Application of GIS and Remote Sensing for Advancing Sustainable Fisheries Management in Southeast Asia

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Through the adoption of the ASEAN-SEAFDEC Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020 by the Senior Officials of the ASEAN-SEAFDEC Member Countries in June 2011, the countries recognized that various "*management approaches are required to sustainably manage the region's critical coastal habitats, such as mangroves, coral reefs, and sea grasses*," and that "*information on the appropriate measures and interventions should be disseminated to improve fisheries management*." At the same time, the countries also agreed that there is a need to "*enhance the resilience of fisheries communities to participate and adapt to the changes in environmental conditions of inland and coastal waters*" as indicated in the ASEAN-SEAFDEC Resolution on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2020 also adopted in June 2011. In this connection, this article therefore provides some insights on the application of geographical information system (GIS) and remote sensing (RS) technologies as means to advance the development and management of inland and marine capture fisheries in the Southeast Asian region.

The countries in the Southeast Asian region are among the world's highest producers of fish and fishery products from capture fisheries that come from the waters identified by FAO as major fishing areas (**Figure. 1**). In 2014, the world's fisheries production totaled 195.7 million metric tons (MT) of which 94.6 million MT was contributed by capture fisheries while 101.1 came from aquaculture

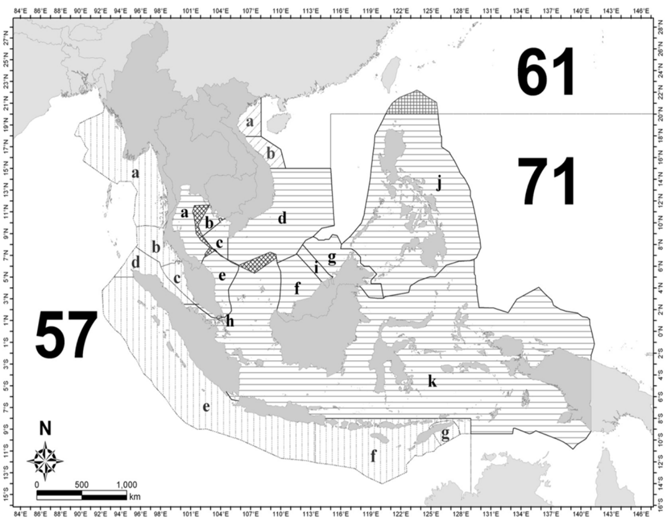


Figure 1. FAO Major Fishing Areas in Southeast Asia (SEAFDEC, 2008)

(SEAFDEC, 2017). Of this total, the Southeast Asian region accounted for about 22% (42.2 million MT) with Indonesia as the region's highest producer generating about 20.6 million MT (SEAFDEC, 2017). With this scenario, effective management of the region's inland and coastal areas as well as its oceans is therefore necessary to enhance the production trend of fisheries and aquaculture in Southeast Asia and ensure food security for peoples not only in the Southeast Asian region but also in the whole world.

There are existing technologies that could be used for better planning and management of fisheries and aquaculture, *e.g.* GIS and RS technologies. The usage of these technologies is therefore worth exploring, especially in obtaining the necessary information for formulating appropriate approaches, policies, as well as management plans for medium and long-term sustainable utilization of fishery resources and environmental facilities for fisheries and aquaculture.

GIS and RS Technologies

GIS can be in the form of computer hardware, software, and data that allows any trained staff to update, manipulate, analyze, and display geographically the referred information (Rahel, 2004). Since GIS integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information, it can provide the unlimited amount of information needed in research (Foote and Lynch, 2015). **Box 1** presents the numerous GIS resources that are available online.

