L. Velasco

Southeast Asia is one of the world's most vulnerable regions to climate change and thus, it is urgent to mitigate the impacts of climate change and build up adaptive capacity of the region in order to ensure long-term food security and sustainability. As a climate change hotspot, the Philippines had been ranked eighth among the countries most vulnerable to some of the worst manifestations of climate change. It is for this reason that the Philippine Government enacted the Philippine Climate Change Act of 2009 (RA 9729) providing for the creation of the Philippine Climate Change Commission which is tasked to formulate and implement plans for the country to better prepare for and respond to natural disasters. Although the impacts of climate change on the structure and the productivity of the marine ecosystems vary with the fishery, it could result in modifications of the distribution of the resources, the consequences of which could be very significant to the development of the region's fisheries.

Southeast Asia is one of the world's most vulnerable regions to climate change because of its long coastlines, specific dependence on seasonal patterns of the monsoon, high concentration of population and economic activity in coastal areas, and heavy reliance on agriculture, fisheries, forestry and other natural resources (IPCC, 2007). To ensure long-term food security and sustainability in the Southeast Asian region, the need to mitigate the possible impacts of climate change and build up adaptive capacity to mitigate its effects on the natural resources, ecosystem, and livelihoods was deemed urgent. Although the impacts of climate change on the structure and the productivity of the marine ecosystems could vary depending on the type of fishery, stressors, and the biological characteristics of the target species, any movements in a particular aquatic environment could be conducive to rapid growth of high-value species in that environment. However, the reverse may not be true in some instances because more often than not, climate change results in modifications of the area of distribution of resources resulting to migrations towards the North or South pole whichever is closer from such environment. Therefore, the consequences of such phenomenon could be very crucial for the sustainability of fisheries.

The United Nations Climate Summit in Copenhagen in 2009 declared the Philippines as the eighth among the top ten countries most vulnerable to climate change and the only country in Southeast Asia included in the top ten

countries led by Bangladesh and India. The Philippines as an archipelagic nation of over 90 million faces, is more exposed to more severe typhoons, floods, landslides, droughts, volcanic eruptions, earthquakes, and tsunamis than any other country in Southeast Asia. In the last two decades, the country has experienced the worst of extreme weather conditions. From the early 1990s until 2008, the country suffered the most casualties and experienced the most damages from extreme weather with almost 800 deaths per year and an average of US\$ 544 million worth of climate-related damages (Natividad, 2009).

In 2009, tropical storm "Ondoy" and Typhoon "Pepeng" caused massive flooding and landslides, damaging infrastructures and resulting in losses of crops worth close to Philippine Pesos (PHP) 30.0 billion, while more than 600 human lives were lost from Metropolitan Manila to Northern Luzon and an estimated 7 million Filipinos seriously affected. The impacts of the natural hazards since 1900s cost the country more than US\$ 7.0 billion in damaged properties losing an estimated 50,000 human lives. Aside from typhoons, the country is also periodically affected by the El Niño Southern Oscillation (ENSO) phenomenon.

Specifically, during the period from 1990 to 2003, a severe El Niño-driven drought was attributed to agriculture losses worth more than US\$ 372.0 million. The impacts of climate change therefore constitute additional pressure that could exacerbate the current degradation of the Philippine ecosystem. Moreover, the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) made projections of some attributes to climate change in the Philippines for 2020 and 2050 (The Philippine



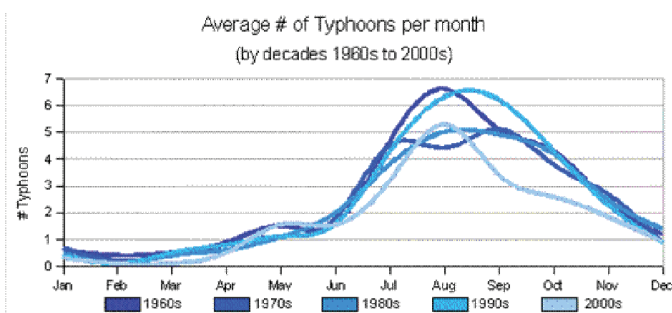


Fig. 1 Average monthly occurrence of typhoons in the Philippines

Strategy for Climate Change and Adaptation, DENR, unpublished), indicating that there would be a projected rise in mean annual temperature of 0.9-1.4°C, while the dry season from March to May will intensify and the wet season from July to November would be wetter. Most part of Mindanao will experience less or reduction of rainfall for all seasons but an increasing number of much stronger tropical typhoons will hit the Visayas area. The mountainous regions or areas with high elevation in slope mostly in northern Luzon, Mindanao, Mindoro, Negros and Panay will be more vulnerable to excessive rains, landslides, and flashfloods. **Fig. 1** shows the average monthly occurrence of typhoons in the Philippines from 1960s to 2000s.

According to Dr. Herminia A. Francisco of the Singapore-based Economy and Environment Program for Southeast Asia (EEPSEA), 10 provinces in Luzon and the country's capital Metropolitan Manila are the most vulnerable to the impacts of climate change (Yusuf and Francisco, 2009). This claim was also supported by the research conducted by the Asian Development Bank (ADB) and the World Wild Fund for Nature (WWF) some years back, that a 90 cm seawater upsurge due to sea level rise will inundate some of the reclaimed areas in Metro Manila.

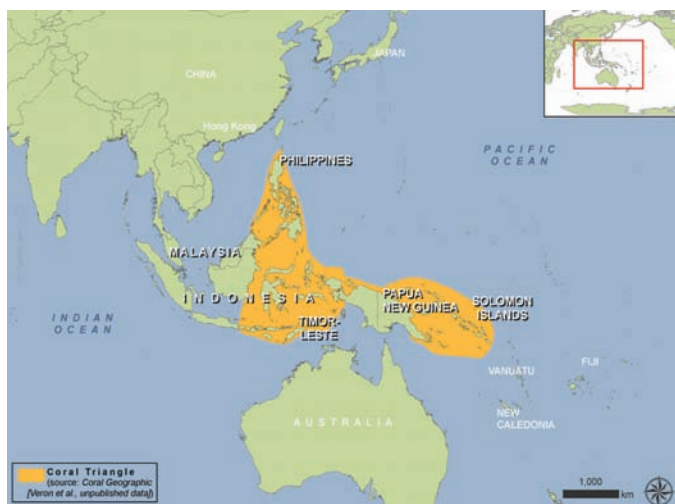
Effects of Climate Change to Philippine Fisheries

As an archipelagic state, the total territorial waters or EEZ of the Philippines is about 2,200,000 km² (coastal: 266,000 km² and oceanic: 1,934,000 km²) and the length of its coastline is 17,460 km. With vast coastal and inland waters, the country ranks the 8th among the world's top-producing countries of fish as well as other aquatic and marine products. The Philippines also sits at the apex of the Coral Triangle, which supports an array of biodiversity and recognized as the global epicenter of marine biodiversity. The Coral Triangle encompasses at least 500 species of reef-building corals in each sub-region and the highest diversity of coral reef fishes in the world.

Seventy percent of the protein requirements of the Filipinos for nutrients, minerals, and essential fatty acids are derived from fish, and over 1.6 million Filipinos depend on the fishing industry for their livelihood. The contribution of the Philippine fishing industry to the country's Gross Domestic Products (GDP) was 2.3% and 4.3% at current and constant prices, respectively. The country's 2008 fisheries production of 4.965 million mt (**Table 1**) indicated a remarkable 5% increase from the 2007 production of 4.711 million mt. In terms of value, the country's 2008 fish production valued at US\$ 4.7 billion was about 20% higher than the US\$ 3.9 billion production value of 2007 (SEAFDEC, 2010).

The Philippines' total production of 4.965 million mt of fish, crustaceans, mollusks and aquatic plants including seaweeds in 2008 contributed 3.5% of the world's total catch of 142.3 million mt (FAO, 2010), and made the country the 8th largest producer of fish in the world. Specifically in 1999, the Philippines became the 3rd biggest producer of seaweeds and other aquatic plants accounting for 10% (1,505,070 million mt) of the world's production of 14.85 million mt. Moreover, in 2008 the country's fishery exports amounted to US\$ 768.0 million from production of 205,274 mt compared to imports of only US\$ 195.0 million. The major fisheries export commodities include tuna, shrimps/prawns and seaweeds, while the major imports were chilled/frozen fish and fish meal (Philippine Fisheries Profile, 2008).

Despite the vastness of the country's fishery resources, it is unfortunate that the Philippines is also considered the world's top biodiversity hotspot, mainly because of its depleted fishery resources; degraded coastal environment and critical fisheries habitats due to siltation from deforestation, destructive fishing practices, overharvesting of mangroves, lime and sand quarrying, among others; low incomes and dissipated resource rents; reduced value of



Coral Triangle with Philippines at the apex

Table 1. Fisheries production of the Philippines: 2004-2008 (Qty in '000 mt; Value in '000 000 US\$)

Fisheries Sub-sectors	2004		2005		2006		2007		2008	
	Qty	Val	Qty	Val	Qty	Val	Qty	Val	Qty	Val
Marine capture	2,067.1	1,597.4	2,122.2	1,680.7	2,154.8	1,997.6	2,327.8	2,452.0	2,377.5	2,810.9
Inland capture	142.0	80.4	143.8	84.1	165.1	101.5	168.4	125.5	179.5	145.9
Aquaculture	1,717.0	799.8	1,895.9	892.5	2,092.3	1,085.0	2,214.8	1,334.7	2,407.7	1,718.6
TOTAL	3,926.1	2,477.6	4,161.9	2,657.3	4,412.2	3,184.1	4,711.0	3,912.2	4,964.7	4,675.4

Source: Fishery Statistical Bulletin of Southeast Asia 2008 (SEAFDEC, 2010)

catches due to poor post-harvest practices; inter-sectoral as well as intra-sectoral conflicts and poverty; and poor system of fisheries management (Luna *et al.*, 2004). Thus, the fishing communities and people dependent on fisheries and aquaculture as producers and consumers in inland or coastal areas would be vulnerable to the impacts of climate change in terms of dwindling stable livelihood, decreasing availability or quality of fish for food, and increasing safety risks from fishing operations during harsh weather conditions (FAO, 2008).

Increasing sea surface temperature and El Niño southern oscillation

Aquatic animals such as fishes are poikilothermic, which means that their body temperatures vary with the ambient temperature. Any changes in habitat temperature (climate change induced) greatly affects the growth rate, metabolism, reproduction seasonality and efficacy, susceptibility to diseases and toxins, and spatial distribution of fishes (Lehody *et al.*, 1997). This in turn, affects fishing operations or the “hunt for fish” due to loss of traditional fishing grounds. This phenomenon has been observed on the migration of tunas particularly the skipjack which moves to the cooler central Pacific Ocean reducing tuna stock supply for the people in the Coral Triangle region including the Philippines (Alcala, 2010).

Increasing sea surface temperature (SST) has also been attributed to the recurrence of harmful algal blooms

(HAB) specially the dominant alga *Pyrodinium bahamense* var *compressum*, whose growth development pattern is easily affected by major climate changes (Capili *et al.*, 2005). Too much warming also affects the growth rate and physiological function, distribution, and patterns of sea grass reproduction. Lakes, rivers and inland bodies of water are also greatly affected. As the sea surface temperature increases and precipitation lessens, water level may drop resulting in stronger and longer stratification of lakes and reservoirs, and with limited seasonal turnover deoxygenation of bottom layers occurs that results to massive fish kills, *e.g.* fish kill in Magat Dam in 2010.

Due to the effect of the El Niño phenomenon in 1998, the Philippines experienced the hottest and driest season ever recorded. It is expected that the El Niño Southern Oscillation or ENSO will increase its frequency and intensity in the coming decade. Increased temperature is one stressor that causes the corals to bleach, diminishing their growth and threatening the critical habitats for fish and other marine organisms. In fact, the 1998 El Niño caused massive coral bleaching around the world, and as reported in the National Geographic, over 16% of the world’s coral reefs were lost in that one year which also affected 49% of the Philippine coral reefs. According to Reef Check, fish species were already starting to disappear as coral reefs were destroyed around the Philippine archipelago, while



Magat Dam is a large rock-fill dam in Magat River, a major tributary of Cagayan River in the Philippines. Massive fish kills occurred in the Dam in early 2010 due to lack of oxygen in its waters.