In fact, GIS has many applications related to planning, management, transport/logistics, insurance, telecommunications, and business (Maliene *et al.*, 2011). The application of GIS has various advantages as shown in **Box 2**. Foote and Lynch (2015) added that the numerous innovations, one of which is the use of the GIS, could boost the region's efforts to improve fisheries development and management as it could link a number of technologies, thus emerging as a powerful technology. During the development of the technology, researchers are assured that they could integrate their data and methods

Box 1. GIS Resources
GIS Resources • *http://www.agi.org.uk* - Association for Geographic Information • *http://www.wiley.com/legacy/wileychi/longley/* - Companion website to Geographical Information Systems and Science textbook • *http://www.gis.com* • *http://www.tandf.co.uk/journals/tf/13658816.html* - The International Journal of Geographical Information Science • *http://www.ncgia.ucsb.edu/gissc/* - The NCGIA core curriculum in GIScience • *http://www.rgs.org* - The RGS-IBG Geographical Information Science Research Group • *http://www.ucgis.org* - University Consortium for Geographic Information Science
Softwares • ESRI – *http://training.campus.com* • Google Earth - *http://earth.google.com/intl/en/userguide/v4/tutorials/index.html* • Digital Worlds - *http://www.digitalworlds.co.uk/* • Ordnance Survey: *http://www.ordnancesurvey.co.uk/oswebsite/education/mappingnews/previouseditions/33/p38-39.pdf*
Databases • Ordinance Survey (maps) - *http://www.ordnancesurvey.co.uk* • Office of National Statistics (socio-economic variables) – *http://www.statistics.gov.uk* • English Nature (landcover datasets) - *http://www.english-nature.org.uk/pubs/gis/GIS_Register.asp* • British Geological Survey (small scale bedrock and deposit maps) - *http://www.bgs.ac.uk/products/digitalmaps/data_625k.html* • Earth Science Data Interface (satellite data) - *http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp* (satellite data can be very demanding to set up) • Street map (useful postcode information) – *http://www.streetmap.co.uk*

Box 2. Advantages in the application of GIS
1. Cost savings from greater efficiency GIS is widely used to optimize maintenance schedules and daily fleet movements. Typical implementations can result in a savings of 10-30% in operational expenses through reduction in fuel use and staff time, improved service with a more efficient scheduling.
2. Better decision making GIS is a technology for making better decisions about location. Common examples include real estate site selection, route selection, evacuation planning, conservation, natural resource extraction, etc.
3. Improved communication GIS-based maps and visualizations greatly assist in understanding different situations. They are a type of language that improves communication between different teams, departments, disciplines, professions, fields, organizations, and the public.
4. Better record keeping Many organizations have a primary responsibility of maintaining authoritative records about the status and change of geography. GIS provides a strong framework for managing these types of records with full transition support and reporting tools.
5. Managing geographically GIS is becoming essential to understanding what is happening and what will happen in geographic space. Once it is understood, appropriate actions could be prescribed.

in ways that support traditional forms of geographical analysis, such as map overlay analysis as well as new types of analysis and modeling that are beyond the capability of manual methods. With the application of GIS, it is now possible to map, model, query, and analyze large quantities of data all held together within a single database (Foote and Lynch, 2015).

Correspondingly, a technology using satellite or aircraft-based sensor technologies known as RS is used to detect and classify objects on earth, including those on the surface as well as in the atmosphere and oceans, based on propagated signals (*e.g.* electronic radiation). The instruments used in RS are passive and active instruments (Earth Observatory, 2018). Passive instruments are those that are used to detect natural energy that is emitted from observed source, such as reflected sunlight. The most common passive RS instruments include: radiometer, imaging radiometer, spectrometer, spectroradiometer. While active instruments are those used to illuminate the objects observed using the electromagnetic radiation they provide. The most common active remote sensors include: radio detection and ranging (radar), scatterometer, light detection and ranging (lidar), and laser altimeter.

Application of GIS and RS in Fisheries

In applying GIS to fisheries research, Simpson (1992) suggested that through remote sensing, much data could be generated for GIS applications. The application of GIS in marine environmental research started in the 1980s, when GIS was used as means of locating new sites for mariculture (Mooneyhan, 1985; FAO, 1989). During the early phase of using GIS in fisheries, RS was used to generate marine environmental data relevant for GIS applications.

These data are useful for monitoring fishing effort, tracking pollutants, mapping bathymetry and sea bed habitats, and providing measurements of physical and biological properties in the water column (Carocci *et al*., 2009). For studies on the environmental properties of the oceans, Stuart *et al*. (2011) indicated that the use of RS could provide the overall picture on fish distribution, abundance, migration, and other information necessary for the monitoring and management of the ocean ecosystems.

After mid-1990s, the applications and uses of GIS in fisheries grew rapidly with expanded applications (Meadan, 2001), such as constructing spatially explicit models for fish habitat suitability, especially for mapping the mangrove areas, estuaries, sea grass beds, bottom sediments among others (Carocci *et al*., 2009). Nowadays, there are a number of GIS applications available, ranging from high-power analytical software (or desktop GIS, *e.g.* ArcGIS software) to web-based applications (*e.g.* online ArcGIS, Google Earth).

While the application of GIS in fisheries-related research is increasing, Carocci *et al*. (2009) mentioned four studies with GIS applications (**Box 3**) which could be used to exemplify the advantages of the use of GIS, especially in terms of addressing the various challenges, enhancing awareness and understanding of the GIS technology, displaying the various uses of GIS, utilizing various data sources, and the coverage which include different geographical areas and spatial scales. These examples could be used as references in carrying out GIS-related research in the fisheries sector of the Southeast Asian region.

In 2010, the Project "Societal Applications in Fisheries and Aquaculture using Remotely-sensed Imagery" (SAFARI) organized the International Symposium on Remote Sensing and Fisheries from 15 to 17 February 2010 in Kochi, India. The Symposium discussed the latest developments in RS applications, and the output of which could be used to enhance the application of RS in fisheries and aquaculture research, and especially in the development of potential fishing zones (Stuart *et al*., 2011). It should be noted however, that as recommended during the abovementioned Symposium, the use of RS for the assessment of potential fishing zones (PFZs) should be considered as the most appropriate approach for an

Box 3. Case studies on the application of GIS in fisheries-related research

Optimum time to release juvenile chum salmon into the coastal waters of northern Japan

Considering the decline in salmon stocks worldwide, release of hatchery-reared salmon juveniles into the coastal environment has also been considered by Japan as an economical strategy to address such concern. Miyakoshi *et al*. (2007) used remote sensing data to establish the sea surface temperature which was related to the date of juvenile release as well as the site of release. Results of the GIS-based analysis showed that salmon production, indicated by salmon returns, could be optimized when sea temperature range between 8°C and 13°C and when the juveniles are > 5 cm in length. Such results could provide the maximum benefits from fish stocking operations.

Identification of essential fish habitat for small pelagic species in Spanish Mediterranean waters

Small pelagic fishes such as sardines and anchovies are economically-important species in the Mediterranean coast of Spain. The development of a model that would give the optimum relationship between abundance and location of the species stocks was therefore deemed necessary to define the essential fish habitats (EFH) of the species (Bellido *et al*., 2008). Using environmental variables such as bathymetry, sea surface chlorophyll-a, and sea surface temperatures, the results indicated a substantial inter-annual variability in the distribution and quality of the EFH, which is crucial for the management of these local marine resources.

Development of GIS system for the marine resources of Rodrigues Island

Located in the Indian Ocean and about 600 km from Mauritius, Rodrigues Island is like any tropical island, under pressure from natural resource exploitation and increased tourism activities. The absence of standard information on the marine resources in the Island had hampered the management of the available marine resources. In 2000, a GIS-system was developed (Chapman and Turner, 2004) where the data on the distribution of biodiversity was integrated with the environmental factors controlling the distribution of such resources as well as the human activities such as fishing and conservation activities. A biotope mapping was carried out based on satellite imagery and ground truthing of the waters surrounding the entire Island. The results led to the designation of marine protected areas and development of marine resource conservation measures.