Incidence of coral bleaching in Philippine coral reefs

O'Meara of the Washington-based Worldwatch Institute said that "a 1-2°C increase in temperature can cause corals to bleach and sustained increase of 3-4°C causes corals to wither and die as they expel the algae (zooxanthellae) that provides them with food and lend them their vibrant colors". The total economic value from coral reef fisheries of the Philippines is estimated at US\$ 1.1 billion annually and ranks second in the region following Indonesia with 1.6 US\$ billion annually. The El Niño phenomenon in 1998 resulted in decreased live coral cover nationwide by about 49% due to coral bleaching associated with the warming of sea water surface. This had severely damaged the network of corals in the world's largest contiguous coral reef system, the 27,469 ha Apo Reef in Occidental Mindoro, Philippines.

Sea level rise

Sea level rise (SLR) has been considered as a significant effect of global warming, where the sea level increases due to the thermal expansion of the water and through the addition of water to the oceans from the melting mountain glaciers, ice caps and ice sheets. According to Greenpeace, a one-meter rise in sea level is projected to affect the country's 64 out of 81 provinces, covering at least 703 out of 1,610 municipalities and inundating almost 700 million square meters of land, threatening low-lying communities and endangering the quality of drinking water and agricultural productivity due to salt intrusion. The IPCC (2009) also added that a centimeter rise in sea level erodes at least a meter of beach horizontally, damaging or destroying many coastal ecosystems such as mangroves and salt marshes, essential to maintaining wild fish stocks as well as supplying seeds for aquaculture. Mangroves and other coastal vegetation buffer the shore from storm surges that can damage fish ponds and other coastal infrastructures, which could become more frequent and intense due to climate change. UNEP estimated that the annual ecosystem value of mangroves in the country is US\$ 200,000-US\$ 900,000/km². Other climate change-related threatened critical ecosystems of the Philippines

include the nesting sites of sea turtles and sea birds as well as the premier beaches in the country. Increasing sediment loading due to SLR affects the submerged aquatic sessile organisms, disrupting ecosystem balance and increasing the potential for disease among oysters. As a result, aquatic flora and fauna will be more susceptible to the stresses affecting their reproductive processes as they endure the prolonged environmental warming.

Sea level rise would also affect tidal variations, alter water movements and reduce light intensity vital to the productivity of sea grasses and corals (Short, 1999). The possible effect on marine protected areas, *refugia*, and marine reserves could be its inability to continue preserving the habitats of aquatic flora and fauna as climatic zones shift. The physical effects of SLR may cause substantial socio-economic losses of coastal structures both natural and man-made, dislocation of the population and loss of livelihoods (Perez *et al.*, 1999).

Ocean acidification

Warming of the ocean decreases its capacity to dissolve CO₂ (Capili *et al.*, 2005) and the rise of CO₂ in ocean waters leads to more corrosive conditions for calcifying organisms, making it more difficult for rebuilding and maintaining their carbonate skeletons. Moreover, too much CO₂ concentration will also enhance the primary production of carbon limited sea grass areas disrupting the balance between sea grass and algal populations.

Ocean currents and circulation

The deepening of the thermocline layer and stronger thermal stratification brought about by climate change will affect and ultimately change the dynamics of plankton productivity and disrupting upwelling zones by preventing cool nutrient rich waters from being upwelled in some areas (Roemmich and McGowan, 1995). This can enhance plankton productivity and result in faster water evaporation allowing the colder, nutrient-rich waters to surface. Thus,

Box 1. Status of major fish resources and habitats in the Philippines

Resource/Habitat	Status	Source
Corals	Degraded state	BFAR-NFRDI-PAWB. 2005. BINU
Seaweeds	Unknown (except declining seed source)	BFAR-NFRDI-PAWB. 2005. BINU, GTZ (2009)
Sea grass beds	Heavily stressed	BFAR-NFRDI-PAWB. 2005. BINU
Mangroves	Degraded state	BFAR-NFRDI-PAWB. 2005. BINU
Invertebrates	Declining trend	BFAR-NFRDI-PAWB. 2005. BINU
Demersal fishes	Declining trend	BFAR-NFRDI-PAWB. 2005. BINU
Small pelagic fishes	Declining trend	BFAR-NFRDI-PAWB. 2005. BINU
Tunas	Stable trend (except big eye tuna)	BFAR-NFRDI-PAWB. 2005. BINU, WCPFC (2009)
Sharks and rays	Declining trend	NPOA Sharks (2009)
Marine turtles	Threatened	BFAR-NFRDI-PAWB. 2005. BINU
Marine mammals	Threatened	IUCN Red List (2009)

toxic algal blooms become very eminent, and as a matter of fact, the recurrence of toxic algal blooms in Manila Bay has been attributed to the increased SST (Capili *et al.*, 2005).

Climate change is also modifying the distribution of both marine and freshwater species. Warmer-water species are being pushed towards the poles, and experience changes in habitat size and productivity affecting the seasonality of biological processes (Box 1), altering the marine and freshwater food webs with unpredictable consequences for fish production.

Increased occurrence of stronger typhoons, storms, and drought

Increased incidence of extreme events such as floods, droughts and storms will affect the safety and efficiency of fishing operations, and increase damages and disruptions to coastal and riparian homes, services and infrastructures (Box 2). Extreme events such as cyclones and associated storm surges as well as inland flooding can have serious impacts on fisheries, damaging or losing some stocks, facilities and infrastructures and increasing the risks and safety of lives at sea. According to Dr. Leoncio A. Amadore, a Meteorologist of PAGASA, the extreme tropical cyclones/southwest monsoon-induced events from the 1990s until

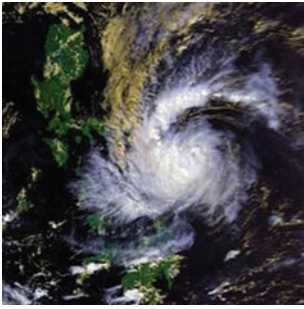
2000s were influenced by global warming. For example, Typhoon *Reming* which hit the Philippines in 2006 had triggered the Legazpi Mudslide and the Guinsaugon, Leyte Landslide, the 2nd and 3rd World's Deadliest Disasters of 2006, respectively, where more than 2,500 people were killed and almost 800,000 families were affected by such calamities (Center for Research on the Epidemiology of Disasters).

Specifically, tropical cyclones had intensified from 1975 to 2002 causing annual average damages to property of PHP 4.5 billion (around US\$ 90.0 million) including damages to agriculture amounting to PHP 3.0 billion (around US\$ 60.0 million). In 2006, the typhoons that passed the country affected at least 11 million Filipinos and inflicted damages to agriculture and infrastructures amounting to almost PHP 20.0 billion (Greenpeace, 2007). This does not include the PHP 500.0 million worth of assistance and donations in 2006 and PHP 10.0 billion allocated by the Philippine Government in its 2007 national budget to rehabilitate direct-hit areas.

Thus, in order to address these pervasive and longer-term impacts, climate change adaptation (CCA) should be mainstreamed into key development processes.

Box 2. Abiotic changes associated with climate change and effects on fishery resources and habitats

Abiotic changes due to climate change	Effects on fishery resources, habitats, and people
<ul style="list-style-type: none"> Sea surface temperatures (SST) Observed: ~ 0.11°C/decade (1950-2007) Projected: ~ 1.00-3.00°C by end of century 	<ul style="list-style-type: none"> Coral bleaching, branching corals vulnerable Fishes move to cooler areas, since tolerance limits narrow, risks of extinction increased: tuna, skipjack moving to cooler central Pacific Ocean, reducing fish supplies for people elsewhere in Coral Triangle region including the Philippines
<ul style="list-style-type: none"> Ocean acidification Observed: ~ 0.1 units Projected: ~ 0.3-0.4 units by 2010 Aragonite saturation state and coral calcifications marginal in 2020-2050 	<ul style="list-style-type: none"> With doubling atmospheric carbon dioxide, reduction of calcification in corals and species with carbonate skeletons, corals become more fragile, recovery becomes slower; both increasing SSTs and acidification increase stress to corals through increased disease virulence, making corals susceptible to breakage
<ul style="list-style-type: none"> Sea level rise Observed: ~ 10-20 cm over 20th century (especially true for Philippines) Projected: a further rise of 30-60 cm by 2010, with ice melting 4-6 m by 2100 	<ul style="list-style-type: none"> Flooding of low islands and low lying areas resulting in land erosion, sea water intrusion in coastal land areas, population displacement, landward growth movement of mangroves, changes in phenology of mangroves
<ul style="list-style-type: none"> Tropical cyclones Observed: Doubling in frequency of super typhoons Projected: Become more intense with heavier rainfall 	<ul style="list-style-type: none"> Increasing frequency and strength weaken skeletal framework of corals, accelerate erosion of beaches, weaken coral resistance to disease, prevent normal recruitment of marine species including fish species used as food
<ul style="list-style-type: none"> El Niño Southern Oscillations Observed: Has occurred in recent past Projected: Will be significant source of climate variability 	<ul style="list-style-type: none"> Worsen the effects of other climate change stresses
<ul style="list-style-type: none"> Storm surges, strong monsoon winds Observed: Increasing frequency and severity Projected: Will increase in severity 	<ul style="list-style-type: none"> Coastal erosion in small islands, destruction of infrastructures and buildings
<ul style="list-style-type: none"> Ocean circulation Observed: Little information at present Projected: Some upwelling could cease and horizontal currents could change directions, altering oceanographic regimes, resulting in changes in ocean productivity 	<ul style="list-style-type: none"> Prevents normal dispersal and distribution of larvae of marine species, mangrove and coral propagules, resulting in low fish and fishery productivity, degradation of coral reef systems, decline of coastal and reef fishes, and failure of fish recruitment



Strong typhoon approaching the Philippine area of responsibility in November 1991

Nevertheless, there are barriers to mainstreaming CCA, which could include: (a) general lack of awareness and understanding of climate change and adaptation specifically both the public and top-level decision makers; (b) institutional weaknesses and unclear mandates of various agencies and coordinating bodies; (c) inadequate budget allocations and lack of secure financing to effectively and sustainably promote the integration of CCA in policies; and (d) inadequate linkage between longer-term adaptation efforts and immediate responses to extreme weather events and natural disasters, which could address both more effectively. *“What occurred this year and the previous year can only be expected to be repeated or to become worse in the future. Our people must therefore prepare for the worst scenario. The key to this preparation is the Local Government Unit...”* (Alcala, 2010).

Mitigation, Adaptation and Responses to Changing Environmental Conditions.

“The Philippines vulnerability or the extent to which its people and systems are affected as a developing country is determined by three factors: their exposure to specific change; their sensitivity to that change; and their ability to respond to impacts or take advantage of opportunities. Understanding these patterns of vulnerability enables the identification of specific adaptation interventions...” FAO.

In 1995, the Philippines hosted the First Asia-Pacific Leaders’ Conference on Climate Change where representatives from 133 countries signed the Manila Declaration. Among others, the Manila Declaration acknowledged the dangers posed by climate change phenomenon to archipelagic nations such as the Philippines. *“Small island states, coastal, and other nations of the Asia Pacific region, including the many centers of economic, biological, and cultural viability and diversity, are extremely susceptible to climate change and sea level rise,”* was emphasized in the Declaration.

Republic Act (RA) 9729: The Philippine Climate Change Act of 2009

In order to harmonize the country’s programs involving climate change adaptation and mitigation, RA 9729 or the

Philippine Climate Change Act of 2009 was enacted into law recognizing the urgent need for a “Framework Strategy” and “National Climate Change Action Plan”. The law also provides for the creation of a Climate Change Commission as “the sole policy-making body of the government and tasked to coordinate, monitor and evaluate the programs and action plans of the government relating to climate change,” with the Philippine President as Chairman of the Commission. The Climate Change Act provides that both the Framework and the Plan should be completed within a period of two years. The CCC has thus far completed its National Framework Strategy, while the Action Plan was due for completion by April 2011. Moreover, Sec. 14 of the Local Climate Change Action Plan of RA 9729 recognizes the important role of the LGU (municipal and barangay levels) in the formulation, planning and implementation of climate change action plans in their respective areas, consistent with the provisions of the Local Government Code, the Framework, and the National Climate Change Action Plan.