Influence of closed areas on fishing effort in the Gulf of Maine

There had been variety of problems associated with the establishment of closed areas to fishing, which could include "boundary" and "displaced effort" effects, which were also noted in the Gulf of Maine in the Atlantic Ocean off the coasts of Maine, New Hampshire and Massachusetts in the United States of America. Murawski *et al*. (2005) compared fishing effort distribution data for 1990-1993 (pre-area closure) with the effort for 2003 (post-area closure) and concluded that the 2003 effort had been concentrated and about 10% of total effort was deployed within 1.0 km of the closed area boundaries. They added that effort concentration varies in the different closed areas which implied that different fishing densities are related to habitat sustainability, and that there had been positive effect in some closed areas, especially in terms of increased revenues.

Box 4. Projects utilizing the GIS and RS technologies to support sustainable development and management of capture fisheries in Southeast Asia
EcoGIS Project In 2004, the project "GIS Tools for Ecosystem Approaches to Fisheries Management" (EcoGIS) was launched through a collaborative effort between NOAA's National Ocean Service (NOS) and National Marine Fisheries Service (NMFS) and four regional Fisheries Management Councils. The project investigated how GIS, marine data, and custom analysis tools can enable fisheries scientists and managers to adopt the Ecosystem Approach to Fisheries Management (EAFM). The project focused on four main areas: (1) fishing catch and effort analysis; (2) area characterization; (3) bycatch analysis; and (4) habitat interactions.
SAFARI Project Funded by the Canadian Space Agency (CSA), the project "Societal Applications in Fisheries and Aquaculture using Remotely-sensed Imagery" (SAFARI) was carried out in 2007 to facilitate international coordination on the application of rapidly evolving satellite technology to fisheries management. In 2010, the first SAFARI International Symposium was organized with contribution from the Indian Space Research Organization and Ministry of Earth Science on the development of potential fishing zones (PFZs) using satellite information. The Symposium provided a platform for deliberations on the latest developments in the field of RS in relation to fisheries with various case studies using satellite technologies for earth observations.
Fisheries Component of the UNEP/GEF South China Sea Project (SCS Project) The South China Sea Meta-Database was developed by the SCS Project in 2002 (Paterson and Cooper, 2006) with contributions from national governments, academic institutions, and non-government organizations in Cambodia, China, Indonesia, Malaysia, Philippines, Thailand, and Viet Nam. The data set in the meta-database of the SCS Project used information on coastal habitats and resources including sea grass beds, mangroves, wetlands, fisheries, and land-based pollution. This database can be used as a search tool for identifying environmental and fisheries data sets of the area covering South China Sea and the Gulf of Thailand sub-region where the meta-data set from the search can be summarized and downloaded. The SCS Meta-Database can be applied to other projects/initiatives to avoid duplication of effort and resources. In addition, the SCS Project collaborated with the Southeast Asian Regional Learning Center (SEA-RLC), a regional initiative of the global GEF-funded International Waters Project, as well as with the Regional Center for the Southeast Asian System for Analysis, Research and Training (SEASTART RC) to develop the SCS GIS-based data and information (*http://metadata.unepscs.org/metadata*).

ecosystem-based fisheries management to ensure that overfishing does not take place.

In capture fisheries, a number of common issues such as fishing capacity (in terms of fishing vessels, efforts), deterioration of habitats, greenhouse gas emissions from the use of fossil fuels (believed to add impact to global climate change), could be addressed through the use of satellite remotely sensed (SRS) information and vessel monitoring system (VMS) technology, *e.g.* for management of skipjack tuna fisheries in the western North Pacific (Saitoh, 2011). In pelagic fisheries, Saitoh (2011) also reported that there are two aspects in the operational application of the SRS, *i.e.* (1) for identifying PFZs based on the relationship between target species and environmental factors; and (2) for developing the management measures particularly minimizing the bycatch of aquatic endangered species. He also reported that simultaneous analyses of VMS and SRS data could be used to improve operational fishery forecasting models and management measures, *e.g.* in the design of dynamic marine protected areas or to control fishing effort. For the Southeast Asian region, the applications of GIS and RS have supported the sustainable development and management of capture fisheries, some examples of which are shown in **Box 4**.