The Philippine Climate Change Commission

Established by Republic Act 9729 or the Philippine Climate Change Act, the Philippine Climate Change Commission is an independent and autonomous body that has the same status as a national policy and is attached to the Office of the President. Among its tasks are the formulation and implementation of plans for the country to better prepare for and respond to natural disasters. The Commission also promotes close coordination with local government units (LGUs) and private entities to address vulnerability to the impacts of climate change in the regions, provinces, cities and municipalities; capacity building for local adaptation planning, implementation and monitoring of climate change initiatives in vulnerable communities and areas; and provision of technical and financial support to local research and development programs and projects in vulnerable communities and areas.

National Framework Strategy on Climate Change 2010-2022

Within the context of the country’s sustainable development goals and governance factors that affects the country’s ability to respond to climate change, its National Framework Strategy on Climate Change was formulated to cover the period from 2010 until 2022. The Framework is specifically geared towards ensuring and strengthening the adaptation of the natural ecosystems and human communities to climate change. It also seeks to chart a cleaner development path for the Philippines highlighting mutually beneficial relationships between climate change

adaptation and mitigation. The Framework highlights the critical aspects of adaptation intended to be translated to all levels of governance alongside the coordinating national efforts toward integrated ecosystem-based management which shall render all sectors climate-resilient.

The Philippine government has submitted its National Framework Strategy on Climate Change (NFSCC) to the United Nations (UN) in order to be able to access the US\$ 250-350 million Adaptation Fund (AF) established under the Kyoto Protocol. The proposal was also envisaged to enable the Philippines and its people cope with the impacts of the changing climate. The Climate Change Commission (CCC) Vice Chairman, Mr. Heherson Alvarez reported that the Framework highlighted the vulnerability of the Philippine archipelago to heavy rains, floods, landslides, droughts and sea level rise, in a bid to access the Fund by 2012.

The Philippine Climate Change Adaptation (CCA) Project

The objective of the Climate Change Adaptation (CCA) Project of the Philippines is to develop and demonstrate approaches that would enable the target communities to adapt to the potential impacts of climate variability and change. The project has four components as shown in **Box 3**.

The Philippine Water Sector Adaptation Strategy on Climate Change

The Water Sector Adaptation Strategy on Climate Change was developed to reduce the vulnerability of the water

Box 3. Components of the Climate Change Adaptation Project of the Philippines

- i) Strengthening the enabling environment for climate change adaptation, by supporting the integration of climate change adaptation into the agriculture and natural resources sectors, and strengthens the capabilities of relevant government agencies;
- ii) Demonstration of climate change adaptation strategies in the agriculture and natural resources sectors, by helping poor rural communities, which are most at risk of climate change impacts, to adapt to the effects of climate change. It will demonstrate both tangible reductions in climate-related risks, and increased resilience to longer-term climate changes and climate-related disasters;
- iii) Enhanced provision of scientific information for climate risk management. This component improves the access of end users, especially in the agriculture and natural resources sectors, to more reliable scientific information that would enable more rapid and accurate decision making for climate risk management; and
- iv) Project coordination.

Box 4. Expected outcomes of the Philippine Water Sector Adaptation Strategy on Climate Change by 2050

- i) Effective, climate change responsive, and participative water governance;
- ii) Reduced water sector vulnerability and resilient communities and natural ecosystems;
- iii) Improved knowledge on water sector adaptation and climate change; and
- iv) Sustainable and reliable financing and investment for climate change adaptation in the water sector.

sector and increase the resilience of communities and ecosystems to climate change utilizing a broad based participatory process of key stakeholders of the sector. The four strategic outcomes to be achieved by 2050 were identified supported by 12 strategic objectives and several key actions for 2010 until 2022 (**Box 4**).

Adaptive water governance includes the mainstreaming of adaptation in national and local policies and development plans. It also entails reforming the policies to address institutional fragmentation in water resources management in the country and to climate-proof existing laws. Building resilient communities and ecosystems, improve their adaptive capacities, and reduce vulnerability would entail taking serious assessment of the existing water infrastructures to determine their vulnerability to extreme events; implementing modifications in the processes and demands of existing systems and water users; adopting low cost, “no regret” adaptation technology options; and enhancing the capability of communities and existing institutions for integrated water resources management.



BFAR and NFRDI Climate Change Adaption Programs

The Bureau of Fisheries and Aquatic Resources (BFAR) as the lead agency in safeguarding, protecting and conserving the vulnerable fishery resources as well as the people, community and institutions associated with the fishery sector, has identified key mitigation and adaptation programs, and National Action Plan in response to the impacts of the changing environment (**Box 5**). On the other hand, the National Fisheries Research and Development Institute (NFRDI) also identified and included in the 2011 pipeline, climate change-related research and development projects (**Box 6**).



Establishment of coral garden and marine protected area in Aklan, central Philippines

Regional Fisheries Policy Recommendations on Mitigation and Adaptation of the Impacts from Climate Change

Due to the drastic changes of global environment and the declining of fishery resources, the challenges on “climate change” and its impacts to fisheries had been the serious topics progressively discussed at the international and regional arena. In tropical waters, the impacts of climate change are generally seen from the “sea level rise and increasing sea-surface temperature, the most probable major climate change-related stresses on the coastal ecosystems”. This situation could affect the development of fisheries making it more difficult to improve the people’s

livelihoods and ensure food security as well as address fisheries management approaches.

Through a series of regional consultations, the issue on the effect climate change to fisheries has been raised, and the required follow-up actions for SEAFDEC and Member Countries to undertake in response to the issues had been identified (**Box 7**).

Recommendations for Future Activities

Many artisanal fishers are extremely poor. Even in cases where they earn more than other rural people, fishers are often socially and politically marginalized and can afford only limited access to healthcare, education and other public services. Social and political marginalization leaves many small-scale and migrant fishers with little capacity to adapt, and makes them highly vulnerable to climate impacts affecting the natural capital resource that they heavily depend on for their livelihoods. Heightened migration to cope with and exploit climate-driven fluctuations in production could also worsen a range of cultural, social and health problems. Focusing on the recommendations of emerging regional fisheries policy issues relevant to climate changes during a series of regional consultations, SEAFDEC in collaboration with the Member Countries especially with the Philippines as the Lead Country for the AFCF key cluster on Climate Change, would consolidate all efforts to implement the activities that are aimed at mitigating the impacts of climate change as shown in **Box 7**.

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Box 5. Key adaptation programs and the National Action Plan of BFAR in response to the impacts of changing environment

- i) Vulnerability assessment and establishment of rapid alert systems (BFAR SOP on Disaster mitigation and preparedness)
- ii) Diversify livelihoods:
 - Mariculture Parks (Fish cages for livelihood)
 - Expansion of aquaculture production areas targeting abandoned or unproductive fishfarms (FLAs)
 - Allocate seed money that will help fisherfolks become fishpond operators
 - Provision of guarantee fund
- iii) Formulation and implementation of High Value Fish Species Development Plan
- iv) Active participation in the activities of the Coral Triangle Initiative
- v) Conduct of more research and development

Box 6. R&D projects of NFRDI on climate change

- i) Vulnerability assessment of Philippine Fisheries and aquaculture to climate change
- ii) Geospatial information technologies and application for fisheries management modernization (GITAFIMM)
- iii) Socio-economic survey of women and children in Philippine fisheries
- iv) National Stock Assessment Program (NSAP)

Box 7. Proposed activities to mitigate the impacts of climate change to be undertaken by SEAFDEC and the national agencies responsible for fisheries in the Member Countries

Strengthen capacity of fisheries sector in tackling with climate change

- Clear organizational long-term policy on human resources development and capacity building in response to the emerging needs relevant to climate change (SEAFDEC and national agencies responsible for fisheries)
- Promote awareness program on climate change and its impact to fisheries and aquaculture to all stakeholders (Member Countries)
- Build up the resilience of fisheries communities in response to the impact of climate change
- Establish simple meteorological information system and network for fisheries communities
- Mainstream policy on poverty alleviation and remedial actions for the people affected by the climate change

Integrate climate change into fisheries policy framework

- Review existing regional policy framework and priority actions to accommodate the issues on climate change and its impacts to fisheries/aquaculture (SEAFDEC)
- Conduct national seminar/workshop involving other relevant agencies and stakeholders to develop national fisheries policy and action plans on climate change and fisheries/aquaculture (Member Countries)
- Increase dialogue and discussion with other sectors on issues relevant to climate change (Member Countries) that due consideration be given to the contribution from fisheries and aquaculture as the main food production sector, when developing respective national policy action plans to minimize their impacts to climate change (Member Countries)
- Use the climate change as an opportunity for fisheries related agencies to pro-actively approach higher level authorities in assisting the affected sectors to get supportive measures from the government, e.g. appropriate subsidies, pricing policy, poverty alleviation program, etc. (Member Countries)

Integrate climate change into existing fisheries program frameworks

- Identify (Member Countries) and monitor vulnerable fishing communities that will be submerged by sea-level rise or affected by erosion, destruction of natural habitats, storms as well as those affected by fisheries and aquaculture activities (SEAFDEC and Member Countries)
- Identify and develop appropriate indicators for monitoring and assessing the impacts of climate change to fisheries resources and aquaculture, e.g.: water cycle, change in season and temperature, seawater intrusion, fisheries resources, indicator species (SEAFDEC and Member Countries)

Marine Fisheries

- Integrate climate change into existing marine fisheries program frameworks
- Identify (Member Countries) and monitor vulnerable fishing communities that will be submerged by sea level rise or affected by erosion, destruction of natural habitats, storms as well as those affected by fisheries and aquaculture activities (SEAFDEC and Member Countries)
- Identify and develop appropriate indicators for monitoring and assessing the impacts of climate change to fisheries resources and aquaculture, e.g.: water cycle, change in season and temperature, seawater intrusion, fisheries resources, indicator species (SEAFDEC and Member Countries)

Inland Fisheries

- Collaborate with relevant agencies (e.g. WorldFish Center and MRC) in conducting research activities and develop a model on the impact of climate change to flooding (SEAFDEC/Member Countries)
- Undertake program on management of inland fisheries during the dry season (establishment of refuge) in order to alleviate the impact of climate change on the rural people's livelihood (Member Countries)
- Undertake program on wetland management in the broader context (Member Countries)

Aquaculture

- Investigate the possible impacts of climate change to aquaculture, e.g. stratification and eutrophication, freshwater shortage in dry season, flooding in rainy seasons, sea water intrusion, increasing feed requirement for aquaculture, change in availability of seedstocks, disease susceptibility, etc. (SEAFDEC and Member Countries)
- Adapt aquaculture technologies and practices in response to the impact of climate change (SEAFDEC and Member Countries), e.g.:
 - Recycling of nutrient water in shrimp ponds
 - Selective breeding of species to develop seedstocks with wider tolerance to environmental changes
 - Development of eco-friendly feeds
 - Development of alternate feed materials (e.g. earth worms)
 - Promotion of the culture of lower trophic level species with appropriate HRD programs

Minimizing impacts from fisheries/aquaculture to climate change

- Undertake energy saving measures, and promote the use of alternative sources of energy (SEAFDEC and Member Countries)
- Fully utilize low-economic value fish species (e.g. jellyfish) with value-added processes, for human consumption (Member Countries)

Information Collection and inter-agency coordination

- Compile information from local communities and stakeholders, e.g. through community networking (Member Countries)
 - Encourage inter-agency coordination and sharing/mobilization of expertise (SEAFDEC and Member Countries)
 - Facilitate sharing of information specifically on adaptive measures relevant to climate change and fisheries/aquaculture (SEAFDEC)
- At the end of the consultation, it was recommended that the outcomes from this Consultation would be submitted to the higher authorities of ASEAN and SEAFDEC for consideration and policy support.



Installation of mariculture parks in the Philippines, where 50 parks/zones have been established as of April 2010 and another 9 were scheduled for launching

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Responsible Blood Cockle Fisheries Management in Petchaburi Province, Thailand: An Ecosystem Approach to Fisheries Management

Phattareeya Suanrattanachai, Rattana Tiaye and Yuttana Theparoonrat

In Thailand, blood cockle (*Anadara granosa*) is a popular species exploited for its economic value. As reported by FAO, the consumption by the Thais of this species far exceeded local production. In order to address the high demand for blood cockle, the Government of Thailand on one hand chiefly imported blood cockle seeds from Malaysia, and on the other hand, the Department of Fisheries of Thailand has been promoting the culture of blood cockle in many coastal provinces of the Gulf of Thailand. Considering that blood cockles are economically valuable, the commercial and small-scale fishers heavily exploit this commodity, and as a result its production had rapidly declined accordingly.

The lessons learned and experience gained (Fig. 1) from the small-scale fishers of Ban Bang Khunsai Village, Bang Khunsai Sub-district, Ban Laem District, Petchaburi Province (Fig. 2) on blood cockle fisheries management provides insights on the process and responsible practice of fisheries management as well as on local fishers' participation in the management, an example of a cohesive practice of ecosystem approach to fisheries management. In addition, it should also be noted that such practice and the local fishers' participation in management has been coherent with creating sustainable livelihoods and promoting integrated management towards sustainable fisheries (FAO, 2010). In terms of livelihood sustainability, the local fishers were able to earn income by collecting blood cockles and selling the produce to markets. Additionally, local fishers practice integrated management approach by conserving the mangrove forests and conducting surveillance on irresponsible fishing practiced in the area.



Fig. 2. Map of Bang Kunsai Village, Bang Khunsai Sub-district, Ban Laem District, Petchaburi Province

Valuable Lessons Learned

Ban Bang Khunsai Village is located along the coast of the Gulf of Thailand and has mangrove forests as important local ecosystem. The mangrove forests provide various services such as ecological service to both animals and aquatic resources. The forests also potentially provide flora for local resident to exploit for subsistence and other marketable products (Alongi, 2002). A local resident cited that he and other villagers depended mainly on mangrove forests and aquatic resources to generate income for their households.

During the last two decades, the local residents exploited the aquatic resources and deforested the mangroves without care of what will happen in the future (Fig. 3). Moreover, a local resident also mentioned that fishers with cockle dredgers as well as hand collecting fishers compete to exploit the cockle resource to earn income. Consequently, the degraded mangrove forests led to decline of the aquatic resources particularly the blood cockle, seriously affecting the local residents. While the mangrove forests continued to decline, the blood cockle and other aquatic species were becoming scarce. There was no doubt that the local residents also lost their source of income and were confronted with hardships with no means of livelihood. When the blood cockle resource had deteriorated due to irresponsible and competitive exploitation, many local residents left the village and moved to work in urban areas.

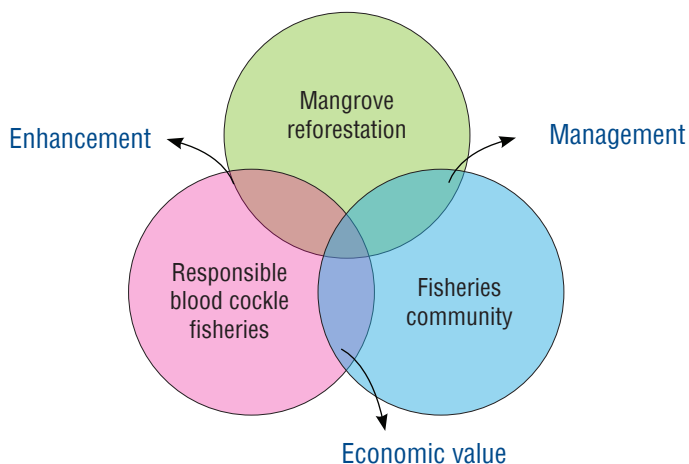


Fig. 1. Lessons learned and experience gained on cohesive interaction in responsible blood cockle fisheries management



Fig. 3. Deterioration of mangrove forest in Ban Bang Khunsai Village due to irresponsible exploitation

nursing grounds of many aquatic resources. Additionally, re-plantation of the forests would also enhance the habitats of the aquatic resources therefore, supporting the very vital link of the mangrove resources with the resources that sustain capture fisheries and aquaculture production (Rönnbäck, 1999). Specifically in muddy areas next to mangrove forests, abundant blood cockle resource could be found (Fig. 5). In order to strengthen the management of the species, the local residents formed a blood cockle conservative group in 1994. The group designated the areas for cockle conservation, covering about 27 km². Recently, the group has more than one hundred members.

Management and Surveillance

The members of the blood cockle conservative group revealed that attention is paid and efforts are exerted to safeguard the designated cockle conservation areas for enhancing new recruitment of the species. Moreover, the provincial and district government offices provided support to the group to enable them to execute their activities. In this connection, the group has established their own regulations to protect the cockles from irresponsible harvesting. The first regulation is cockle size restriction where local residents are not allowed to catch the size of cockle which is smaller than 2.6 cm, and the second is to prohibit the operation of illegal fishing gear in the designated cockle fishing grounds. In order to implement the second regulation, the group has set up a surveillance unit to monitor any illegal fishing operations and encroachment into the conservation areas.

Accordingly, the society and economy of the village had collapsed. Most heads of families left for the city to work while many young local residents also moved to urban areas to find work. The women, children and elderly people remained in the village during that time, making the village society became vulnerable. In addition, the low purchasing power of local residents led to low dynamic of the village economy.



Eligible management

Upon recognizing the impacts of the declining mangrove forests that resulted in the slack of the social and economic development of the village, the remaining residents decided to put initial focus on reforestation of the mangrove forests to enhance the ecological services that the forests could ultimately provide them. After receiving support from nearby Mangrove Forest Station Office, the villagers organized mangrove reforestation and conservation activities with the objective of sustaining the forests as source of natural capital and to revitalize the once rich aquatic resource (Fig. 4).



Fig. 4. Mangrove reforestation

The villagers were aware that the forest areas are credible and vigorous source of food, and serve as spawning and



Fig. 5. Blood cockle fishing ground in Ban Bang Khunsai Village

The surveillance unit monitors with a tentative schedule but implements the regulation by seizing the fishing boat and corresponding gear found to have encroached in the said areas. All seized properties are kept in a community storing plant called boat cemetery (Fig. 6). Arrested fishers are sent to court and in most cases are required to pay a fine before redeeming their fishing equipments. If the arrested fishers could not comply with the requirements, the group would sell all seized fishing assets out and the money obtained would be used to defray the operating costs of the group. Moreover, in order that the group's surveillance unit could seriously conduct monitoring of the cockle areas, the Bang Khunsai Sub-district Administrative Organization allocated a budget of Thai Baht 100,000 to the group for fuel expenses in their surveillance activity.



Fig. 6. The village boat cemetery

Revitalize Livelihood and Better Society

In the mangrove and blood cockle conservation areas, the group's regulations and surveillance are significantly carried out, and as a consequence the cockle resource had continued to improve. A local resident stated that there are now one thousand blood cockle collectors including those coming from adjacent villages and generate income from blood cockle collection. One blood cockle collector declared that he had been collecting cockles by hand for more than 30 years. He said that his fishing equipments for collecting the bivalves include boat, mud-ski board, plastic box, and plastic bag (Fig. 7).

When tide is low at daytime, a cockle collector goes to the cockle fishing ground at 0700 or 0800 hrs and return to shore at 1400 hrs. Additionally, when tide is low at night-time, he leaves the shore at 1900 hrs and come back to shore at 0300 or 0400 hrs of the next day. During the peak fishing season, a cockle collector could earn income of Thai Baht 500-700 per trip while off fishing season, a collector could get an income of Thai Baht 100-200 per trip. Recently, the price of blood cockle is Baht 15-16 per kg (interview in August 2010, US\$ 1.0 = Baht 30.0).

The minimum income of Thai Baht 100-200 per trip is equivalent to US\$ 3.33-6.67, so that blood cockle collectors



Fig. 7. Blood cockle collection and equipments used in the operation

can earn income higher than the poverty line defined in Thailand, which is lower than US\$ 2.0 per day. This indicates that the collectors can secure their purchasing power to contribute to the economic development of the village. The abundance of blood cockle does not only lead to the development of the village economy, but also improves the village society considering that many local residents who moved out have returned to the village to engage in cockle fisheries. These local residents are the important manpower who could fundamentally drive the village economy and at the same time maintain their culture and society.

Precaution and Security

Competition in collecting blood cockles is not only among the small-scale shellfish collectors but also with fishers operating the cockle dredge fishing boats. The latter stakeholders have higher potentials and efforts in terms of fishing gear, technology and labor to exploit the bivalves than the former. A public relation officer of the blood cockle conservation group remarkably pointed out that the local users collect blood cockle by hand in one hour and accordingly, they earn income of Baht 50. However, a blood cockle dredge operation could earn an income of Baht 5,000-10,000. This is major reason for the prohibition of dredge operation in coastal areas of the village 3 km from the shoreline. Nowadays, the use of scoops for collecting the bivalves had been illegally used. To prevent this latest fishing gear operation, the surveillance unit and other group members are altruistically monitoring the use of scoops in the cockle conservation areas. Nevertheless, the villagers also recognized the fact that the blood cockles could be abundant or scarce in accordance with their natural fertilization rate, so that if the natural fertilization is low consequently, the blood cockle resource could severely decrease.

Conclusion

Responsible blood cockle fisheries management implemented by the local residents of Ban Bang Khunsai Village has provided good lessons and experience for tangibly practicing the ecosystem approach to fisheries. Both integrated management and sustainable livelihood approaches were definitely handled by local residents through their active participation in the resource management. Such integrated management could be seen from the people's participation in mangrove reforestation in order to secure the natural capital and maintain the ecological services that sustain production from capture fisheries. The amount of income derived from cockle collection and the increasing number of bivalve collectors employed could be indications on how the

local residents react to such accessible and sustainable livelihood. Based on such experience therefore, the local residents have more reasons to protect their social rights to access the bivalve resources from commercial fishing boats by setting and implementing the regulations by the blood cockle conservation group. Meanwhile, the regulation limiting the size of bivalves to be harvested coupled with the designation of the conservation area are effective applications to promote rights-based fisheries for sustainable development. Nevertheless, the promotion of social rights and rights-based fisheries in fisheries community strongly needs legitimate policies for proper application in the fisheries communities.

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Fisheries Human Resource: Gaps and Requirements of Southeast Asia

Ahmadi, Halimah Mohamed, Ngo Thi Thanh Huong, Nopparat Nasuchon, Aung Naing Oo, Akhane Phomsouvanh, Hort Sitha, and Pierre Easter Ladrado Velasco

SEAFDEC conducted a survey of the Existing Human Resources and Expertise in the ASEAN countries in order to review the available human resources in fisheries in the region, and identify the gaps and areas where human resources may be limited and would be required in the future. The survey was also envisaged to support human resources development (HRD) in fisheries by building and enhancing the capacity of fisheries officials, government officials engaged in fisheries activities, as well as other stakeholders, while recognizing that it is through HRD that the contribution of fisheries to food security could be sustained and further enhanced. The survey specifically aims to determine the availability of expertise in various disciplines of fisheries in the fisheries-related agencies and institutions in the ASEAN countries; and identify the areas where fisheries human resources are limited and where further HRD activities may be required in the future.

Fisheries is one of the most important sectors contributing to socio-economic developments in the Southeast Asian region. While moving towards global competitiveness, countries in the region have been confronted with challenges threatening the sustainable development of fisheries resulting from irresponsible utilization of the fishery resources, increases in trans-national and trans-sectoral issues, stringent requirements for safety, quality and traceability of fish and fisheries products in the world market, as well as other emerging issues including the impacts of climate change to fisheries and aquaculture. In view of such challenges, the availability of human resources in the relevant fisheries disciplines is very crucial for the efforts of the countries to address such challenges. SEAFDEC and the ASEAN had always recognized the importance of human resources in the sustainable development of fisheries. As a matter of fact, the Resolution for Sustainable Fisheries for Food Security adopted during the ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security in the New Millennium: “Fish for the People” organized in 2001, specified the need to: “Acknowledge the need for enhanced human resource capabilities at all levels and encourage greater involvement by stakeholders to facilitate consensus and compliance in achieving sustainable fisheries” and “Mobilize regional technical cooperation to reduce disparities and promote solidarity among ASEAN Member Countries”. In order to ensure the long-term availability of human resources for sustainable development of fisheries, it is necessary to

review and have a clear picture of the current availability and gaps of relevant expertise, as well as the future challenges and other relevant information necessary to address such gaps and requirements of the region as a whole.