Key Issues and Challenges

It is likely that currently there are only few regional/national initiatives in Southeast Asia that apply GIS and RS technologies in fisheries. Prior to the application of GIS and RS technologies to fisheries, Nishida (1994) examined the progress on the use of GIS for spatial analysis of the marine fishery resources, and summarized the major challenges as shown in **Box 5**. Although raised in the 1990s, these concerns have not yet been fully addressed, especially in the fisheries of the Southeast Asian region.

When the First International Symposium on GIS in Fisheries Science was organized in 1999, various papers on GIS applications for marine fisheries were presented in different thematic areas, *i.e.* fisheries oceanography/habitats, fisheries resource analysis, remote sensing and acoustics, ecosystems/forecasting, estuary and coastal management, general review, concepts, education, research in progress, and software/database/computer system (Nishida *et al.*, 2001; Nishida *et al.*, 2004; Nishida *et al.*, 2007). Moreover, GIS-based applications had also been promoted in various fora through seminars, conferences, workshops and the like, as well as in publications and scientific journals. However, in spite of such development, GIS applications in fisheries remains

Box 5. Major challenges for GIS applications in the spatial analyses of marine fishery resources (Nishida, 1994)
1. Data • Standardization of data collection structures with adjustment for discrepancies in space or time • Conversion of analog data to digital data • Consolidation of data gathering and databases • Automation of data collection • Establishment of simple database linked to GIS platform • Consideration of 3D or 4D database for GIS • Development of easy methods to access oceanography and satellite information • Development of easy methods to process matrix (raster) information
2. Presentation • Application of enhanced visualization to fisheries GIS • Effective and easy ways to present 3D and 4D parameters of fisheries and oceanography information such as catch, CPUE, temperature, and salinity
3. Stock assessment, prediction, and spatial numeral analyses • Development of linkages between GIS and stock assessment • Applying GIS methods, models, simulation, and geo-statistics in a fluid, dynamic 3D environment • Development of space oriented prediction methods for fishing and oceanographic conditions
4. Fisheries management using GIS • Space oriented fisheries management • Ecosystem-based fisheries management • Essential fish habitats and marine reserves • Fishing effort monitoring systems using global positioning system (GPS) and vessel monitoring system (VMS) • Fisheries impact assessment (development of space-based stock assessment) • Spatial allocation of the results of stock assessments such as MSY and TAC • Monitoring and modeling of quota arrangements
5. Software • Development of user-friendly and high performance fisheries GIS software that can handle simple parameters and also satellite information, and that can perform simple mapping as well as complex integrated spatial numerical analyses
6. Human interaction • Establishment of the international fisheries GIS association for networking to exchange ideas and information • Collaborative and interactive GIS activities in fisheries resource research by fisheries scientists, oceanographers, fishers and fisheries managers for effective, meaningful, and realistic achievements • Fostering a trustful relationship between researchers, fishers, and politicians

at its infancy stage mainly because of the fragmented nature of the fisheries (Meadan, 2001).

Nonetheless, after about two decades of using GIS for the spatial analysis of the fishery resources, some progress had already been achieved, especially in temperate countries but may be not yet in the Southeast Asian scenario because of the abovementioned challenges. Once these challenges are overcome, then GIS will have achieved its significant usage especially in advancing the management of the fishery resources in Southeast Asia.

In a survey of relevant publications issued before 2000, Fisher (2007) noted that most of the publications were qualitative in nature and involved jingle parameters with a few that dealt with multiple parameters although there were some which made use of the quantitative methods. Recently, when Fisher (2007) analyzed the latest publications, he found out that contents of more recent publications now included multiple parameters that adopted the geostatistical techniques, and added that the main thematic areas of fisheries-related research that utilize GIS applications include: habitat mapping, species distribution and abundance, fisheries oceanographic modeling, fishers' activities, and fisheries management.

Considering that fishing activities occur in a large extent of geographical area including inland, coastal, and marine waters, it is necessary to apply spatial analytical methodologies to enhance the management of these ecosystems for sustainable fisheries. Specifically for the sustainable development and management of capture fisheries in the Southeast Asian region, the application of GIS and RS technologies could play prominent role. However, there are key issues and challenges that need to be addressed. These concerns and the possible and suggested applications of GIS and RS are based on regional, sub-regional, and national initiatives in Southeast Asia (**Box 6**).