Survey of Existing Human Resources and Expertise in the Southeast Asian Region

Starting in early 2010, SEAFDEC initiated the survey on the “Existing Human Resources and Expertise in Fisheries in the ASEAN Member Countries” through questionnaires distributed to ASEAN countries to determine the existing human resources and expertise in fisheries-related governmental agencies, governmental universities/academes, private sectors and private universities and the academe. The questionnaire primarily focused on eight disciplines of fisheries, namely: fisheries biology, capture fisheries, fisheries management, aquaculture, fisheries post-harvest, laws and legislations, cross-cutting issues, and others, with more detailed disciplines under each scope. The inputs from the countries indicated in the returned questionnaires were compiled and analyzed by the Members of the Regional Fisheries Policy Network (RFPN) stationed at the SEAFDEC Secretariat in Bangkok, Thailand.

Brunei Darussalam

Brunei Darussalam has higher number of expertise in capture fisheries than in other areas. The most number of experts are in the 45-54 years old age range followed by 35-44 years old, where the experts were mostly men. However, for the younger age group of 25-34 years old, there were more women. Although in general, the available experts in fisheries were mostly men (> 74%) and in certain areas such as fisheries biology and capture fisheries, almost all experts were men, it should be noted that in Brunei Darussalam both men and women have similar working opportunities. The higher number of men than women may be due to their preference and the nature of some activities which could be more suitable for men than for women.

From the questionnaire survey, it could be gleaned that the expertise available in the country would not be sufficient to address the challenges and conditions of the fisheries industry (**Table 1** and **Fig. 1**). In particular, from the results of the survey it was indicated that climate change is a very

Table 1. Number of experts¹ in each discipline by gender and age group, Brunei Darussalam

Discipline	Gender		Total	Age Group				
	M	F		< 25	25-34	35-44	45-54	≥ 55
1. Fisheries Biology	11	1	12	0	0	4	7	1
2. Capture Fisheries (marine and inland)	29	0	29	0	0	11	18	0
3. Fisheries Management	10	7	17	0	0	7	10	0
4. Aquaculture	5	9	14	0	5	2	7	0
5. Post-harvest and trade	2	4	6	0	2	0	4	0
6. Laws and Legislation	2	0	2	0	0	0	2	0
7. Cross-cutting Issues	11	3	14	0	0	6	8	0
8. Others	9	7	16	0	0	6	10	0
Total	79	31	110	0	7	36	66	1

¹ At the Department of Fisheries and University of Brunei Darussalam

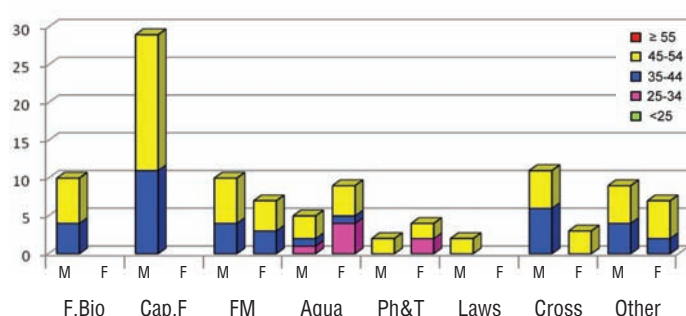


Fig. 1. Number of experts by age group, gender and discipline, Brunei Darussalam

critical concern of the country but there are no expertise in such area in the country. In addition, there are also other fisheries disciplines where there is a need to further enhance the available expertise to enable the country to confront the emerging challenges especially in fisheries physiology, ecology, population dynamics, among others.

Cambodia

The Kingdom of Cambodia has an area of 181,035 km² and has two water ecosystems rich in fisheries biodiversity, the inland and marine waters. The inland ecosystems of Cambodia include the unique and beneficial hydrological system of the Mekong River and its tributaries, and the Tonle Sap Great Lake watershed, which together form a huge natural wetland covering about 20% of the country's total territory during the peak flood period in the rainy season. As for its marine waters, Cambodia has a small coastline of only about 435 km. The fishing activities in Cambodia's Exclusive Economic Zone (EEZ) comprise two main groups: coastal and commercial fisheries. There are four provinces of the country that border the sea: Koh Kong, Sihanoukville, Kampot and Krong Kep. The Fisheries Administration (FiA) of Cambodia supports the long-term human capacity development plan to ensure the availability of human resources in fisheries in the future for the sustainable development of fisheries, food security and food safety. The FiA has identified experts based on their performance and specialization (Table 2 and Fig. 2).

From the statistics on HRD of the FiA, there were 150 experts where female experts comprised only 8%. In the eight disciplines in fisheries, only few women were employed, *i.e.* in the field of fisheries biology (33%), fisheries management (50%), and post-harvest (17%). The women experts belonged to the 55 years old age range or 50% of the female staff, 45-54 years old (17%), 35-44 years old (25%) and 8% in the 25-34 years old group. The results further indicated that women were not involved in fisheries management, aquaculture, law and legislation and others. In this regard, it would be necessary for the FiA to encourage more women to be involved in each discipline of fisheries. In terms of the age ranges of the experts, 50% were over 55 years old, 35% belonged to the 35-44 years old group, 9% in the 25-34 years old range, and 6% in the 45-54 age group. Moreover, there is also comparatively higher number of experts in fisheries management followed by aquaculture and capture fisheries. However, most of the available experts are more than 55 years old.

Indonesia

The Ministry of Marine Affairs and Fisheries (MMAF) or Kementerian Kelautan dan Perikanan is the principal agency responsible for marine fisheries sector planning, management and administration in Indonesia. The Ministry comprised five Directorate Generals, namely: Aquaculture; Capture Fisheries; Marine, Coastal and Small Islands; Marine and Fisheries Resource Surveillance and Controlling; and Fisheries Product Processing Marketing; three Agencies, namely: Marine Affairs and Fisheries Research; Human Resource Development; and Fish Quarantine, Quality Control and Fish Product Safety; the Secretariat General; the Inspector-General; and Advisory Staff providing expertise to the Minister in specific fields. The information on the existing human resources and expertise in the MMAF provided to SEAFDEC may still be insufficient in terms of the actual number of experts as it did not cover all the technical directorates (*e.g.* Directorate General of Aquaculture).

Table 2. Number of experts in each discipline by gender and age group at the FiA, Cambodia

Discipline	Gender		Total	Age Group				
	M	F		< 25	25-34	35-44	45-54	≥ 55
1. Fisheries Biology	10	4	14	0	0	7	0	7
2. Capture Fisheries (marine and inland)	24	0	24	0	0	10	2	12
3. Fisheries Management	46	6	52	0	10	14	2	26
4. Aquaculture	30	0	30	0	0	11	4	15
5. Post-harvest and trade	6	2	8	0	1	2	1	4
6. Laws and Legislation	0	0	0	0	0	0	0	0
7. Cross-cutting Issues	20	0	20	0	2	8	0	10
8. Others	2	0	2	0	0	1	0	1
Total	138	12	150	0	13	53	9	75

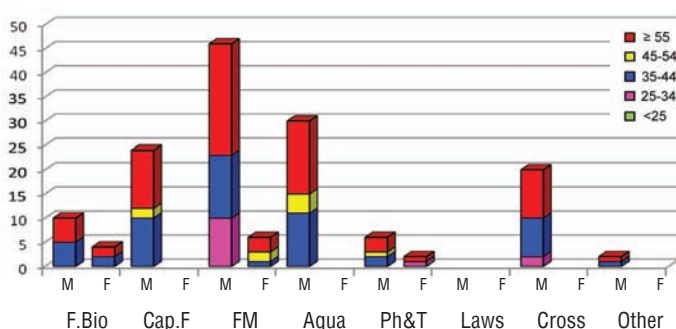


Fig. 2. Number of experts by age group, gender and discipline, Cambodia

The data presented are only the rough estimates as the result of survey does not fully represent the whole profile of Indonesian fisheries experts. Thus, of the more than 10,000 staff of MMAF, only 1,185 experts (12%) in various fisheries-related disciplines were verified, comprising 762 males and 423 females (Table 3 and Fig. 3).

As indicated in Table 3, although in the overall the male experts seemed to be dominant in all fields of expertise (ratio of male to female is 1.8:1.0), the female experts also play an important role in some working areas such as post-harvest and trade, fisheries management and fisheries technology extension and transfer. The survey also revealed that there were almost four times as many males than

females engaged in the capture fisheries (ratio is 3.8:1.0), indicating broad ranges of their tasks and functions. Moreover, there seems to be lack of gender-technical expertise in the fields of aquaculture, fisheries biology, law and legislation, and cross-cutting issues (Fig. 3).

Results of the survey also indicated that the highest number of experts belongs to the 25-34 years old age group (474) followed by the 45-54 (319), the 35-44 (292), over 55 years old (56), and the least number in less than 25 years old group (44). Furthermore, there is more concern in the field of Fisheries Biology because 20 experts would be

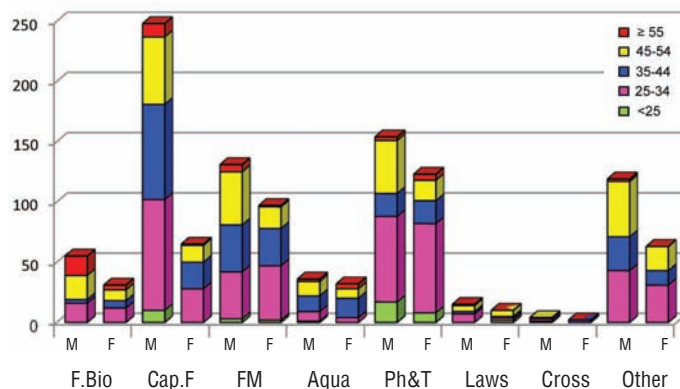


Fig. 3. Number of experts by age group, gender and discipline, Indonesia

Table 3. Number of experts in each discipline by gender and age group at the MMAF, Indonesia

Discipline	Gender		Total	Age Group				
	M	F		< 25	25-34	35-44	45-54	≥ 55
1. Fisheries Biology	55	31	86	0	28	9	29	20
2. Capture Fisheries (marine and inland)	248	65	313	10	120	101	70	12
3. Fisheries Management	131	97	228	5	84	70	62	7
4. Aquaculture	36	32	68	1	12	29	20	6
5. Post-harvest and trade	154	123	277	25	145	38	61	8
6. Laws and Legislation	15	10	25	2	9	3	10	1
7. Cross-cutting Issues	4	2	6	1	2	2	1	0
8. Others	119	63	182	0	74	40	66	2
Total	762	423	1185	44	474	292	319	56

Table 4. Number of experts in each discipline by gender and age group in Lao PDR

Discipline	Gender		Total	Age Group				
	M	F		< 25	25-34	35-44	45-54	≥ 55
1. Fisheries Biology	1	0	1	0	0	0	1	0
2. Capture Fisheries (marine and inland)	3	0	3	0	0	1	2	0
3. Fisheries Management	4	0	4	0	0	1	3	0
4. Aquaculture	38	12	50	0	22	18	8	2
5. Post-harvest and trade	0	0	0	0	0	0	0	0
6. Laws and Legislation	0	0	0	0	0	0	0	0
7. Cross-cutting Issues	0	0	0	0	0	0	0	0
8. Others	0	0	0	0	0	0	0	0
TOTAL	46	12	58	0	22	20	14	2

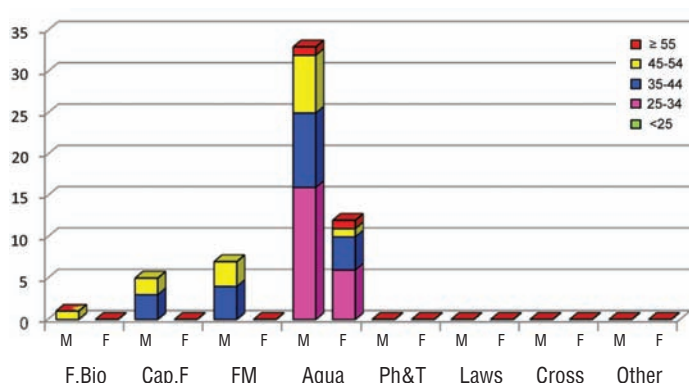


Fig. 4. Number of experts by age group, gender and discipline, Lao PDR

approaching retirement age (over 55 years old), and thus, more young experts should be encouraged to be involved not only in this discipline but in various fields of expertise.