Way Forward

Applications of GIS and remote sensing technologies are essential to delineate the current condition of fishery resources and to provide information for better harvesting strategy. GIS application is effective for monitoring the

Box 6. Suggested applications of GIS and remote sensing to address the challenges encountered in the development and management of Southeast Asian fisheries

Key Issues/Challenges	Recommended Application of GIS and Remote Sensing Technologies	Objectives/Remarks
Fishing vessels and fleets management	• Vessel monitoring system (VMS) using remote sensing technology for position and speed of the registered fishing vessels at sea • Database for licenses of fishing vessels and fishing gear	• Monitoring of the activities of fishing vessels at sea (currently applied mainly for commercial fishing vessels) • Monitoring the changes in the number of fishing vessels and fishing gears
Conservation and management of fishery resources and habitats in inland, coastal, and marine waters	• GIS-based mapping - Fishery resources (including location and abundance) and habitats - Bathymetry and deep-sea habitats - Fisheries/habitat management, fishing zones, fishing seasons, marine protected areas, fishery refugia, etc. - Oceanographic data (biological, physical, and chemical information, *i.e.* chlorophyll-a, sea surface temperature, salinity, wind, wave, etc.)	• Providing information on inland, coastal, and marine fishery resources of the region that would correspond to in situ data collection for further analysis
Improved collection system for catch and landing data for small-scale and commercial fishing	• Calculation of CPUE and Landing Per Unit Effort (LPUE) and data analysis using ArcGIS and MS Access	• Monitoring the fishing effort by tracking and collecting data on fishing seasons, fishing grounds, and number of fishing vessels and fishing gears used in specified fishing areas, period, etc.
Development of national/sub-regional management plan/policy	• Combination of recommendations in items 1 to 3	• Facilitating and/or developing the appropriate/agreed management plans and policies for fisheries and habitat conservation and management
Traceability of fish and fishery products	• Combination of recommendations in items 1 to 3	• Applicable to the ongoing regional and sub-regional initiatives in the region, *i.e.* ASEAN Catch Certification System (ACDS) and the electronic ASEAN Catch Certification System (eACDS)
Ecosystem Approach to Fisheries Management (EAFM)	• Combination of recommendations in items 1 to 3 and others	• Understanding and improving the performance of EAFM in specific areas • Integrating EAFM with ArcGIS software • Providing information and supporting fisheries management decision-making
Fishery Resources and Habitat Enhancement	• GIS-mapping of fishery resources and aquatic habitats	• Conserving and managing natural habitats and fishery resources for sustainable development and utilization

fishing effort in order to control the harvest/fishing effort level in certain highly exploited fishing grounds.

Moreover, RS technology is useful for forecasting fishing grounds to reduce the inefficiency of fishing activities, *e.g.* time travelling to/from fishing ground, energy consumed for fishing operation by the vessel (Haryo, 2016). Nevertheless, there are a number of areas where GIS and remote sensing could be applied for the sustainable development and management of fisheries in the Southeast Asian region, *e.g.* for the management of fishing capacity and combating IUU-fishing. In addition, by linking real-time information on fishing vessels movement at sea and vessels registration, and the shared information among the countries concerned on landing and fisheries management measures, GIS-based mapping could serve as a useful tool for managing various sources of important information that could be used as basis for formulating appropriate management monitoring, control, and surveillance (MCS) programs.

In this connection, SEAFDEC is now promoting the application of electronic system for traceability of fish and fishery products of the AMS whereby the regional fisheries database together with real-time information *via* RS technology could be used to trace the origin of fish and fishery products throughout the supply chain. Recently, SEAFDEC has facilitated the development of a joint management plan for transboundary fish stock through sub-regional programs including the waters of

Box 7. Future SEAFDEC projects that would make use of GIS and remote sending technologies

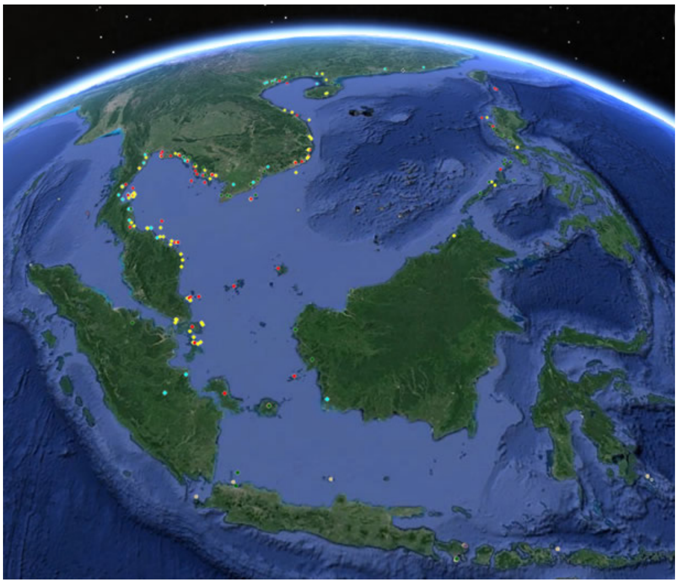
SEAFDEC-Sida Collaborative Project

Referring to activities implemented under the SEAFDEC-Sida Collaborative Project (2017-2019), one of the outputs includes development of GIS-based map for the management of transboundary species in the Gulf of Thailand and the Northern and Southern Andaman Sea. There are three main transboundary species in the Gulf of Thailand, *i.e.* anchovies, Indo-Pacific mackerel, and blue swimming crab. In the Andaman Sea, the transboundary species are neritic tunas (longtail tuna and kawakawa), anchovies, and mackerels (Indian mackerel and Indo-Pacific mackerel). Information inputs from the countries in the Gulf of Thailand and the Andaman Sea sub-regions include data on catch and landing, migratory pattern of transboundary fisheries resources, abundance of fish larvae and area distribution in each monsoon season of the year, fishing efforts (CPUE, number of fishing vessels targeting to catch the target transboundary species), monsoon pattern, environmental information (coastal and marine environment and habitats). This information will be compiled and agreed among the countries whereby the development of a joint management plan for such transboundary species will be based upon the results of data analysis using GIS-based mapping.

Strengthening the Effective Management Scheme with GIS and Remote Sensing Technologies for Inland Fisheries and Aquaculture

SEAFDEC has proposed to Japan-ASEAN Integrating Fund (JAIF) to support the ASEAN Member States (AMSs) in strengthening their respective fisheries management using GIS and remote sensing technologies. With 1-year period of implementation and scheduled to start in 2019, this proposal was developed based on the assumption that information on the environmental changes of various factors in the habitats and aquatic ecosystems affecting the utilization of inland fishery resources, has yet to be sufficiently obtained. This 1-year project will be implemented by collecting catch data at selected fishing grounds of the participating countries to be digitized together with environmental information (geographical and inland water aquatic organisms' habitats based on satellite images obtained from that target sites). All information will be compiled and analyzed by the applications of GIS and remote sensing technologies. The final output from the data analysis could include levels of impact from environmental factors and changes on the inland fishery resources that could be used for effective improvement of inland capture fisheries management.

the Gulf of Thailand and the Andaman Sea by applying GIS-based mapping. Regarding the development of GIS-based mapping for coastal and marine fisheries resources management, SEAFDEC with the financial support from Swedish Government has also initiated sub-regional activities on establishment of a MCS network and management whereby the issues on transboundary fishery stock in sub-regional waters of the Gulf of Thailand and Andaman Sea was initially discussed among countries concerned. In addition, SEAFDEC proposed a new project "Strengthening the Effective Management Scheme with GIS and Remote Sensing Technologies for Inland Fisheries and Aquaculture" which would also make use of the GIS and Remote Sensing Technologies. Details of these two projects are shown in **Box 7**.



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