Lao PDR

It was recognized that Lao PDR lacks well-trained and experienced personnel at all levels and in all sectors (Table 4 and Fig. 4), posing a serious concern on the country's development. Moreover, as efforts are made to develop its human resource base, the demand for qualified, skilled or appropriately trained personnel, particularly managers, is ever increasing in view of the country's rapid economic development. Thus, there is an urgent need to make sustainable improvements in both the number of trained personnel and the quality of training to be provided.

As shown in Table 4, the highest number of experts was in aquaculture followed by fisheries management and capture fisheries, while most of the experts are available in the age range between 25-34 and 45-54 years old. Therefore, for the sustainable development of its fishery resources, the country should put more focus in its development efforts on formal and non-formal education, as well as in vocational skills training. Human resource development activities should also be closely linked with the future needs and requirements of both the public and private

sectors. Strengthened human resource capacity in all stages of development activities in Lao PDR would reduce its dependence on external technical assistance.

Malaysia

In Malaysia, full retirement age for all government servants is 58 years old. But optional retirement is also possible at any time between the 55 and 56 years old or under as recommended by the medical board. Planning and review of human resources in fisheries are in line with the organization's goals, missions, visions and values for 10, 15 years, and so on. The process involved identifying the areas or disciplines, activities, the number of staff to be hired, training, salary rates, operational budget, working environment, benefit, and health among others.

The human resource information based on the questionnaire survey comprised those from the Department of Fisheries Malaysia (DOFM) and universities in the country, namely: University of Malaya, University Malaysia Terengganu, University Sains Malaysia, and University Perguruan Sultan Idris Malaysia. The Department of Fisheries Malaysia included its support staff as experts while the universities considered only the academic staff. The study also considered the fact that one person may have more than one area or subject of expertise.

The results of the survey indicated that there were 1,198 experts in fisheries-related disciplines at the DOFM and in the four participating universities in Malaysia as shown in Table 5 and Fig. 5, of which 76% (911 experts) were male and only 24% (287) were female. The sub-areas with the highest number of experts were Fisheries Management (504 experts) and Aquaculture (328 persons). There was no female expert available in Law and Legislation at the DOFM. Although Fisheries Management had the highest number of experts but the ratio between male and female experts was high at 17:3.

Table 5. Number of experts in each discipline by gender and age group, Malaysia¹

Discipline	Gender		Total	Age Group				
	M	F		< 25	25-34	35-44	45-54	≥ 55
1. Fisheries Biology	61	35	96	1	17	20	13	45
2. Capture Fisheries (marine and inland)	89	11	100	0	43	11	25	21
3. Fisheries Management	422	82	504	0	193	140	133	38
4. Aquaculture	241	87	328	0	179	31	45	73
5. Post-harvest and trade	63	59	122	0	37	60	19	6
6. Laws and Legislation	13	2	15	0	0	2	7	6
7. Cross-cutting Issues	15	7	22	0	7	0	7	8
8. Others	7	4	11	0	1	5	3	2
Total	911	287	1198	1	477	269	252	199

¹ At the Department of Fisheries Malaysia and universities in Malaysia

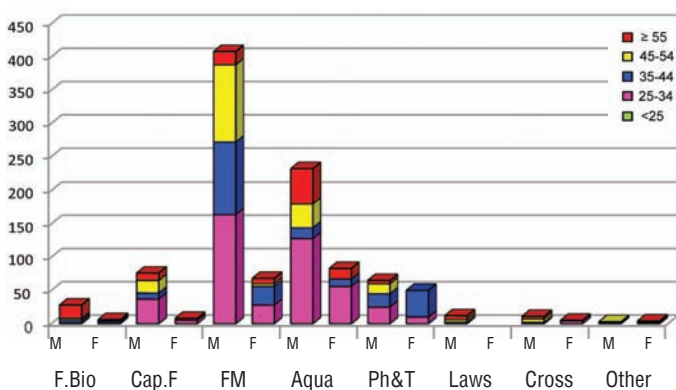


Fig. 5. Number of experts by age group, gender and discipline, Malaysia

The result of the survey however, was not representative of the whole scenario of Malaysian fisheries experts due to poor response from the institutions. As a result, this study could not conclude whether Malaysia has sufficient number of fisheries experts or not. Nevertheless, more accurate information about the total number of academic staff in universities could be collected if the questionnaire was made as simple as possible. In addition, more detailed information could also be collected from other departments such as Ministry of Science, Technology and Innovations

(MOSTI) which compile all information regarding the researchers (government department and universities). Moreover, it should be noted that those in the age range between 25 to 34 years old are still new to be considered as experts in certain fisheries disciplines, and that management should also consider the cases of sudden death, resignation, and health conditions of skilled employees in order to make the organization work properly.

Myanmar

The fishery sector is considered as the most important sector after agriculture to realize the protein requirements of the people of Myanmar and to attain food security as well as afford opportunity for employment to a large number of fisheries/coastal and rural communities. The country's livestock and fisheries sector contributed 7.5% to national GDP in 2008-2009 fiscal years. Myanmar needs many experts who can contribute knowledge, information, and skills on the various fields/areas of fisheries. The Department of Fisheries (DoF) of Myanmar is the only government institution responsible for fisheries in Myanmar and has the highest number of fishery experts among government and private organizations (Table 6). Fishery experts are also available in private agencies such

Table 6. Number of experts in each discipline by gender and age group, Myanmar¹

Discipline	Gender		Total	Age Group				
	M	F		< 25	25-34	35-44	45-54	≥ 55
1. Fisheries Biology	18	10	28	0	2	5	11	10
2. Capture Fisheries (marine and inland)	20	3	23	2	1	2	5	13
3. Fisheries Management	64	8	72	0	3	3	50	16
4. Aquaculture	179	70	249	4	65	101	55	24
5. Post-harvest and trade	7	31	38	1	4	21	6	6
6. Laws and Legislation	21	2	23	0	0	5	8	10
7. Cross-cutting Issues	1	6	7	0	0	4	2	1
8. Others	12	0	12	0	2	0	1	9
Total	322	130	452	7	77	141	138	89

¹ At the Department of Fisheries of Myanmar, government universities in Myanmar and the private sector of Myanmar

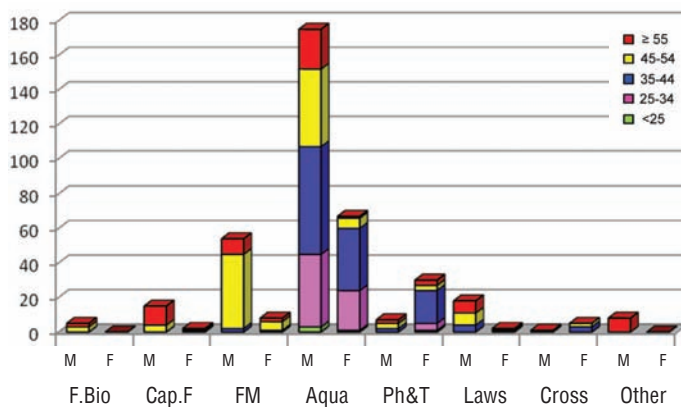


Fig. 6a. Fig. 6a. Number of experts by age group, gender and discipline, Department of Fisheries of Myanmar

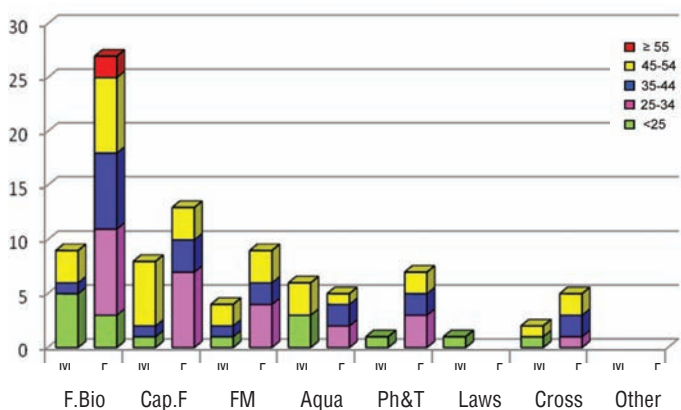


Fig. 6b. Number of experts by age group, gender and discipline, government universities of Myanmar

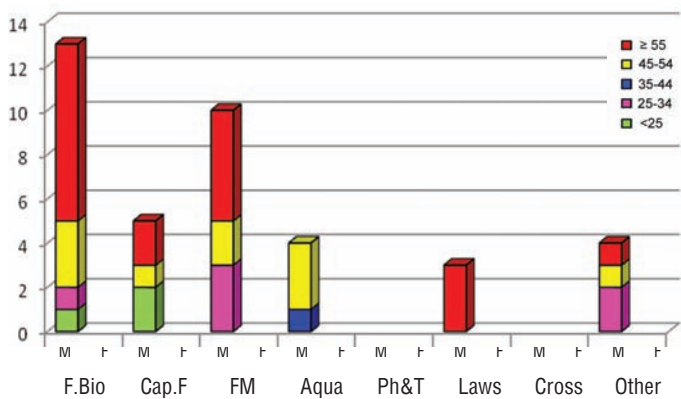


Fig. 6c. Number of experts by age group, gender and discipline, private sector of Myanmar

as the Marine Science Association Myanmar (MSAM), Biodiversity and Nature Conservation Association, and government universities as shown in Fig. 6a, Fig. 6b, and Fig 6c.

The results of the study indicated that at the Department of Fisheries (DoF) of Myanmar there were more male (71%) experts than female (29%). In private agencies only male fisheries experts were available while more women were found in government universities than men, which could be due to the nature/field of work and working environment. In Myanmar, gender does not influence the availability

of expertise in the various fields of fisheries. Aquaculture had the highest number of available expertise and the lowest was in area on cross-cutting issues. The DoF had the most number of expertise in the areas of aquaculture, fisheries management and post-harvest and trade while the government universities had more experts in fisheries biology, and the private agencies have experts in the fields of fisheries biology and fisheries management. However, there were less or insufficient number of “younger” fisheries experts in all areas except in aquaculture. Most of the government universities of Myanmar do not have specific course on fisheries, but fisheries subjects are included only in degrees majoring in Zoology as minor subject. Therefore, there is really a scarcity of human resources in terms of fisheries experts and qualified staff to teach fisheries subjects in government universities.

In terms of age groups, the highest number of experts belonged to the 35-44 age group followed by the 45-54 age groups in the DoF and government universities. On the other hand, private organizations have higher experts belonging in the > 55 and 45-54 age groups. In the DoF, experts were available in all areas and age ranges from 35-44, 45-54, and >55 . However, in the areas of fisheries biology, fisheries management, law and legislation, cross-cutting issues and other (fisheries extension and technology transfer), the DoF lacks young experts (<25 and 25-34 aged groups). While there was no information on fishery experts in government universities in the field of fisheries management, post-harvest and trade, laws and legislation, in private agencies, most fisheries expertise were in the 45-54 and >55 age groups with the highest number in the >55 age group in various fields of fisheries except for post-harvest, trade, and cross-cutting issues.

Myanmar does not have specific fisheries institutions or training department in its educational system. In the DoF, it is necessary that expertise be developed through training in advanced technology at all fisheries areas. Therefore, the DoF of Myanmar is requesting international and regional organizations (e.g. FAO, ASEAN, SEAFDEC, and NACA) and the other Member Countries of SEAFDEC who are leading in fisheries technology to support the country’s technology development and seriously consider providing assistance especially in the areas of aquatic genetic, stock assessment, ecosystem approach to fisheries and aquaculture, fisheries management, and capture fisheries (marine and inland) to fill up the human resources development gaps and requirements, as well as to build up the capacity of the young generation of staff to develop their expertise in fisheries. The government universities and private agencies reported that currently, their available fisheries expertise on the areas of climate change and fisheries, fisheries information and statistics, conservation

and management of aquatic resources, integrated fisheries management, ecosystem approach to fisheries, fisheries for food security, livelihood and poverty alleviation and socio-economic of fisheries were not sufficient and urgently need to be strengthened through human capacity building.

Philippines

The Philippine Bureau of Fisheries and Aquatic Resources (BFAR) of the Department of Agriculture (DA) is the lead

agency mandated to manage, conserve, and protect the country's fishery resources. At present, the country's fishery sector employs over 1 million fishers and fish farmers mostly in the rural areas. Considering its long coastline that stretches over 36,000 km as well as the abundance and vastness of the country's marine resources, BFAR lacks the manpower compliment in terms of human resources to address the many problems confronting the fishery sector. Relevant skills and knowledge have to be acquired through

Table 7. Number of experts in each discipline by gender¹ and age group², Philippines

Discipline	Gender		Total	Age Group				
	M	F		< 25	25-34	35-44	45-54	≥ 55
Fisheries Biology	180	136	316	8	42	22	98	18
Capture Fisheries (marine and inland)	276	46	322	0	27	44	101	45
Fisheries Management	237	117	354	2	46	16	127	36
Aquaculture	286	186	472	0	76	35	171	36
Post-harvest and trade	52	172	224	0	33	19	63	31
Laws and Legislation	30	12	42	0	4	2	9	4
Cross-cutting Issues	149	137	286	0	40	30	113	29
Others	71	63	134	0	17	12	34	10
Total	1281	869	2150	10	285	180	716	209

¹ At the Bureau of Fisheries and Aquatic Resources (BFAR) of the Department of Agriculture, and government universities in the Philippines

² Only for BFAR

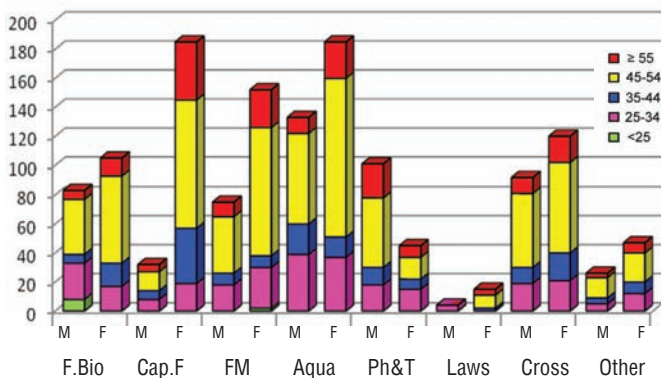


Fig. 7a. Number of experts by age group, gender and discipline, BFAR in the Philippines

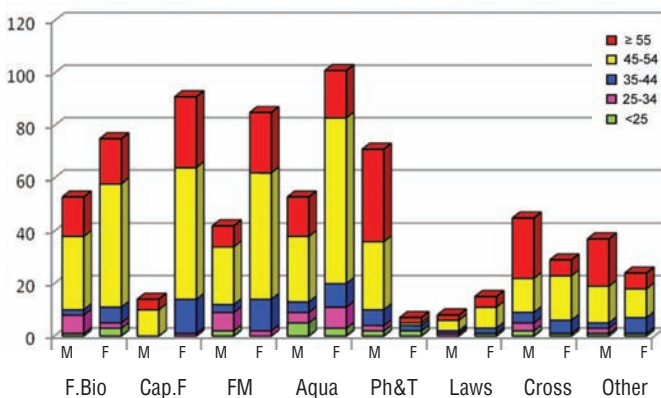


Fig. 7b. Number of experts by age group, gender and discipline in Philippine universities

the development of expertise in various areas particularly in the field of fisheries essential in formulating appropriate strategies to address various threats to food security and the people's livelihoods brought about by the changing climate. Although the responses to the questionnaire survey came from less than one-half of the intended respondents, the results indicated that there were more males (1,281) than females (869) involved or employed in fisheries in the Philippines (Table 7). A significant number of males were involved in aquaculture, capture fisheries and fisheries management which could be attributed to the physical demands in these particular areas of fisheries. On the other hand, the opposite can be observed in the post-harvest and trade sectors where females seemed to outnumber the males while the area on Laws and Legislation in Fisheries had the least number of experts both males and females.

As far as BFAR is concerned, the involvement of age group 45-54 years old is relatively high in the fields of aquaculture followed by fisheries management, cross-cutting issues, capture fisheries, and fish biology (Fig. 7a). This is followed by age group 25-34 years old in all fields except in capture fisheries. It should be noted that except for few experts in Fisheries Biology and Fisheries Management, there are no experts from the age group <25. Notably, the field of Fishery Laws and Legislations accounts for the lowest involvement of experts from all the age groups.

Compared to that of BFAR, in government universities many experts in the age group of 45-54 years old dominated the various fields except for the post-harvest area where age group >55 years old was dominant (Fig. 7b). It is interesting to note that although the next distinct group is the age group >55 years old, and since this is the age group where most experts would be retiring (the optional retirement age of civil servants in the country is 65 years old), there is a wide gap between senior staff and the younger age group.

The results of the survey further indicated that there was not enough manpower and technical expertise in BFAR to conduct research, training, and handle different interventions and challenges on fish production and on climate change. This had inhibited BFAR from proactively addressing the emerging issues on climate change. Shortage is partly blamed on the current government policy that inhibits recruitment of additional personnel. On the other hand, many government universities maintained that they have sufficient expertise or competencies most of whom are PhD and Master's degree holders in the various fields of fisheries. However, there were also few universities which conveyed the apprehension that more of what is remaining from their expertise would soon be retiring and some are also due to retire in the next 4-5 years thus, there is a need to tap or "entice" new and younger recruits.

Most respondents from BFAR asserted on the insufficiency or depletion of experts in certain disciplines and thus, requested to avail of opportunities for further training and education. However, the educational institutions on the other hand, were keen on providing more opportunities in terms of scholarship programs, training and seminar workshops for their faculty and the recruitment of young personnel, and financial aid for instructional and research programs of the universities. Moreover, the need for open admission to programs of Member Countries, sponsored by SEAFDEC, should be given consideration in the formulation of policies. Furthermore, SEAFDEC was requested to provide continuous updates on fisheries

development especially on the latest advancements in aquaculture, post-harvest technologies and capture fisheries, through strengthened linkages among SEAFDEC Member Countries in human resource enhancement such as training programs, scholarships, collaborative activities, and capacity building.

Singapore

For Singapore, the priority scopes of fisheries focused in the areas of post-harvest and trade, aquaculture, capture fisheries, fishery information and statistics, food security and poverty alleviation, and climate change. Although human resources with expertise were available in these disciplines, the country in general still confronted with the situation of lack of manpower and expertise in fisheries. The results of the questionnaire survey showed that both men and women fisheries experts were available in Singapore although in the areas of capture fisheries and fishery management the experts were all men (Table 8). There were gaps of expertise in the areas of importance, particularly on international cooperation and marine affairs, and climate change.

It should however be noted that, with increase use of technologies, changes in laws and regulations for fisheries

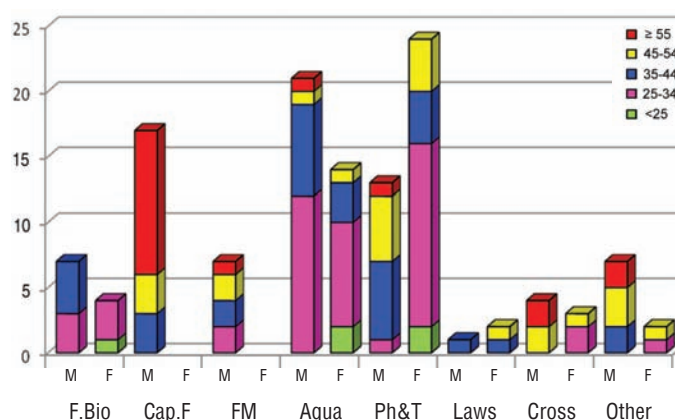


Fig. 8. Number of experts by age group, gender and discipline at the Agri-Food & Veterinary Authority of Singapore

Table 8. Number of experts in each discipline by gender and age group, Singapore

Discipline	Gender		Total	Age Group				
	M	F		< 25	25-34	35-44	45-54	≥ 55
Fisheries Biology	7	4	11	1	6	4	0	0
Capture Fisheries (marine and inland)	17	0	17	0	0	3	3	11
Fisheries Management	7	0	7	0	2	2	2	1
Aquaculture	21	14	35	2	20	10	2	1
Post-harvest and trade	13	27	40	2	15	10	12	1
Laws and Legislation	1	2	3	0	0	2	1	0
Cross-cutting Issues	4	3	7	0	2	0	3	2
Others	7	2	9	0	1	2	4	2
Total	77	52	129	5	46	33	27	18

management, emerging requirements for environmental sustainability aquaculture and fishery practices, and requirements for safety and traceability of seafood products, there are even more needs for human resources to address these emerging challenges and requirements. Thus, in response to emerging challenges, Singapore identified the areas where expertise should be strengthened in the future, *e.g.* aquatic animal health, bio-security in aquaculture, fisheries post-harvest; international fisheries laws and regulations; international cooperation and marine affairs; fishing vessel/gear technology; on-board fish handling technologies; advanced open water technologies for marine and food fish; assessments of impact of large scale operations on the environment; fisheries information and statistics, fisheries extension and technology transfer.

Thailand

Thailand comprises 77 provinces, 23 of which are surrounded by the two main fishery areas, the Gulf of Thailand with a coastline of approximately 2,700 km and the Andaman Sea with 865 km. Marine fisheries is very important for the Thai economy and it is a main source of the world food fish supply. The Department of Fisheries (DOF) of Thailand reported that the aquatic production of Thailand in 2008 was around 3.2 million metric valued at about Baht 3,595.5 million while the country's export of fisheries products in 2007 was around 2.0 million metric tons valued at about Baht 5,966.0 million. About 76.6% of its aquatic production came from marine resources while 23.4% came from inland water resources. Two main organizations are involved in the country's fisheries development; the DOF and the Department of Marine and Coastal Resources (DMCR) with the Thai Royal Navy, Marine Department and Marine Police Division, as supporting agencies.

Results of the survey indicated that in Thailand gender is not much of a concern in fisheries. However, the data showed that the number of males involved in fisheries was higher than the women both at the DOF and government

universities, especially in fisheries management and aquaculture (**Table 9**). Specifically, the number of women experts was higher than that of men only in the post-harvest and trade and in the cross-cutting issues for the DOF but only in post-harvest and trade for the universities. Such discrepancy could be closely related with the processing of fisheries products which customarily requires women's capability.

At the DOF, experts are available in the age range of between 25 to more than 55 years old and the highest number of experts was in the age group between 35-44 years old. As shown in **Fig. 9a**, DOF had the highest

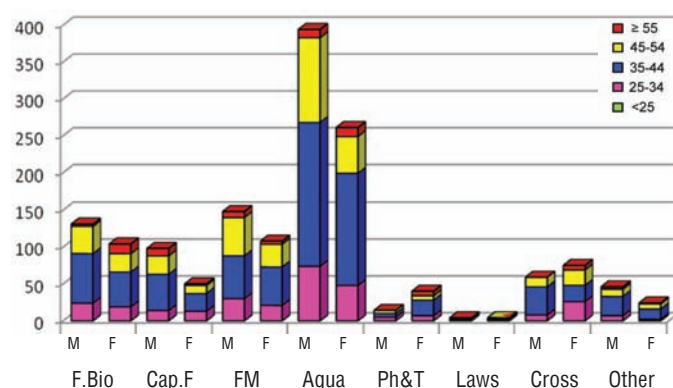


Fig. 9a. Number of experts by age group, gender and discipline at DOF of Thailand

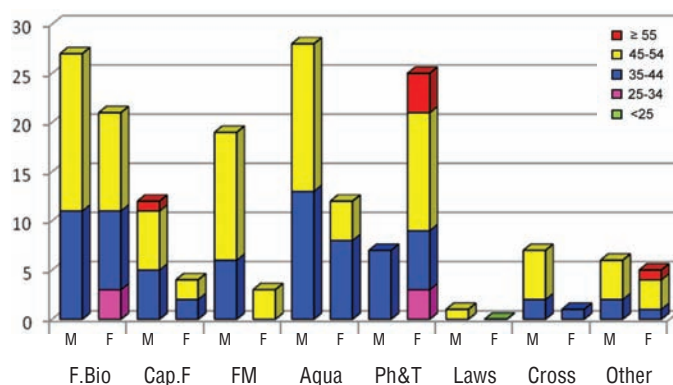


Fig. 9b. Number of experts by age group, gender and discipline in universities of Thailand

Table 9. Number of experts in each discipline by gender and age group, Thailand

Discipline	Gender		Total	Age Group				
	M	F		< 25	25-34	35-44	45-54	≥ 55
Fisheries Biology	158	125	283	0	46	133	88	16
Capture Fisheries (marine and inland)	110	54	164	0	27	80	44	13
Fisheries Management	182	96	278	0	51	116	99	12
Aquaculture	422	273	695	0	122	366	184	23
Post-harvest and trade	25	61	86	0	15	39	22	10
Laws and Legislation	5	4	9	0	2	2	4	1
Cross-cutting Issues	66	76	142	0	34	63	39	6
Others	52	29	81	0	9	43	24	5
Total	1020	718	1738	0	306	842	504	86

number of expertise in aquaculture while the number of expertise was quite high in fisheries management, fisheries biology and capture fisheries. However, the DOF also lacked the expertise in laws and legislation.

For the government universities, although the results could be limited because some universities did not return the questionnaires, the collated data indicated that experts were available in the age ranges between 25 to more than 55 years old and the highest number of experts was in the age group between 45-54 years old (**Fig. 9b**). In terms of areas of expertise, the highest number of experts was in fisheries biology followed closely by aquaculture and post-harvest and trade. While there was also lack of expertise in law and legislation because such experts had knowledge only in the international cooperation and marine affairs, the existing experts in this discipline were in the age range between 45-54 years old. This gap should be considered urgent and needs immediate attention. Moreover, the sampled universities also had few numbers of experts in the cross-cutting issues and in fisheries extension and technology transfer.

Conclusion and Recommendations

Although the survey received partial inputs only, the trend seemed to suggest that in the ASEAN countries, there are shortages in human resources especially in the governmental offices in the important disciplines of fisheries. The gaps and shortage are summarized in **Box 1**.

Therefore, it can be observed in **Box 1** that there are areas where expertise could be insufficient in several countries, especially in such disciplines as Plant Taxonomy, Physiology, Genetics, Population dynamics, Ecology, Limnology, Oceanography, Stock Assessment, Fishing ground/resources exploration, Ecosystem approach to

Indonesia	<ul style="list-style-type: none"> • Physiology • Population Dynamics • On-board fish handling technologies • Backyard and traditional fish processing • Product residual monitoring and analysis • Products certification and labeling • International fisheries laws and regulations
Lao PDR	<ul style="list-style-type: none"> • Plant taxonomy • Physiology • Genetics • Population Dynamics • Ecology • Limnology • Ecosystem approach to fisheries • Conservation and management of aquatic resources • Fisheries socio-economics/bio-economics • Post-harvest and trade (every subjects) • Laws and Regulation (every subjects) • Fisheries information and statistics • Fisheries for food security, livelihood and poverty alleviation • Climate change and fisheries
Malaysia	<ul style="list-style-type: none"> • Plant taxonomy* (expertise available in academe) • Limnology* (expertise available in academe)
Myanmar	<ul style="list-style-type: none"> • Plant taxonomy • Physiology • Genetics • Population dynamics (expertise available in academe) • Ecology (expertise available in academe) • Oceanography • On-board fish handling technologies • Stock assessment* • Ecosystem approach to fisheries • Fisheries socio-economics/bio-economics* • Fish processing factory/plants • Backyard and traditional fish processing • Products certification and labeling • Fisheries for food security, livelihood and poverty alleviation • Climate change and fisheries
Singapore	<ul style="list-style-type: none"> • International cooperation and marine affairs • Climate change and fisheries • Oceanography * • Stock Assessment * • Fishing ground/resources exploration * • Fishing Vessel/gear technology * <p>(Not high priority areas)</p> <ul style="list-style-type: none"> • Plant taxonomy • Population dynamics • Limnology • Integrated Fisheries Management • Fisheries-socio-economics/bio-economics

* Possible shortage in the near future

Box 1. Gaps and shortage of expertise in the Southeast Asian region

Brunei Darussalam	<ul style="list-style-type: none"> • Climate change and fisheries (Not high priority areas) • Plant Taxonomy • Genetics • Limnology • Products Certification and Labelling
Cambodia	<ul style="list-style-type: none"> • Plant taxonomy • Physiology • Limnology • Fishing ground/ resource exploration • Fisheries navigation and engineering • On-board fish handling technologies • Fisheries socio-economics/bio-economics* • Grow-out technologies • Feed and Nutrition • Backyard and traditional fish processing • Product quality monitoring and control • Products certification and labeling • International cooperation and marine affairs • International fisheries laws and regulations

fisheries, Fisheries socio-economics/bio-economics, Products certification and labeling, Climate change and fisheries, International fisheries laws and regulations, International cooperation and marine affairs. Thus, in order to enhance the capacity of existing human resources and ensure the availability of human resources in fisheries in the future, actions at the national and regional levels had been recommended as shown in **Box 2**.

Furthermore, based on the questionnaires and the feedback from the ASEAN countries, the enumerators as well as the

respondents encountered some difficulties (**Box 3**) during the survey, which should be taken into consideration especially when pursuing similar survey in the future.

Box 2. Recommended actions at national and regional levels that need to be considered

At national level, governments (fishery-related agencies) should:

- Establish clear policy and plans in ensuring long-term sustainability of human resources;
- Encourage officials to be involved in relevant national/international workshops, conferences to enhance their knowledge and expertise;
- Carry out measures to acquire expertise in areas where there are currently gaps, by supporting the existing staff in building up their knowledge and capacity in the areas outside their current expertise; and consider recruiting new staff with relevant expertise; and
- Ensure the future availability of qualified human resources particularly for the areas where shortages of expertise are envisaged, through the development of appropriate curriculum in collaboration with fisheries-related academe, and provision of scholarship or research funds on the required scopes.

At the regional level, organizations relevant to fisheries should:

- Conduct regional training programs to support human resources development activities for the existing fisheries-related officials of countries based on their priorities and needs;
- Convene technical events such as consultations, workshops, symposia and conferences to provide opportunities for officials from countries to exchange views and expertise;
- Develop and facilitate exchange programs for the region's researchers and national/regional experts;
- Conduct research activities of mutual interest in collaboration with Member Countries; and
- Arrange study visits for government/non-governmental sectors and other related stakeholders to enhance their experiences and knowledge in the required disciplines.

Box 3. Difficulties and concerns relevant to the survey which need to be addressed in future similar surveys

Many respondents had difficulty in answering the questionnaire and recommended that the term "expert" should be clearly defined and categorized (in terms of educational background, years of service and field of expertise). More accurate information about the total number of universities' academic staff could have been collected if the questionnaire was simpler and provided the criteria of the experts. Due to different interpretation of the term "expert", SEAFDEC should develop guidelines as well as methodology for the analysis of the information provided by the Member Countries.

Data obtained from the survey did not represent the actual/general scenario of the countries in terms of available expertise in the various fields of fisheries due to the poor response from target institutions. More government agencies in the countries should also be involved as well as other concerned institutions and the non-government organizations.

As generally observed, there is lack of fisheries manpower and expertise in the region, especially with respect to the increased use of technology and the changes made in the laws and regulations for fisheries management, the shift in focus of environmental sustainability, the movement of aquaculture towards offshore, and the current changes that lie ahead. ASEAN governments should therefore strengthen their capabilities in addressing the challenges on aquatic animal health, bio-security in aquaculture, fisheries post-harvest, international fisheries laws and regulations, international cooperation and marine affairs, fishing vessel/gear technology, on-board fish handling technologies, advanced open water technologies for marine food fish, assessment of the impacts of large-scale operations on the environment, fisheries information and statistics and fisheries extension and technology transfer. It should also be noted that there would be greater need for expertise in the traceability of seafood products in the future.

Finally, incentives for data collection and compilation should be provided to the enumerators in Member Countries, to encourage them to efficiently collect the necessary information.

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CALENDAR OF EVENTS

Date	Venue	Title	Organizer
2011			
4-8 April	Malacca, Malaysia	43 rd Meeting of SEAFDEC Council	Secretariat
27-29 April	Siem Reap, Cambodia	19 th Meeting of ASEAN Sectoral Working Group on Fisheries (ASWGF)	ASEAN
25-29 April	Iloilo, Philippines	Training Course on Catfish Hatchery and Grow-out Operations	SEAFDEC/AQD
3-5 May	Samut Prakan, Thailand	4 th Working Group Meeting of Information Collection of Highly Migratory Species in Southeast (IPTV Countries)	SEAFDEC/TD
4-17 May	Iloilo, Philippines	Training Course on Seed Production, Nursery & Grow-out of Sandfish	SEAFDEC/AQD
9-11 May	India	22 nd Meeting of NACA Governing Council	NACA
23-25 May	Ranong, Thailand	Regional Training Workshop on Identification of Deep-sea Living Organisms	SEAFDEC/TD
25-26 May	Jakarta, Indonesia	1 st ASEAN Tuna Working Group Meeting	ASEAN
24-26 May	Kathmandu, Nepal	APFIC Regional Consultative Workshop on Implications of Climate Change on Fisheries and Aquaculture	APFIC
19 May-24 June 20 June-26 July	Iloilo, Philippines	Training Course on Marine Fish Hatchery	SEAFDEC/AQD
24 May-10 June	Iloilo, Philippines	Training Course on Cage/Pond Culture of Selected Marine Species	SEAFDEC/AQD
25 May-4 June	Iloilo, Philippines	Training Course on Mangrove Conservation, Management & Rehabilitation	SEAFDEC/AQD
13-17 June	Bangkok, Thailand	ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security Towards 2020 "Fish for the People 2020: Adaptation to a Changing Environment"	ASEAN-SEAFDEC, DOF Thailand
27 June-19 July	Iloilo, Philippines	Training Course on Crab Hatchery, Nursery & Grow-out	SEAFDEC/AQD
28-30 June	Panama	OIE Global Conference on Aquatic Animal Health Programmes: Their Benefits for Global Food Security	OIE
4-6 July (tentative)	Samut Prakan, Thailand	Meeting on Training and HRD Requirements	SEAFDEC/TD
7-8 July (tentative)	Bangkok, Thailand	Inception Workshop on Follow-up Activities to the ASEAN-SEAFDEC Conference	SEAFDEC
25-26 July	Samut Prakan, Thailand	Workshop on Inland Small-scale Fisheries	SEAFDEC/TD
25-30 July	Samut Prakan, Thailand	On the Job Training Program on Identification of Deep Sea Living Organisms in Malaysia	SEAFDEC/TD
To be confirmed	Samut Prakan, Thailand	Regional Training Course on Fisheries Management and Extension Methodology	SEAFDEC/TD
To be confirmed	Samut Prakan, Thailand	Regional Workshop on promotion of MCS to combat IUU fishing in the Southeast Asian Region	SEAFDEC/TD
To be confirmed	Samut Prakan, Thailand	Advanced Regional Training Program on Cetacean Information Gathering and Research Methodology on Cetacean	SEAFDEC/TD
2012			
20-24 Feb	Hyderabad, India	13 th Session of FAO/COFI Sub-Committee on Fish Trade	FAO
2-6 April	Cape Town, South Africa	6 th Session of FAO/COFI Sub-Committee on Aquaculture	FAO
9-13 July	Rome, Italy	30 th Session of FAO Committee on Fisheries	FAO
13 July	Rome, Italy	4 th Meeting of Regional Fishery Body Secretariats Network	FAO

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.

Mandate

To develop the fisheries potential of the region by rational utilization of the resources for providing food security and safety to the people and alleviating poverty through transfer of new technologies, research and information dissemination activities

Objectives

- To promote rational and sustainable use of fisheries resources in the region
- To enhance the capability of fisheries sector to address emerging international issues and for greater access to international trade
- To alleviate poverty among the fisheries communities in Southeast Asia
- To enhance the contribution of fisheries to food security and livelihood in the region

SEAFDEC Program Thrust

- Developing and promoting responsible fisheries for poverty alleviation
- Enhancing capacity and competitiveness to facilitate international and intra-regional trade
- Improving management concepts and approaches for sustainable fisheries
- Providing policy and advisory services for planning and executing management of fisheries
- Addressing international fisheries related issues from a regional perspective



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On the occasion of the Millennium Conference in 2001, a drawing contest was organized for the children in the respective ASEAN-SEAFDEC Member Countries, with the theme "Fish and the Culture". There are the winning drawings from the ASEAN-SEAFDEC Member Countries: Brunei Darussalam (1), Cambodia (2), Indonesia (3), Japan (4), Lao PDR (5), Malaysia (6), Myanmar (7), Philippines (8), Singapore (9), Thailand (10) and Vietnam (11).

